TECHNICAL PROVISIONS

ATTACHMENTS

for

010 MA 149 F007201C
PHOENIX-CASA GRANDE HIGHWAY (I-10)
I-17 (SPLIT) TO SR 202L (SANTAN)

between

ARIZONA DEPARTMENT OF TRANSPORTATION

and

Pulice Construction, Inc., FNF Construction, Inc., and Flatiron Constructors, Inc., A Joint Venture

Dated as of: January 5, 2021

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TP Attachment 105-1 – Maintenance During Construction

TP Attachment 105-1 Maintenance During Construction		
Element	**Performance Requirement**	**Repair Response**
Graffiti	Maintain all surfaces including barriers, abutments, walls, concrete channels, curbs, cabinets and poles within the Project Limits free of graffiti. Area shall be repainted to match existing color.	24 hours for profanity, areas visible to travelling public, and for specific call outs. 72 hours for other graffiti discovered in the course of maintenance activities.
Debris and Obstruction	Maintain paved surfaces and roadway free from debris and obstructions that present a hazard to motorists.	1 hour for paved surface. 48 hours for other areas.
Litter and Trash	Maintain Project Limits in a neat condition. Remove and dispose of litter and trash regularly.	1 hour for significant incidents of litter/trash deposited on paved surfaces. 48 hours for other significant incidents of litter/trash within the Project Limits. 7 days for all others.
Sweeping	Maintain all roadways including shoulders and gore areas within the Project Limits. Use only PM-10 certified street sweepers capable of picking up the material without coming to a complete stop, equipped with the standard safety equipment and delineations.	Bi-weekly or sooner if warranted by traffic safety conditions or construction activities.
Barrier and Attenuator	Repair or replace guardrail, cable barrier, concrete barrier, glare screen, and crash attenuator. Replacements shall be MASH compliant.	Immediately remove hazards to public or protect in place. Repair or replace within 7 days.
Drainage System	Repair and clean drainage features including pipes, headwall, catch basins, and drain inlets.	Repair Drainage Features • If warranted by traffic safety conditions, protect in place within 24 hours; repair within 7 days. • 21 days for all others.
Lighting System	Repair or replace lighting components.	Within 7 days after notification.
Pavement Striping	Maintain all roadway striping such that it is clearly visible under mid-day sunlight or full roadway lighting.	Within 30 days after notification.

TP Attachment 105-1 Maintenance During Construction		
Element	**Performance Requirement**	**Repair Response**
Fencing	Control of Access limits to be maintained at all times.	Temporary repairs within 24 hours. Permanent repairs within 5 days.
Signs	Repair or replace.	Immediately remove hazards to public or protect in place. Repair or replace within 7 days.
Homeless Removal	Vacate homeless from the work area with the assistance of law enforcement. Remove belongings/debris and hazardous items if encountered. Sanitize area as needed.	Within 7 days after notification.

Landscaping Maintenance Limits and Location

Developer shall provide landscape, inert ground cover, and irrigation systems maintenance of the entire corridor and traffic interchanges. Landscaping maintenance (LM) responsibilities will be transferred to the Developer at the start NTP 2 activities for any portion of the Project as defined in the Maintenance Exhibits. Developer shall continue to maintain existing landscaping, inert ground cover, and irrigation systems until Substantial Completion of the Project. When Irrigation systems extend outside of the Project limits the Developer shall be responsible for the entire irrigation system regardless of the Maintenance Exhibits. An irrigation system is defined as the conduit, sprinkler heads, emitters, valves and other components that are serviced by a common point of connection to a water source.

Subcontractor(s) providing landscape maintenance services shall have at least three years of experience providing plant maintenance, pest control, and irrigation on projects of similar size and scope.

Landscaping Maintenance Plan Requirements

Developer shall provide a LM Plan that details the seasonal requirements for maintaining and protecting all plants (new and protect-in-place plantings within the project limits) in a living and well-maintained condition within the Project ROW, including all inert ground cover and irrigation systems until Substantial Completion of the Project. LM Plan shall address all existing previously planted areas that are to be salvaged or protected-in-place and all new ROW areas as defined in the TP's and these requirements.

The Developer shall prepare a LM Plan detailing the equipment, materials, processes, techniques, and labor activities as required and provide seasonal schedules and checklists for activities generally outlined as follows and detailed further herein.

A. Limits and Location of Maintenance Activities
B. Equipment: Detailed list of required tools, manual and mechanical, including vehicles
C. Schedule
D. Inert Materials / Erosion Repair Requirements
E. Landscaping Maintenance
    a. General Pruning
    b. Tree Pruning
    c. Shrub and Groundcover Pruning
    d. Staking and Guying
    e. Plant Removal / Replacement
F. Pest Control
    a. Weeds
    b. Vermin
G. Irrigation Maintenance

Maintenance Schedules and Checklists for:

A. Monthly Maintenance and Developer Inspection Reports
B. Pruning, Staking and Guying
C. Plant Removal/Replacement
D. Pest Control
E. Seasonal Weeding
F. Irrigation Controller Enclosure
G. Irrigation Equipment Maintenance

The LM Plan shall be provided for review and comment a minimum 60 Days prior to the start of NTP 2. The Developer shall revise and resubmit the LM Plan as needed to address comments.

LANDSCAPING MAINTENANCE CONSTRUCTION REQUIREMENTS

General:
The Developer shall furnish equipment, materials, and labor for maintenance of the Project and limits as defined herein during LM Period and BMP's for the following Landscaping Maintenance activities:

A. Inert materials and erosion repairs;
B. Plants - pruning, removals, and replacements;
C. Pest control;
D. Irrigation systems repair and maintenance.

Equipment:
Developer shall provide and maintain the appropriate equipment for the tasks identified herein and consistent with industry standards during the entire period of this contract. Developer shall have appropriate equipment available at all times and shall keep them clean and in operative conditions.

Schedule:
Developer shall provide a Landscape Feature Work Frequency Schedule for the listed activities below. An example schedule is included in Exhibit A of this attachment.

Inert Materials / Erosion:
The Developer shall be responsible for corrective repairs of erosion and inert materials within the Project due to routine operation of the irrigation, construction activities, or weather as directed by ADOT.

General Pruning: Applies to all plant pruning activities.
Developer shall:

A. Conduct all pruning according to standard horticultural practices noted in the Sustainable Landscaping Management standard developed by the Arizona Landscape Contractors Association (www.azcla.com), most current ANSI standards, and OSHA standards.
B. Prune to promote strong branching structures and remove dead branches, suckers and stakes.
C. Prune to remove injured or diseased wood.
D. Prune at the time(s) of year that is most beneficial for the plant material. Examples include shrub pruning after flowering, crown thinning before monsoon season, and after freeze back of foliage. Pruning is generally seasonal with growth cycles.
E. Prune all plants by approved methods to ensure that no plants are permitted to encroach on or over any adjacent R/W.
F. Prune to maintain safe sight line distances; signage visibility; and utility cabinet, pedestrian, and maintenance access.
G. At minimum prune to facilitate visual inspection of the irrigation system (for trees to 24" above the ground level) and as necessary to remove dead, diseased, or injured wood, control or direct growth, remove crossed limbs, and eliminate growth encroaching on roadways.

H. Remove all branches, fronds, trimmings, and other rubbish by the end of each day. In no event shall Developer leave debris on site for a period exceeding three (3) days. Debris shall not be left down on weekends or holidays. In the event debris must be left of any period of time, Developer will stack all trimmings near the base of a tree if possible, without blocking streets, sidewalks, maintenance access, driveways, and without covering up utility cabinets, aesthetic features, water meters, smaller plants, etc.
I. Leave all areas in a condition better than that which was existing prior to commencement of work.

Tree Pruning:
Developer shall prune all trees to result in a pleasing, aesthetics, and balanced appearance in relation to the tree itself as well as in relationship to surrounding trees and structures.

A. No heading or pollarding cuts.
B. Maintain the minimum distance from overhead electrical conductors as identified in the most current ANSI standards. Pruning under overhead wires shall be coordinated with the appropriate Utility Company and the registered Professional Engineer.
C. Do not remove more than 20% of canopy during any single pruning.
D. Hedge trimmers shall not be used to prune trees.
E. Palms: all palm trees shall be trimmed/skinned so no more than one year's growth is present.

Shrub and Groundcover Pruning:
Developer shall prune all shrubs and groundcover only as necessary to result in a pleasing, aesthetics, and balanced natural appearance in relation to the shrub itself as well as in relationship to surrounding plants.

Developer shall:

A. Prepare a seasonal pruning schedule for submittal and approval registered Professional Engineer
B. Not make hedge trimming with or shearing cuts that create an undesirable, unnatural geometric form such as cylinders, boxes, or balls.
C. Not remove more than 30% of canopy during any single pruning except as noted below.
D. Prune woody perennials (e.g. shrub form Caesalpinia sp.) to the base once every year or at minimum once during the LM Period.

Native Vegetation (Non-Granite Areas):
Developer shall identify wildflowers and desirable native grasses and protect native vegetation and maintain it in such a manner that plant species shall not become a monoculture.

A. Native grasses shall be cut, as needed after seed heads have matured.
B. Native shrub species shall be left to grow in a natural state and pruned or removed only when necessary for visibility, safety, or maintenance of the roadway or drainage structures.

Staking and Guying:
All staking and guying as directed by ADOT shall adhere to the landscape details in TP Attachment 800-3 during the maintenance activities.

Plant Removal/ Replacement:
Refer to Section 800.04.03 of the TPs and Section 807-3 of the Standard Specifications for all plant removal and replacement requirements.

Pest Control:
Developer shall be responsible for controlling pests within the Project starting at NTP 2 through Substantial Completion. Pest control includes weeds, pest, and vermin typically controlled through mechanical and manual means or chemical methods.

A. Developer shall keep the Project free from weeds.
    a. Inert Ground Covers Areas:
        i. Developer shall maintain the granite, rock mulch, decomposed granite, and riprap free from weeds through preventative pre-emergent and post-emergent measures.
    b. Weeding Activities:
        i. Developer shall use preventative measures through pre-emergent herbicide applications in areas of inert materials are as defined in Section 800.04.04.02 of the TPs and Section 803-3.02 of the Standard Specifications.
        ii. Post-Emergent herbicides shall be used to spot treat weed growth during active growing periods.
        iii. Spot weeding shall be by mechanical or manual methods.
    c. Other Pests/Vermin:
        i. Developer shall identify potential other pests/vermin including but not limited to ants, bees, rodents, insects, gophers, and other pests that burrow, crawl, fly, nest, or otherwise reside within the Project.
        ii. Identify proposed methods for control including equipment, materials, processes, and techniques for each pest/vermin type on an as needed basis.

B. Use of Chemicals: Developer shall ensure all materials, techniques, and processes involving the use of chemicals are in compliance with all Federal, State, County, and local laws, rules, regulations, standards, ordinances, and statues and applied according to manufacturer's/label directions by a certified pest control operator. All chemicals including herbicides, insecticides, fertilizers, rodenticides, and pesticides used by the Developer shall have Environmental Protection Agency registration and the Arizona Department of Agriculture approval.
    a. Developer shall submit a list of all proposed use of the chemicals as part of the LM Plan for approval by ADOT.
    b. Developer shall not enter the Project without providing the most current SDS to IQF.
    c. All chemicals shall in in the original manufacturer's marked containers.

C. Pest control activities in NTP 2 does not relieve the Developer from the responsibility to prepare a separate Noxious and Invasive Species Control Plan as defined in Section 800.02.05 of the TPs and as part of the Environmental Mitigation Requirements, refer to Section 119 of the TPs.

IRRIGATION MAINTENANCE:

Irrigation maintenance during NTP 2 by the Developer shall ensure that all plants receive the proper amount of irrigation to maintain health and vigor.

Existing Plants:
All existing landscape watered by an underground irrigation system that is “Protect-In-Place” (PIP) or not disturbed by construction activities shall receive regularly scheduled irrigation to maintain plant health throughout NTP 2, the LE Period, and per TP requirements.

Prior to construction the Developer shall walk areas of the Project with the registered Professional Engineer to review the existing irrigation system. The objective will be to understand the existing irrigation system as it relates to existing and PIP plant materials that are serviced by irrigation control zones being modified in the project scope.

Irrigation Maintenance Plan:
Developer shall prepare an Irrigation Maintenance Plan that includes the following:

A. Identify limits of existing system within and portions that extend beyond Project limits.
B. An irrigation plan with watering calculations for watering Protect-in-Place plant materials throughout the duration of the NTP 2 and Landscaping Establishment (LE) Phase. This will involve seasonal adjustments to the irrigation systems.
C. An irrigation plan with watering calculations for new plant materials throughout the duration of the NTP 2 and LE Phase. This will involve seasonal adjustments to the irrigation systems.
D. Irrigation System Reviews: Provide frequencies, protocols, and reporting plans for:
    a. Irrigation watering schedule for seasonal and plant growth adjustments and required watering calculation sheets;
    b. Timely irrigation damage repair;
    c. Visual inspection for breaks and malfunctions of irrigation equipment;
    d. Physical inspection of controllers and valves;
    e. Confirmation of irrigation system controller program;
    f. Run system to identify problems (review pressure and flow data)
    g. Check lists, Schedules, and Reports (examples are provided at https://azdot.gov/node/5336)

Check lists, Schedule, and Reports shall be provided to ADOT on a monthly basis throughout the duration of NTP and the Developer shall maintain a log of inspections performed that can be made available for review by ADOT as needed.

Corrective Rework

ADOT will perform routine inspections of the Project during NTP 2 and submit written notice of landscape maintenance performance deficiencies to the Developer. Photographic examples of deficiencies, damage, and area of disrepair requiring maintenance are provided herein. The Developer shall correct deficiencies within the following time limits:

Table 800-4.1 Corrective Rework		
	Activity	**Days**
1	Inert materials / erosion	14
2	Native Vegetation: trimming, cutting, removals	14
3	Pruning trees, shrubs, or groundcovers	14
4	Plant removals/replacements	14
5	Staking or guying	14
6	Pest Control: Pre-emergent weed treatments	14
7	Pest Control: Post-emergent weed treatments	14
8	Pest Control: Vermin	14
9	Irrigation Inspections	14
10	Irrigation Repairs	3

Discontinuing Existing Landscaping Maintenance:
Existing landscaping areas that are to be demolished by the Developer must be maintained in a living and well-maintained condition until at maximum 15 Business Days prior to beginning of construction within that area. The Developer shall notify IQF and ADOT of the change in status from a maintained to non-maintained area in accordance to the LM Plan.

Landscaping and Irrigation Deficiencies and Maintenance Practices Photographic Examples



Broken Limb Removal Needed



Tree Pruning and Debris Disposal Needed



Tree Branch Pruning



Excessive Tree Pruning



Improper Pruning Technique



Proper Pruning Technique



Tree Sucker Growth Needing Removal



Trees Overhanging Private Property



Slope Erosion and Wall Damage





Slope Erosion:
Potential Broken
Irrigation Repair
Subgrade and Patch
Granite as Needed



Slope Erosion: Potential Broken Irrigation Needs Subgrade Repair and Granite Patching



Broken Irrigation: Subgrade and Granite Repairs Also Needed



Weed Infestation in Planting (Manual Removal)



Weed Growth in Granite Area (Spray Treatment)



Irrigation: Multi-Emitter Leak



Valve Box Top Missing and Clean Out Needed



Pest Control / Rodent Damage



Extensive Rodent Damage



Sedimentation at Drainage Structure Clean Out Needed



Sedimentation at Drain Inlet (Debris Clean Out)





Concrete Clean Out
Improper Disposal



Rebar Disposal / Debris Removal



Construction Debris / Traffic Garbage



Freeway Trash / Debris



Freeway Trash / Debris Removal Needed



Graffiti Remediation Needed

TP Attachment 107-1 – Prior Rights Document Index

Preliminary Prior Rights

Prior Rights Number	TP Attachment 107-2 Ref No.	Company	Description	Prior Rights Document from Utility	Document	Section	Township	Range	1/4 Section	Land Right	Station	Location	Notes	ADOT Prior Rights
1.	1	SRP Irrigation	30” RCP	SRP_Irrigation_PR.zip	101-440-MCR Plat 191-147-MCR	S24	T1N	R3E	SW	USA Fee. 40’ wide.	7971+16	West of 32nd Street		Yes
2.	2	SRP Irrigation	30” RCP (inactive)	SRP_Irrigation_PR.zip	101-440-MCR	S24	T1N	R3E	SE	USA Fee. Width undefined.	8011+27	38th Street		Yes
3.	3	SRP Irrigation	24” RCP (inactive)	SRP_Irrigation_PR.zip	44-165-MCR	S19	T1N	R4E	SE	SRP easement of undefined width.	8068+91	West of 48th Street		Yes
4.	4	SRP Irrigation	36” RCP (inactive)	SRP_Irrigation_PR.zip	101-440-MCR	S19	T1N	R4E	SE	USA Fee. Width undefined.	22+75 (SR 143)	Crossing SR 143		Yes
5.	5	SRP Irrigation	42” RCP	SRP_Irrigation_PR.zip	36-433-MCR	S20	T1N	R4E	SW	SRP easement of undefined width.	8075+50	East of 48th Street		Yes
6.	6	SRP Irrigation	54” Drain Line	SRP_Irrigation_PR.zip	36-433-MCR	S20	T1N	R4E	SW	SRP easement of undefined width.	8076+44	East of 48th Street		Yes
7.	7	SRP Irrigation	24” RGRCP	SRP_Irrigation_PR.zip	WRA_SE4 Sec 29- T01N-404E	S29 S32 S32	T1N T1N T1N	R4E R4E R4E	SE NW NE	USA Fee. Width undefined.	8143+70	West Side of I-10 from Fairmont to Western Canal		Yes
8.	8	SRP Irrigation	Box Culvert	SRP_Irrigation_PR.zip	111-254-MCR Plat 2016-0647906 MCR	S32	T1N	R4E	NE	USA Fee. Varies 70’-98’ wide.	8177+32	Western Canal		Yes
9.	9	SRP Irrigation*	6’x4’ Box	None submitted at this time.		S5	T1S	R4E	Lot 1 & 2		8214+75	Highline Canal		Yes
10.	10	SRP Irrigation*	60” RCP	None submitted at this time.		S20	T1S	R4E	SW		8419+62	North of Ray Road		Yes
11.	11	SRP Irrigation*	21” RCP	None submitted at this time.		S29	T1S	R4E	NW		8424+80	South of Ray Road		Yes
12.	12	SRP Irrigation*	27” RGRCP	None submitted at this time.		S29	T1S	R4E	NW		8424+98	South of Ray Road		Yes
13.		SRP Irrigation*	36” RGRCP	None submitted at this time.		S20	T1N	R4E	NW		33+69 (SR 143)	South of Tempe Drain		Yes
14.		EPNG	4.5” HP Steel	L2033 Northern Crossing	DKT 812 P585 10.18.1949 Lots 16.15	S5	T1S	R4E	NE		8222+91	Calle Cerritos	Gas line installed prior to freeway ROW acquisition.	Yes
15.		EPNG	6” HP Steel	L1007 Crossing I-10 Middle Crossing	ADOT ROW_A-7-T-655A	S5	T1S	R4E	SE		8263+38	Guadalupe Rd	Gas line installed prior to freeway ROW acquisition.	Yes

Prior Rights Number	TP Attachment 107-2 Ref No.	Company	Description	Prior Rights Document from Utility	Document	Section	Township	Range	1/4 Section	Land Right	Station	Location	Notes	ADOT Prior Rights
16.		EPNG	16” HP Steel	L20108 Southern Crossing	ADOT ROW_A-7-T-655A	S8	T1S	R4E	NE		8288+25	Mineral Rd	Original crossing installed prior to freeway ROW acquisition. EPNG abandoned the existing facilities and installed new 16” via ADOT Permit No. 95354. EPNG owns fee title land adjacent to the I-10 ROW.	Yes
17.		Air Products	6” Steel	City and ADOT Permits		S20 S19	T1N T1N	R4E R4E	NW NE	Permit	37+36 SR 143	Medtronic Way		Yes
18.	1	SRP Power*	OH 69kV w/12kV	None submitted at this time.		S24	T1N	R3E	SW		7982+87	34th Street		Yes
19.	2	SRP Power	OH 69kV w/2 circuits of 12kV	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	Work Order AC24	S24	T1N	R3E	SW	Prior Right	7995+62	36th Street		Yes
20.	3	SRP Power	OH 12kV	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	Easement No. 01-6285522, 15-0634302	S24	T1N	R3E	SE	Easement	8009+40	38th Street		Yes
21.	4	SRP Power	OH 12kV	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	Easement No. 8358-120, 8715-4, 2009-1027965	S19	T1N	R4E	SW	Easement	8035+81	42nd Street		Yes
22.	5	SRP Power	OH 69kV w/12kV	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	Easement No. 15816-235, 15690-895	S19	T1N	R4E	SE	Easement	8062+42	46th Street		Yes
23.	6	SRP Power*	OH Double Circuit 69kV w double circuit 12kV	None submitted at this time.		S20 S19	T1N T1N	R4E R4E	NW NE		33+97.16 SR 143	Tempe Drain		Yes
24.	7	SRP Power*	OH Double circuit 12kV	None submitted at this time.		S20 S19	T1N T1N	R4E R4E	NW NE		34+68.04 SR 143	Tempe Drain		Yes
25.	8	SRP Power*	OH	None submitted at this time.		S20	T1N	R4E	SW			NW Corner Broadway Rd & 48th Street		Yes
26.	9	SRP Power	UG power in 30” RCP	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	ADOT Permit No. 38686 Easement No. 83-063113, 83-049300	S29	T1N	R4E	NE	Easement	8123+39	North of Alameda	Prior rights for facilities parallel to I-10. No prior rights for crossing.	Partial

Prior Rights Number	TP Attachment 107-2 Ref No.	Company	Description	Prior Rights Document from Utility	Document	Section	Township	Range	1/4 Section	Land Right	Station	Location	Notes	ADOT Prior Rights
27.	10	SRP Power	OH 12kV	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	Work Order AD29 Peterson Park Plat No. 3 Warranty Deed 1995-0607444	S29	T1N	R4E	SE	Public Utility Easement	8144+23	Fairmont		Yes
28.	11	SRP Power	UG Crossing	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	Utility Agreement 1582-91-SRPP Utility Agreement 1582-92-SRPP	S32	T1N	R4E	NE	Relocation Agreement	8176+00	US 60 System TI		Yes
29.	12	SRP Power	OH Double circuit 69kV	20190927 Early Relocation Land Rights Memo Combined Attachments.pdf	Utility Agreement 1558-92-SRPP	S32	T1N	R4E	NE	Relocation Agreement	8182+40	US 60 System TI		Yes
30.	13	SRP Power*	UG Power Crossing	None submitted at this time.		S32	T1N	R4E	SE		8210+10	Baseline Rd		Yes
31.	14	SRP Power*	Double Circuit 230kV	None submitted at this time.		S5	T1S	R4E	Lot 1 & 2		8214+75	Highline Canal		Yes
32.	15	SRP Power*	OH 69kV/12kV	None submitted at this time.		S5	T1S	R4E	Lot 1 & 2		8223+14	Calle Cerritos		Yes
33.	16	SRP Power*	69kV/12kV	None submitted at this time.		S8	T1S	R4E	SE		8290+89	Mineral Road		Yes
34.	17	SRP Power*	UG Crossing	None submitted at this time.		S17	T1S	R4E	NW		8343+85	Mid-Section Line between Elliot Rd and Warner Rd		Yes
35.	18	SRP Power*	UG Crossing	None submitted at this time.		S17	T1S	R4E	SW		8362+61	Approximately 850 feet north of Warner Rd		Yes
36.	19	SRP Power*	OH 69kV	None submitted at this time.		S29	T1S	R4E	NW		8430+90	South of Ray Rd		Yes
37.		SRP Power*	UG 12kV	None submitted at this time.		S20	T1N	R4E	NW			East side of SR 143 – Tempe Drain to 14th Street		Yes
38.		COT – Water*	Size varies	None submitted at this time.		S20	T1N	R4E	NW			East side of SR 143 – University to 14th Street		Yes
39.		COT-Sewer*	Size varies	None submitted at this time.		S20	T1N	R4E	NW			East side of SR 143 – University to 12th Street		Yes
40.		COT – Water	12” DIP in 24” RGRCP Casing	I-10 – Prior Rights Lists.pdf	As-builts I-10-3(33) 906329A	S20	T1N	R4E	SW		8100+61	South of Broadway Rd	Original line installed prior to freeway ROW acquisition.	Yes

Prior Rights Number	TP Attachment 107-2 Ref No.	Company	Description	Prior Rights Document from Utility	Document	Section	Township	Range	1/4 Section	Land Right	Station	Location	Notes	ADOT Prior Rights
41.		COT – Water	12” CIP in 24” RCP Casing - Abandoned	I-10 – Prior Rights Lists.pdf	As-builts I-10-3(33) 906329A	S20	T1N	R4E	SW		8101+25	South of Broadway Rd	Original line installed prior to freeway ROW acquisition.	Yes
42.		COT - Sewer	15” VCP	I-10 – Prior Rights Lists.pdf		S29	T1N	R4E	NE		8130+59	Alameda Dr	No prior rights within ADOT 1966 ROW (approximately 300’) Prior rights outside of ADOT 1966 ROW.	Partial
43.		COT - Water	18” DIP in 30” CMP Casing – Abandoned	I-10 – Prior Rights Lists.pdf		S29	T1N	R4E	NE		8130+70	Alameda Dr	No prior rights within ADOT 1989 ROW (approximately 300’) Prior rights outside of ADOT 1989 ROW.	Partial
44.		COT - Water	18” DIP in 30” RGRCP Casing East side ties into 24” main	I-10 – Prior Rights Lists.pdf		S29	T1N	R4E	NE		8130+75	Alameda Dr	No prior rights within ADOT 1989 ROW (approximately 300’) Prior rights outside of ADOT 1989 ROW.	Partial
45.		COT – Water*	12” CI	None submitted at this time.		S29	T1N	R4E	SE			West side of I-10 Alameda Drive to Southern		Yes
46.		COT – Sewer*	8” VCP	None submitted at this time.		S29	T1N	R4E	SE			West side of I-10 Alameda Drive to approximately 500’ south.		Yes
47.		COT - Sewer	18” VCP	I-10 – Prior Rights Lists.pdf		S29	T1N	R4E	SE		8143+98	Fairmont Dr	No prior rights within ADOT 1996 ROW (approximately 300’) Prior rights outside of ADOT 1996 ROW.	Partial
48.		COT – Water	12” DIP in 21” CMP Casing	I-10 – Prior Rights Lists.pdf	As-built 67041 pg7	S29	T1N	R4E	SE		8155+90	Southern Ave	Constructed 1964 Shown as existing on ADOT ROW Plans I-10-3(22)	Yes
49.		COT – Sewer*	Shared between Tempe and Mesa 48” CIP Concrete	I-10 – Prior Rights Lists.pdf	As-built 4406	S29	T1N	R4E	SE		8157+19	Southern Ave		No
50.		COT – Water	21” VCP	None submitted at this time.		S32	T1N	R4E	NE		120+93 US 60	Priest Dr		No
51.		COT – Water*	20” DIP	None submitted at this time.		S32	T1N	R4E	NE		121+23 US 60	Priest Dr	Installed prior to freeway ROW acquisition.	Yes

Prior Rights Number	TP Attachment 107-2 Ref No.	Company	Description	Prior Rights Document from Utility	Document	Section	Township	Range	1/4 Section	Land Right	Station	Location	Notes	ADOT Prior Rights
52.		COT – Sewer	42” VCP	None submitted at this time.		S33	T1N	R4E	NW		121+35 US 60	Priest Dr		No
53.		COT – Sewer*	21” VCP	None submitted at this time.		S33	T1N	R4E	NW		121+64 US 60	Priest Dr	Installed prior to freeway ROW acquisition.	Yes
54.		COT – Water	12” CIP	None submitted at this time.		S33	T1N	R4E	NW & SW		48+29 US 60	Hardy Dr		No
55.		COT – Water*	16” DIP	None submitted at this time.		S32	T1N	R4E	SE		8210+27	Baseline Rd	Installed prior to freeway ROW acquisition.	Yes
56.		COP -Sewer	15” VCP	I10 prior rights 24th St to SR143.pdf	As-built 07-1987-0087 10-3(206)	S24	T1N	R3E	SW		7970+88	32nd Street		No
57.		COP -Water	12” ACP	I10 prior rights 24th St to SR143.pdf	As-built 15-1963-0005	S24	T1N	R3E	SW		7971+57	32nd Street	Installed prior to freeway ROW acquisition.	Yes
58.		COP -Sewer	12” VCP	I10 prior rights 24th St to SR143.pdf	ADOT As-built 10-3(206)	S24	T1N	R3E	SW		7971+66	32nd Street	Installed prior to freeway ROW acquisition.	Yes
59.		COP – Water	6” CIP	I10 prior rights 24th St to SR143.pdf	As-built 15-1964-0005 ADOT ROW I-10-3(15) I-10-3(177)	S24	T1N	R3E	SW			South side of I-10 at 32nd Street	Installed prior to freeway ROW acquisition.	Yes
60.		COP -Water	12” CIP in 24” RCP Sleeve	I10 prior rights 24th St to SR143.pdf	15-1963-0106	S24	T1N	R3E	SW & SE		7995+77	36th Street		Yes
61.		COP -Water	60” RCP in 96” Concrete Tunnel	I10 prior rights 24th St to SR143.pdf	ADOT ROW I-10-3(15)	S24	T1N	R3E	SW & SE		7996+03	36th Street	No prior rights within ADOT 1987 ROW (approximately 300’). Prior rights outside of ADOT 1987 ROW.	Partial
62.		COP -Water	54” DIP in 84” Steel Sleeve	I10 prior rights 24th St to SR143.pdf	ADOT ROW I-10-3(15) DKT 1311 pg 17	S24	T1N	R3E	SW & SE		8008+97	38th Street	No prior rights within ADOT 2005 ROW (approximately 300’). Prior rights outside of ADOT 2005 ROW. 30’ Water line easement on the North side of I-10 and 33’ on the South side of I-10 per Docket 1311 pg 17.	Partial

Prior Rights Number	TP Attachment 107-2 Ref No.	Company	Description	Prior Rights Document from Utility	Document	Section	Township	Range	1/4 Section	Land Right	Station	Location	Notes	ADOT Prior Rights
63.		COP -Sewer	15” CIP in 24” RCP Sleeve	I10 prior rights 24th St to SR143.pdf	As-built 07-1965-0049 ADOT ROW I-10-3(22)	S19	T1N	R4E	Lot 3 & 4		8023+24	40th Street	Prior rights for the sleeve only.	Partial
64.		COP -Water	12” ACP in 30” RCP Sleeve	I10 prior rights 24th St to SR143.pdf	As-built 06-1970-0141 DKT 8014, pg 702 and 703	S19	T1N	R4E	SW		8041+58	43rd Place	No prior rights within ADOT 1970 ROW (approx. 300’). Prior rights within 12’ sewer and water easement on the north side of I-10 Dkt 8014 pg 703 Prior rights within the 12’ water easement on the south side of I-10 Dkt 8014 pg 702	Partial
65.		COP – Water	8” ACP	I10 prior rights 24th St to SR143.pdf	12’ Water line easement Bk 466 of Maps Pg 4	S19	T1N	R4E	SE			SR 143 SB Off-Ramp to WB I-10		Yes
66.		APS	230kV	84-0351738.pdf	Easement No. 84-351738	S23	T1N	R3E	NE	160’ Utility Easement	7934+04	Salt River Bridge		Yes
67.		APS	230kV	DKT 4453 pg 15.pdf	DKT 4453 pg 15	S19	T1N	R4E	SE	120’ Electrical Easement	8061+82	46th Street		Yes

1. Prior rights determinations are preliminary for the purposes of bidding. Additional documentation may be necessary to make a final determination of prior rights during design.
2. * Preliminary determinations of prior rights are presumed for these utilities based on previous project experience. Documentation will be required from the utility to confirm prior rights. Developer shall provide an initial determination to ADOT per Section 107.15.04.04.01.
3. City of Phoenix and Tempe crossings are listed for informational purposes to assist with bidding prior right and non-prior right bid items.
4. Any City facilities not listed in this table are presumed to have prior rights and documentation will be required to confirm prior rights. Developer shall provide an initial determination to ADOT per Section 107.15.04.04.01.
5. Regardless of prior right status Developer is responsible for design and construction of all City relocations per TP Attachment 107-2.
6. All stationing is from I-10 Median Construction Centerline unless otherwise noted.
7. Prior rights determinations are preliminary for the purposes of bidding. Additional documentation may be necessary to make a final determination of prior rights during design.
8. * Preliminary determinations of prior rights are presumed for these utilities based on previous project experience. Documentation will be required from the utility to confirm prior rights. Developer shall provide an initial determination to ADOT per Section 107.15.04.04.01.
9. City of Phoenix and Tempe crossings are listed for informational purposes to assist with bidding prior right and non-prior right bid items.
10. Any City facilities not listed in this table are presumed to have prior rights and documentation will be required to confirm prior rights. Developer shall provide an initial determination to ADOT per Section 107.15.04.04.01.
11. Regardless of prior right status Developer is responsible for design and construction of all City relocations per TP Attachment 107-2.
12. All stationing is from I-10 Median Construction Centerline unless otherwise noted.

TP Attachment 107-2 – Utility Specific Technical Provisions

City of Phoenix (COP)

City of Phoenix (COP) has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of COP facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15 of the TPs.

COP water and sewer crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15 of the TPs.

Station	Location	Water/Sewer	Description
7970+88	32nd Street	Sewer	15" VCP
7971+57	32nd Street	Water	12" ACP
7971+66	32nd Street	Sewer	12" VCP
7995+77	36th Street	Water	12" CIP in 24" RCP Sleeve
7996+03	36th Street	Water	60" RCP in 96" Concrete Tunnel
8008+97	38th Street	Water	54" DIP in 84" Steel Sleeve
8023+24	40th Street	Sewer	15" CIP in 24" RCP Sleeve
8041+58	43rd Street	Water	12" ACP in 30" RCP Sleeve
	48th Street South of Broadway	Sewer	8" VCP

COP Water Services Department (WSD) staff will complete conflict reviews for proposed work near water and sewer facilities. WSD will complete all conflict reviews within 21 Business days. WSD will coordinate with the Developer to process critical reviews as quickly as possible.

Design and Construction of COP Water and Sewer Relocations

Developer shall design and construct all Utility Adjustments to COP owned water, sanitary sewer, and storm drain facilities, as needed, and shall obtain approval of the design from the COP.

Design/construction of all water and sewer facilities/relocations shall be per the current version of the COP Design Standards Manual for Water and Wastewater COP Supplement to MAG and MAG Standard Specifications and Details (Current approved COP version 2015). Trees are not permitted within 6' of water and sewer mains and limited within 10'. All clearances from other utilities, proposed structures or between water and sewer infrastructure shall be followed.

https://www.phoenix.gov/waterservices/publications/design-manuals/systems

Water, sewer, fire line designs and abandonments shall be in accordance with Section 107.15.06.04 and 107.15.06.06 of the TPs and in addition follow the design checklists provided on the Planning and Development Website. https://www.phoenix.gov/pddsite/Pages/civilindex.aspx and the additional checklist for CIP projects. https://www.phoenix.gov/waterservices/publications/design-manuals/checklist

City, and ADOT, both prefer to have utilities located outside of the ADOT ROW, or at least outside the control of access fencing. Valves and manholes in particular must be accessible outside of ADOT's control of access fencing. Perpendicular crossings can remain and be protected in place if there is no conflict. New valves or manholes may be required to be installed on existing perpendicular crossings to

provide access. The Developer's design shall strive to avoid longitudinal conflicts. These will need to be evaluated as the Developer progresses with his design.

All water or sewer relocation plans shall be submitted per COP drawing requirements, format and datum and be signed and sealed by an Arizona Registered Professional Engineer.

Submittals for water and sewer relocations are to be supplied as hard copy (full size & half size) and electronic(pdf). Plan review fees will be charged per PLANNING & DEVELOPMENT DEPARTMENT FEE SCHEDULE Phoenix City Code, Chapter 9, Appendix A.2 https://www.phoenix.gov/pddsite/Documents/TRT/dsd_trt_pdf_00042.pdf

All new facilities require asset management information to be provided on the design plans and updated after construction with the Utility Record Drawings. The asset management spreadsheet will be provided at the beginning of design.

Available COP Documents

Water and sewer quarter section maps are available for purchase at the Infrastructure Records Counter. A government issued id is required. COP WSD Infrastructure Records Section 200 West Washington St, 8th Floor.

Water and sewer as-builts are available for purchase at the Infrastructure Records Counter. A background screening is required and generally takes two weeks to complete. Send an email to the address listed below requesting a security screening and include in the email that the request is in reference to ADOT Project F0072 I-10, I-17 (Split) to SR 202L. A COP staff member will email a link to complete the background screening. Any additional questions should be directed to the staff member that provides the on-line link.

irspubliccounter.wsd@phoenix.gov

Refer to the RIDs for a preliminary list of COP water and sewer as-builts within the Project Limits.

City of Phoenix Water Services Policies, Procedures and Manuals are located at https://www.phoenix.gov/waterservices/publications

COP Water and Sewer Shutdown Requirements

Approval of the Water Services Department director is required prior to the shutdown of a city water main. The Developer shall not operate any valves on the City system. The Developer shall make application to the Water Services Department and pay the established charges, https://www.phoenix.gov/waterservices/devinfo/dev-issues/relatedfees/shutdownfee

Shutdowns are required for water relocations. Small dimeter (12" and under) require a minimum of 3 weeks' notice for shutdowns. Large diameter transmission mains (16" and greater) have an allowable shutdown window between October 15th and April 15th. Shutdowns in the warmer months outside this window are generally not approved. Shutdown availability is based on other planned projects with impacts to the water system.

Water main shutdowns require draining, filling, disinfection, testing and flushing at the Developers expense. The Developer is responsible for obtaining all permits to drain/discharge.

Work near or to water transmission mains (16” or greater) or sewer force mains require additional protection, coordination and review. Mains shall be potholed utilizing vacuum excavation and soft dig. Work may be restricted to approved WSD shutdown period based on impacts and concerns with the mains.

It shall be the responsibility of the Developer to notify the public where a shutdown will cause any city water customer to be without water following the WSD Notification Guidelines.

Coordination and approval will be required by WSD for notification reviews. Please note requirements for outage durations and critical customers.

Developer shall provide a bypass pumping system for relocation of sewer systems sealed by an AZ Registered Engineer. Bypass pumping requires redundancy and full-time watch. Developer shall submit the bypass plan to ADOT and WSD for review and approval.

COP Permitting and Fees

Prior to permit application, Developer shall obtain COP approval of Utility Adjustment design Plans prepared by Developer.

Developer shall adhere to the Maricopa County Environmental Services Department approval processes (Approval To Construct and Approval Of Construction) for all water and sewer adjustment work. All relocated facilities require submittal and approval by Maricopa County Environmental Services. An Approval to Construct (ATC) is required prior to construction and Approval of Construction (AOC) is required at completion. All fees associated with submittal are at the Developer’s expense.

Relocations for water and sewer facilities require permits (CSW & CWT) to be obtained. Fees will be per PLANNING & DEVELOPMENT DEPARTMENT FEE SCHEDULE Phoenix City Code, Chapter 9, Appendix A.2 TABLE D-1: CIVIL ENGINEERING VALUATION-BASED PERMIT FEE https://www.phoenix.gov/pddsite/Documents/TRT/dsd_trt_pdf_00042.pdf

Developer shall pay all fees associated with the establishment of new water services including meter /service install fees, Development Occupation Fees(DOF), Water Resources Acquisition fees(WRA) and impact fees. No fees will be waived. DOF &WRA fees can be located on the website: https://www.phoenix.gov/waterservices/devinfo/dev-issues/relatedfees

Impact fees are dependent on location for new service and can be determined by contacting the Planning and Development Department.

Developer shall pay all costs associated with waterline extensions that may be required in order to get water service to the desired point of service.

COP Agreements

Developer is responsible for preparing, negotiating and entering into an agreement with the COP for any work on COP water and sewer facilities. The standard COP Developer Agreement can be utilized otherwise Council and COP Law Department approval is required.

COP Utility Record Drawings

Developer shall submit Utility Record Drawings for all COP water and sewer relocations and adjustments per COP P-85 and 107.15.06.02.04 of the TPs. This includes meters and hydrants relocates and manhole adjustments. These shall be signed and sealed by an Arizona Registered Professional Engineer.

https://www.phoenix.gov/waterservicessite/Pages/engpoliciesindex.aspx

COP Design and Construction Experience Requirements

The design engineer shall have a minimum of 5 years of designing water and sewer infrastructure in Arizona with no open claims with the City the Phoenix.

Developer shall ensure that any personnel of either the Developer or a subcontractor assigned to perform any work on COP water or sewer shall have a minimum of 5 years and $5 million dollars of installing water and sewer infrastructure in Arizona with no open claims with the COP.

Developer shall submit documentation of required experience for the proposed personnel to ADOT and COP at least 30 Business Days prior to any anticipated work involving active water or sanitary sewer lines for approval.

COP Inspection

COP may choose to have an inspector attend meetings, perform plan reviews and be on-site for any construction activities in close proximity of an existing COP water or sewer line or during the adjustment, relocation and installation of COP water/sewer facilities. ADOT and the COP will enter into an IGA that will include the cost of 800 hours of COP inspection for anticipated inspection based on the information in this TP-Attachment. Should the Developer cause additional COP inspecting due to instances including creating additional conflicts, misidentifying conflicts or conflict resolution, multiple significant design iterations, modified schedule, delay in work or production, or alternative mitigation after approval the Developer shall be responsible for additional COP inspection hours per 5.4.4.10 of the DBA.

City of Chandler

The City of Chandler has no existing utilities within the Project Limits.

City of Tempe (COT)

City of Tempe (COT) has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of COT facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

COT water and sewer crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Station	Location	Water/Sewer	Description
2+26	Broadway Rd	Sewer	8" VCP
3+13	Broadway Rd	Water	12" PVC

Station	Location	Water/Sewer	Description
64+08	SR 143 (North of University Dr)	Sewer	16” CIP
79+51	SR 143 (North of University Dr)	Water	72” RCP
81+52	SR 143 (North of University Dr)	Sewer	48” RCP
8100+61	South of Broadway Rd	Water	12” DIP in 24” RGRCP Casing
8101+25	South of Broadway Rd	Water	12” CIP in 24” RCP Casing
8130+59	Alameda Dr	Sewer	15” VCP
8130+70	Alameda Dr	Water	18” DIP in 30” CMP Casing – Abandoned
8130+75	Alameda Dr	Water	18” DIP in 30” RGRCP Casing East side ties into 24” main
8143+98	Fairmont Dr	Sewer	18” VCP
8155+90	Southern Ave	Water	12” DIP in 21” CMP Casing
	Southern Ave	Sewer	Shared between Tempe and Mesa 48” CIP Concrete
120+93	Priest Dr	Sewer	21” VCP
121+23	Priest Dr	Water	20” DIP
121+35	Priest Dr	Sewer	42” VCP
121+64	Priest Dr	Sewer	21” VCP
48+29	Hardy Dr	Water	12” CIP
8210+27	Baseline Rd	Water	16” DIP
	East of 48th Street	Water	8” CIP

Design and Construction of COT Water and Sewer Relocations

Developer shall design and construct all Utility Adjustments to COT owned water, sanitary sewer, and storm drain facilities, as needed, and shall obtain approval of the design from the COT.

Any adjustments to existing COT water and sewer facilities or any new COT water and sewer facilities shall be per the current version of the COT Engineering Design Criteria.

For any water lines that the Developer requests to shutdown the City will perform a mock shutdown two weeks in advance of the shutdown.

All new COT water and sewer facilities shall be designed /constructed per COT Supplements to MAG and MAG Standard Specifications and Details.

All COT water or sewer relocation plans shall be submitted per COT drawing requirements, format and datum and be signed and sealed by an Arizona Registered Professional Engineer.

All COT water and sewer plans must be submitted electronically per the COT Electronic Plan Review Submittal Guidelines included in the RIDs. Full size shall be 24” x 36” sheets and be legible at 50% reduction. All final plan sets submitted for City Engineer approval signature must be printed on front side of 3 mil minimum double matte black line reproducible mylar.

https://www.tempe.gov/government/engineering-and-transportation/engineering/standards-details

Available COT Documents

COT water and sewer quarter section maps and as-builts are provided in the RIDs.

COT Water and Sewer Shutdown Requirements

Water line shutdowns shall be performed by COT Water Division staff and will be dependent upon current workload and maintenance activities of other COT facilities. The Developer shall provide a minimum of three months' notice to the COT for a requested water line shutdown. COT will perform a mock shutdown two weeks prior to the scheduled shutdown. Once the mock is completed the Developer shall provide a minimum of one week notice to schedule the shutdown.

Developer shall provide a bypass pumping system for relocation of sewer systems sealed by an AZ Registered Engineer. Bypass pumping requires redundancy and full-time watch. Developer shall submit the bypass plan to ADOT and COT for review and approval. The bypass plan shall include, but is not limited to the following requirements:

REQUIREMENTS

Developer shall have the entire bypassing system in place and successfully pressure tested with potable water at a minimum of 1.5 times the maximum operating pressure of the system before bypassing any sewage.

Developer shall notify the City 48 hours prior to shutting down or bypassing any pipeline. The bypass system equipment and existing flows shall be continuously monitored.

It is Developer's responsibility to arrange all necessary access and temporary construction agreements with all affected parties for Developer's proposed location of the bypass pumping system.

Developer is responsible for immediate and proper cleanup as per 107.15.03.02 of the TPs.

SUBMITTALS

Developer shall submit complete design data showing methods and equipment Developer proposes to utilize in sewer bypassing for review by COT. The submittal shall include the following information:

1. Drawings indicating the scheme and location of temporary sewer plugs and bypass discharge pipes. The drawings shall also show the method and location for discharging the bypass pipes.

2. Capacities of pumps, prime movers, and standby equipment.

3. Design calculations verifying adequacy of the capacity of the pumping system and selected equipment, Developer shall have a professional civil engineer, registered in the State of Arizona, design and professionally seal bypassing pumping plan and calculations.

4. Standby power source.

5. Staffing plan.

PROTECTION

No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.

SCHEDULING

The bypassing system shall operate continuously and shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the City. The

bypass system shall have attendants monitoring 24 hours a day whose only duty is to maintain the bypass pumping system until the bypassing of that specific pipeline is no longer required.

SERVICE LATERALS

Sanitary sewers to be by-passed may have service laterals connected to adjacent users. Developer shall verify the locations of these laterals and any other service laterals not shown on the Design Drawings.

MATERIALS

Developer shall provide temporary pumps, conduits, and other equipment to bypass sewer flow around the Developer's work area as required during CCTV inspection, cleaning and rehabilitation activities. Developer shall furnish all necessary labor and supervision to set up, operate and remove the pumping and bypass piping system.

Developer shall provide adequate size pump(s) to accommodate 150 percent of the maximum instantaneous flow. Developer shall determine the required flow capacity. COT may provide flow information to Developer, but shall provide no guarantees regarding such data.

Developer shall provide 100 percent redundant bypass pumping capability when only one pump is required to accommodate the flow. When multiple pumps are required to accommodate the bypass flows, Developer shall provide a minimum of 50 percent additional number of pumps.

Developer shall provide a fulltime operator/inspector with full responsibility for the bypass pumping operation.

In no case shall Developer allow any sewage to surcharge and backup into homes or businesses, or in any way overflow into the environment. If the bypass pumping capacity is insufficient to prevent surcharge and/or overflow at any time, Developer shall pull the line plugs irrespective of the status of the application or rehabilitation process.

Developer shall maintain on site, sufficient equipment and materials to ensure continuous and successful operation of the bypass and dewatering systems. The standby equipment shall be installed, fueled/powered and fully operational at all times including all pumps, support equipment being in-place. Developer shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, sewer plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the system as necessary.

All pumps, generators and other fueled equipment shall be placed in a containment barrier to protect against gasoline, oil, and hydraulic fluid spills.

COT Permitting and Fees

Prior to permit application, Developer shall obtain COT approval of Utility Adjustment design Plans prepared by Developer.

Developer shall adhere to the Maricopa County Environmental Services Department approval processes (Approval To Construct and Approval Of Construction) for all water and sewer adjustment work. All relocated facilities require submittal and approval by Maricopa County Environmental Services. An Approval to Construct (ATC) is required prior to construction and Approval of Construction (AOC) is required at completion. All fees associated with submittal are at the Developer's expense.

Developer shall be responsible for obtaining all necessary permits and paying all fees per COT municipal code.

https://library.municode.com/az/tempe/codes/city_code?nodeId=APXASCFECH_STREETS_SIDEWALKS

COT Utility Record Drawings

Developer shall submit Utility Record Drawings for all COT water and sewer relocations and adjustments per 107.15.06.02.04 of the TPs. This includes meters and hydrants relocates and manhole adjustments.

Air Products (AP)

Air Products (AP) has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of AP facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

AP crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Station	Location	Facility	Description
37+36	SR 143	Nitrogen	6" Steel

AP Design and Relocations

AP will design and relocate their facilities with AP crews and/or contractors. Developer shall coordinate with AP per 107.15 of the TPs.

AP Inspection and Protection of AP Facilities

The Developer shall contact AP 48 hours prior to any work within 10-feet of the pipeline to arrange for an AP inspector at (480) 225-1406 or (480) 203-0853. The Developer shall use soft dig methods to locate and identify the 10-inch nitrogen pipeline when the work has brought them to within 10-feet of the 10-inch pipeline.

Any continuous exposure that undermines the pipeline for 15-feet or more shall be supported by the Developer using an approved method agreed upon by the AP Representative.

The Developer shall provide safe job site access/egress for the AP representative to the pipeline for the purpose of monitoring activity, inspection of pipe and / or coating damage, as well as excavation for any repairs if required.

New underground structures to be installed shall maintain a minimum two-foot separation from the nitrogen pipeline in all directions. Back fill material shall consist of clean sand for one-foot around the

nitrogen pipeline. Slurry is not to be placed on or within two-feet of the nitrogen pipeline. Any directional drilling running parallel to AP underground pipelines with less than five-feet separation, shall pothole the bore head at maximum 20-foot intervals to confirm running line to be true and accurate. AP line shall be potholed every 100-feet minimum or closer pending AP assessment. No utilities are to run parallel within AP easements.

If during the project Developer encounters any AP Test Station(s), wiring, and/or casing vent piping that is determined relocation of these facilities is necessary, Developer shall provide trenching, vent pipe welding, and backfilling as required to an adequate depth and width from the existing test station/vent location to an area agreed upon by all parties in the field.

Developer shall protect and maintain open access to all flush mounted valve hand-holes as well as providing material to make adjustments to match new elevation grade. Upon completion, hand-holes shall be free of obstruction, vacuum as necessary.

The AP pipeline is cathodically protected. Developer shall not step, stand, place tools, or set shoring on the nitrogen pipeline. AP signage and or pipeline markers may be removed during the construction phase to accommodate equipment operation but shall be re-installed in close proximity by AP, post construction.

Use of "Root Barriers" shall be used when placing any type of tree or deep rooting plants within 12-feet of the centerline of AP pipelines. Developer shall submit the root barrier to ADOT and AP for approval.

Developer shall provide protection, as approved by AP, for any and all AP facilities above and below ground within the scope of this project for the duration of the project.

AP Prior Rights

AP is claiming prior rights for their facilities within the Project Limits.

ADOT is currently reviewing AP's prior right's claim and has provided an initial determination in TP Attachment 107-1.

Southwest Gas (SWG)

Southwest Gas (SWG) has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of SWG facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

SWG crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Station	Location	Facility	Description
37+36	University	Gas	2" Abandoned
7896+06	East of 24th Street	Gas	4" HP Steel
	W. of 32nd Street	Gas	2" abandoned
7995+72	36th Street	Gas	2" Steel
8020+71	40th Street	Gas	2" Steel 1963 Gas line crossing I-10 is active. On the south side of I-10 the line tees into

Station	Location	Facility	Description
			an existing east-west gas line. The line going to the east is active. The line going to the west is active for approximately 50' west of the tee and then abandoned.
8068+80	W of 48th Street	Gas	16" Steel joint trench w/4.5" abandoned EPNG line
20+43	South of Tempe Drain	Gas	4" PE
40+01	North of Tempe Drain	Gas	8" Steel
8158+38	Southern Ave	Gas	8" PE
8210+01	Baseline Rd	Gas	4" PE and 4" Steel (high pressure)
8309+16	North of Elliot	Gas	4" Steel

SWG facilities along Diablo Way and adjacent to Galleria Palms Apartment Complex were denoted as abandoned during a previous project. Developer shall coordinate with SWG to determine the exact limits of abandonment and shall remove remaining utilities in accordance with the TPs.

Design and Construction of SWG Facilities

SWG will design and construct all Utility Adjustment to their facilities.

Developer shall coordinate with SWG per 107.15 of the TPs.

Actual conflicts can be avoided by determining the exact location and elevation of the gas pipelines. Please be aware that SWG does not provide depth information on its natural gas facilities. Gas pipeline locations shall be confirmed by potholing and exposing the gas pipeline.

There may be abandoned steel gas lines within the Project Limits that are potentially coated or wrapped with unidentified materials. SWG treats all its steel gas pipe with unidentified coating/wrapping materials as potentially containing asbestos. Accordingly, whenever such pipe is in direct conflict and requires removal, it must only be done so by one of SWGs' NESHAP certified contractors. Care shall be taken when working near and exposing these lines. Developer shall contact SWG in advance to coordinate any removal.

Minimum cover over gas mains shall be 36 inches. Any underground facility installed shall have at least 24 inches face-to-face clearance at the point of crossing.

SWG system has pipeline valves, line locating stations, test points and underground vaults each with protective valve box lids and vault manhole covers. These are designed to be flush with the existing ground. Under U.S. Dept. of Transportation's Pipeline Safety Regulations and SWG operating procedures, these facilities are required to be accessible always.

SWG will paint yellow all protective valve box lids and vault manhole covers. Developer shall protect in place these facilities during construction. Developer shall be responsible for adjustments to all valve box lids and vault manhole covers due to grading and paving per MAG Details 391.1 and 391.2. Contact SWG at Tempe Operations 480-730-3670 for coordinating work and inspections. For emergencies, please call 1-800-528-4277.

Only SWG Corporation personnel can adjust high pressure valve boxes due to high pressure sense lines and lubricating lines within the valve box enclosure. The costs associated with such adjustments will be the responsibility of the Developer.

Once mechanical trenching is in progress, do not attempt to trench within two feet of a gas pipe. This trenching shall be done by hand to prevent any damage to the gas pipe. In the event the Developer should "hook" or otherwise strain a gas pipe while excavating, a call should be placed immediately to 1-800-528-4277 or 911.

If a steel facility is exposed and the pipe coating is found to need repair, Developer shall contact 602-271-4277 so a crew can be dispatched to rewrap the pipe.

When the excavations are complete, all exposed gas pipes shall be protected. If left unattended, the exposed pipe shall be surrounded with at least 6 inches below and 6 inches above with Portland cement concrete fine aggregate sand. If the trench is more than 3 feet wide, the pipe shall be supported in a manner where the supporting material does not damage the pipe or the protective pipe coating. Developer shall contact SWG Engineering at 480-730-3855 to review and approve all proposed pipe support designs.

When backfilling, SWG requires both six inches of bedding and six inches of shading with sand or material free of rocks and able to pass through a 3/8-inch screen. Developer shall not drop backfill directly over the gas pipe. During the compaction process, Developer shall use extra care when directly over the gas pipe to avoid any damage.

Developer is advised that special fittings and material used to tap into SWG high-pressure gas pipelines require up to 6 months ordering time. Some of the high-pressure gas pipelines cannot be taken out of service during the winter heating season from October 15 thru March 15.

SWG relocation schedule requires a minimum twelve (12) week notice.

General Notes for working adjacent to SWG facilities are included in the RIDs.

New SWG Crossing

At Sta 8068+67, West of 48th Street, there is an existing 16” steel SWG line crossing I-10. The existing SWG line was installed in 1966 in a joint trench with a 4.5” EPNG line. The EPNG line is abandoned in place.

SWG will design and construct a new 16” crossing ROW to ROW, in close proximity to the existing crossing, that extends to Elwood Street. SWG anticipates that construction of this new crossing will take approximately four months. If the relocation cost is less than $500,000 it will be awarded to SWG’s Blanket Contractor, Arizona Pipeline. If the relocation cost is greater than $500,000 SWG is required to put the contract our for a competitive bid. This process takes approximately 60-90 days.

Developer shall coordinate with SWG and their contractor and include this work in Developer’s CMP schedule.

SWG Prior Rights

SWG is researching possible prior rights at this time.

Kinder Morgan/El Paso Natural Gas (EPNG)

Kinder Morgan/El Paso Natural Gas (EPNG) has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of EPNG facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

EPNG crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Station	Location	Facility	Description
8222+91	Calle Cerritos	Gas	4.5" HP Steel
8263+38	Guadalupe Rd	Gas	6" HP Steel
8288+25	Mineral Rd	Gas	16" HP Steel
8288+42	Mineral Rd	Gas	10.75" HP Steel (abandoned)
8288+57	Mineral Rd	Gas	10.75" HP Steel (abandoned)

Design and Construction of EPNG Facilities

EPNG will design and construct all Utility Adjustment to their facilities.

Developer shall coordinate with EPNG per 107.15 of the TPs.

EPNG Gas Inspection and Permitting

When working within 25-feet horizontally of these crossing Developer shall contact EPNG five days in advance to have an inspector on-site (Rusty Williams, Damage Prevention Supervisor 520-509-3266). Coordination of the inspection schedule shall be coordinated by Developer. The weekly rate for the inspector is $3994/Week ($570.57 per day). See RIDs for the encroachment form which must be filled out by Developer. EPNG will procure an encroachment agreement/letter for the Developer that must be signed by both parties prior to working within their easement. **The cost of inspection, as required, shall be included in the Developer's bid**.

EPNG Prior Rights

EPNG is claiming prior rights for their facilities within the Project Limits. The prior rights documents submitted are included in the RIDs.

Developer must obtain approval from EPNG for any improvements with EPNG ROW or easement.

ADOT is currently reviewing EPNG's prior right's claim and has provided an initial determination in TP Attachment 107-1.

Century Link, Level 3, Cox Communications, Sprint, MCI Verizon, and Zayo

Century Link, Level, 3, Cox Communications, Sprint, MCI Verizon and Zayo have facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of their facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Design and Construction of Century Link, Level 3, Cox Communications, Sprint, MCI Verizon, and Zayo Facilities

Century Link, Level 3, Cox Communications, Sprint, MCI Verizon, and Zayo will design and construct all Utility Adjustment to their facilities.

Developer shall coordinate with these utility owners per 107.15 of the TPs.

Cox Communications has one new crossing planned within the Project Limits (see table below). Plans will be provided as they become available.

Location	Tentative Construction Date
36th Street	TBD

Verizon has six new crossings planned within the Project Limits (see table below). Plans will be provided as they become available.

Location	Tentative Construction Date
36th Street	TBD
Alameda	TBD
Priest	TBD
Baseline	TBD
Elliot	TBD
Warner	TBD

Century Link, Level 3, Cox Communications, Sprint, MCI Verizon, and Zayo Prior Rights

Century Link, Cox Communications, Sprint, MCI Verizon, and Zayo have not claimed prior rights at this time.

AT&T Communication

AT&T has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of their facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Design and Construction of AT&T Communication Facilities

AT&T will design and construct all Utility Adjustments to their facilities. AT&T has advised that any utility adjustment or relocation to their facilities will take approximately six months for design and construction. Developer shall be responsible to verify this schedule and coordinate per 107.15 of the TPs.

Available AT&T Documents

AT&T as-builts plans are available upon request to:

AT&T INQUIRIES
22311 Brookhurst Street, Suite #203
Huntington Beach, CA 92646
joef@forkertengineering.com

AT&T Communications Prior Rights

AT&T Communications has not claimed prior rights at this time.

AT&T Communications Inspection and Permitting

Locating of AT&T's facilities must be arranged by contacting Blue Stake or AT&T's Cable Hazards Center at 1-800-252-1133 no less than 2 working days in advance of any activity within 10' of cable. AT&T Plant Protection Services must be contacted, and be on site prior to any proposed activities within 10' of AT&T cable. The AT&T Plant Protection Supervisor in charge of the cable locators for the AT&T cable facilities in the area of the Project Limits is Mr. Mike McNeal, AT&T OSP Supervisor at Phoenix AZ. (480) 827-6048.

SRP Coordination

SRP and ADOT have entered into an agreement for SRP to provide technical services including preliminary design, engineering and land rights analysis and final design for the entire Project limits.

The preliminary information provided below is based on the kick-off meeting between SRP and ADOT in February 2019. This information will be updated per the on-going coordination between ADOT and SRP as it becomes available.

IPR Process: SRP utilizes an Initial Plan Review (IPR) process which helps identify the impact of a proposed project upon the operation and maintenance of SRP facilities. In order to accommodate the project needs in a responsible and effective manner, SRP Land Department's Land Rights Management Division will facilitate and coordinate a Compatibility Review Process for the proposed improvements within existing SRP Facilities and Land Rights through our IPR Process.

Any improvements within Salt River Project's Water easements/ROW shall have written approval which is given by SRP in the form of a License Agreement.

Any improvements within Salt River Project's Transmission (SRP-T) easement/ROW shall have written approval which is given by SRP in the form of the Consent to Use Agreement.

Prior to the start of any construction Developer shall upload their final plans to the SRP Land Portal. SRP will review the plans and determine if any Land Use Licenses or Consent to Use Agreements will be required. If it is determined that a license or consent is required Developer shall allow ten business days for the execution of the license or consent. The license or consent will be issued to ADOT at no cost.

SRP Power

SRP Power has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of SRP Power facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

SRP Power crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Crossing No.	Station	Location	Description
1	7982+87	34th Street	OH 69kV w/12kV
2	7995+62	36th Street	OH 69kV w/2 circuits of 12kV
3	8009+40	38th Street	OH 12kV
4	8035+81	42nd Street	OH 12kV
5	8062+42	46th Street	OH 69kV w/12kV
6	33+97.16 SR 143	Tempe Drain	OH Double Circuit 69kV w/12kV
7	34+68.04 SR 143	Tempe Drain	OH Double circuit 12kV
8		NW Corner Broadway Rd & 48th Street	OH
9	8123+39	North of Alameda	UG power in 30" RCP
10	8144+23	Fairmont	OH 12kV
11	8176+00	US 60 System TI	UG Crossing
12	8182+40	US 60 System TI	OH Double circuit 69kV
13	8210+10	Baseline Rd	UG Power Crossing
14	8214+75	Highline Canal	Double Circuit 230kV
15	8223+14	Calle Cerritos	OH 69kV/12kV
16	8290+89	Mineral Road	69kV/12kV
17	8343+85	Mid-Section Line between Elliot Rd and Warner Rd	UG Crossing
18	8362+61	Approximately 850 feet north of Warner Rd	UG Crossing
19	8430+90	South of Ray Rd	OH 69kV

When working under or near OH power lines Developer shall contact SRP Safety Services at 602-236-8117. A safety representative will coordinate a meeting with the Developer to discuss working safely under OH Power lines.

Design and Construction of SRP Power Facilities

SRP will design and construct all Utility Adjustments to their facilities except as noted in the TPs. The Developer shall submit lock down sheets prior to SRP starting relocation construction.

Developer shall coordinate with SRP per 107.15 of the TPs.

Preliminary relocation concepts for crossing 2, 3, 4, 5, 9 and 10 are included in the RIDs.

Outages

Developer shall schedule their work to accommodate SRP restrictions for outages. Outages between May 1st and October 1st will be limited. All other outages shall be requested a minimum of 30 Business days in advance.

SRP Power Prior Rights

SRP is claiming prior rights for all crossings.

ADOT is currently reviewing SRP's prior right's claim and has provided an initial determination in TP Attachment 107-1.

Power Lines:
The project has a network of underground and overhead power lines. All work at or in close proximity to said lines shall be performed in accordance with all Federal, State, and local laws and regulations, including but not limited to:

A) Arizona law regarding "Underground Facilities" (A.R.S. 40-360.21, .22, .24, .26 and .28).
B) Arizona law regarding "High Voltage Power Lines and Safety Restrictions" (A.R.S. 40-360.41-.45).
C) The Occupational Safety and Health Administration.
D) The National Electric Safety Code.

SRP Irrigation

SRP Irrigation has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of SRP Irrigation facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

SRP irrigation crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Crossing No.	Station	Location	Description	Action	USA Fee Land
1	7971+16	West of 32nd Street	30" RCP	New crossing 30"/48" or 36"/54" (pipe/sleeve)	Yes. 40' wide[1].
2	8011+27	38th Street	30" RCP (inactive)	New crossing 30"/48" pipe/sleeve	Yes. Width undefined[2].
3	8068+91	West of 48th Street	24" RCP (inactive)	Install 42"/54" pipe/sleeve along west side of 48th Street. SRP will require a 24' easement. New pipe would replace crossings 3 – 5.	No. SRP easement of undefined width.
4	22+75 (SR 143)	Crossing SR 143	36" RCP (inactive)		Yes. Width undefined[2].
5	8075+50	East of 48th Street	42" RCP		No. SRP easement of undefined width.
6	8076+44	East of 48th Street	54" Drain Line	SRP coordinating w/City of Tempe to determine ownership.	No. SRP easement of undefined width.
7	8143+70	West Side of I-10 from Fairmont to Western Canal	24" RGRCP	Replace only the portion of irrigation line that is in conflict with the proposed	No. New 20' SRP easement

Crossing No.	Station	Location	Description	Action	USA Fee Land
				Project improvements.	for any portion of the irrigation line relocated during the Project.
8	8177+32	Western Canal	Box Culvert	See 600.03.06.04 of the TPs.	Yes. 98' wide.
9	8214+75	Highline Canal	6'x4' Box	No conflict anticipated.	
10	8419+62	North of Ray Road	60" RCP	No conflict anticipated.	
11	8424+80	South of Ray Road	21" RCP	No conflict anticipated.	
12	8424+98	South of Ray Road	27" RGRCP	No conflict anticipated.	

Notes:
1. ADOT and SRP have agreed upon a tentative alignment to allow the new crossing to remain within the existing BOR ROW. New SRP irrigation alignment and profile to be coordinated with Developer during final design.
2. For BOR right-of-way of undefined widths, the width will be defined with the Project. Developer shall be responsible for legal descriptions and exhibit as Approved by SRP. SRP will file a Location Notice. No coordination with BOR is anticipated.

Design and Construction of SRP Irrigation Facilities

SRP Irrigation will design and construct all Utility Adjustment to their facilities. SRP will not accept collar extensions of their existing pipe crossings of the freeway. A new pipe crossing will need to be installed from ADOT ROW to ADOT ROW. All new pipe will be Class 5 RGRCP.

The Developer shall submit lock down sheets prior to SRP starting relocation construction.

The Developer shall be responsible for Preparing the Site per 107.15.04.04.04 of the TPs for any work performed by SRP Irrigation.

Developer shall coordinate with SRP Irrigation per 107.15 of the TPs.

Preliminary relocation concepts for crossing 1, 2, 3, 5 and 7 are included in the RIDs.

The Developer shall maintain access to SRP Irrigation facilities at all times, including, but not limited to, manholes, vaults and access points.

SRP Irrigation relocations and/or tie-ins will require coordination to be completed during annual dry-up periods.

SRP Irrigation Prior Rights

SRP Irrigation is claiming prior rights for all crossings.

ADOT is currently reviewing SRP's prior right's claim and has provided an initial determination in TP Attachment 107-1.

USA Fee Land

The Developer is advised that SRP Irrigation crossings may be located within USA Land. Relocations of USA Land will require coordination with the Bureau of Reclamation (BOR). The BOR requires the existing and proposed USA properties cannot be disturbed until construction has been authorized by the BOR.

BOR authorization to construct generally takes 12-18 months.

APS Power

APS has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of APS facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

APS crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Station	Location	Description
7934+04	Salt River Bridge	OH 230kV
8062+02	West of 48th Street	OH 230kV

Design and Construction of APS Facilities

APS will design and construct all Utility Adjustments to their facilities. APS power line safety requirements are included in the RIDs.

Developer shall coordinate with APS per 107.15 of the TPs.

Outages

Developer shall schedule their work to accommodate APS restrictions for outages. Outages between May 1st and October 1st will be limited. All other outages shall be requested a minimum of 90 Business days in advance.

Power Lines:

The project has a network of underground and overhead power lines. All work at or in close proximity to said lines shall be performed in accordance with all Federal, State, and local laws and regulations, including but not limited to:

E) Arizona law regarding "Underground Facilities" (A.R.S. 40-360.21, .22, .24, .26 and .28).
F) Arizona law regarding "High Voltage Power Lines and Safety Restrictions" (A.R.S. 40-360.41-.45).
G) The Occupational Safety and Health Administration.
H) The National Electric Safety Code.

APS Prior Rights

APS is claiming prior rights for facilities within the project limits.
ADOT is currently reviewing APS's prior right's claim and has provided an initial determination in TP Attachment 107-1.

United Dairymen of Arizona (UDA)

UDA has facilities within the Project Limits which are listed/shown in the Utility Matrix and mapping provided by ADOT. This is not intended to be a complete list of UDA facilities. The Developer shall verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

UDA crossings are summarized in the table below for informational purposes. It shall be the Developer's responsibility to verify the location of all Utilities within the Project Limits per section 107.15.02 of the TPs.

Station	Location	Description
121+47	Priest Drive	4" high pressure steel natural gas line

Design and Construction of UDA Facilities

UDA will design and construct all Utility Adjustments to their facilities.

UDA Prior Rights

UDA has not claimed prior rights at this time.

Available UDA Documents

UDA as-builts are provided in the RIDs.

TP Attachment 107-3 – SRP Technical Provisions

The purpose of this document is to provide interested parties with general information and considerations that may be useful to them in the formulation of their proposals pursuant to a Request for Proposal document ("RFP"). The requirements and information contained in this document are informational only, are not intended to be complete, and not every requirement will apply in all situations. Similarly, time frames and possible cost estimates are general estimates only, and may differ by project.

Land Technical Provisions

IPR Process

SRP utilizes an Initial Plan Review (IPR) process which assists in the evaluation for compatibility of a proposed project upon the operation and maintenance of SRP facilities. In order to accommodate the project needs in a responsible and effective manner, SRP Land Department's Land Rights Management Division will facilitate and coordinate a Compatibility Review Process for the proposed improvements with existing SRP Facilities and Land Rights through our IPR Process. Plans can be submitted to a portal site specifically created for your company. You can access instructions for establishing a Company Portal through our web site at the following location https://srpnet.com/about/land/secure/plansubmittal.aspx. Once you have established your portal you can upload plans for a Compatibility Review. You can also submit plans through other electronic means such as email but we encourage you to use our portal system. It's easy and effective. The more detailed the submitted plans the greater the detail of our review but we will start working with you at any step in your process, even at the conceptual planning stages. Earlier is always better.

> Any improvements within Salt River Project's Water easements/ROW shall have written approval which is given by SRP in the form of a *License Agreement*. See section SRP-W for additional information.
>
> Any improvements within Salt River Project's Transmission (SRP-P) easement/ROW shall have written approval which is given by SRP in the form of the *Consent to Use Agreement*. See section SRP-P Section A for additional information.

In addition, if new power service is required by the project, your plans will be submitted to our Customer Construction Services group to coordinate the Design and Construction of your new services. SRP has many planning, design, construction, operational and maintenance groups that require the opportunity to review proposed encroachments upon its existing facilities and the associated land rights protecting those facilities. Involving SRP early in the initial stages of your project planning and design will reduce overall conflicts, minimize changes and shorten response times helping the project to stay on track. A web portal will be created specifically for your company where New Project plans and information can be uploaded. This simple, quick, and paperless process to initiate your request allows the project to be accessible in a central location. Once the portal has been created, an email will be sent with instructions and a link to your company for access. Please keep in mind that once we receive your submittal a Land Agent will be assigned to coordinate the review. SRP may need a full set of civil engineering plans to conduct a detailed review.
SRP requires that ADOT provides easements for all new capital equipment required for new services. (Refer to the Master Agreement). ADOT and SRP have addressed how cost will be determined in Section B Land Transfers. SRP will contend that if the SRP or USA facilities existed prior to the ADOT ROW being purchased, ADOT will be responsible for the cost of relocation including sufficient land rights in agreed upon locations.

Corridor/Envelopes and Width Requirements

Negotiations and decisions as to corridor/envelopes and width requirements for the Design Builders to work within will be handled and settled directly between SRP and ADOT's Real Estate Department only, per the Master Agreement. The applicant will have no involvement in this part of the process. Decisions will be considered final. The Prior land rights determination memo and analysis will be adhered to, once final. We will try to locate within ADOT ROW but not knowing the final design we can't determine if we always can and if easements will need to be acquired.

The following considerations affect the ability of SRP to relocate and/or impact the time needed for the relocation(s):

1. Water related Land rights. It is helpful to understand that SRP is also the agent of the USA in the operation of the federal reclamation project (Project). Essentially, SRP manages the USA land rights with respect to the Project and coordinates these USA Land and Facilities relocations with the Bureau of Reclamation (BOR). If the job scope includes a USA Relocation, detailed Developer, Surveyor, Title and Landscape Guidelines will be provided, but please be aware of the following:
    - A federal realty transaction generally takes up to 18 months to process depending upon the case load of the BOR.
    - A nonrefundable, up-front fee of $7,500.00 to SRP is required to process the property relocation. This fee reimburses SRP for its administrative costs, as well as part of the cost of the environmental assessment.
    - An initial deposit of $8,000.00 must be paid to the BOR before any relocation can occur. This money is used for administrative costs incurred by the BOR in processing the relocation. If costs exceed $8,000.00, the BOR will bill the applicant and require the additional payment before they will proceed with the case. If the costs are less than $8,000.00, the BOR will refund the difference.
    - The BOR will also require an executed Reimbursement Agreement to process this case. The existing and proposed USA properties cannot be disturbed until construction has been authorized by the BOR.
    - Legal descriptions and tract maps for both the existing and proposed USA land rights are required.
    - Title: Applicants must provide the following, together with official copies of all
    - Schedule B documents: (i) a Commitment for Title Insurance for the new USA easement, in the Department of Justice approved form identified as ALTA US Policy 9/28/91 (Revised 12/3/12) and (ii) a Condition of Title or Special Report on the existing USA easement.
    - Copies of all vesting deeds for the parcels involved in the facility relocation must be provided. If the owner is a corporation or partnership, you may be asked to provide documentation authorizing the signor for the Contract and Grant of Easement to the USA.
    - PLEASE NOTE THAT ANY LAND SALES COULD DELAY THIS LAND EXCHANGE PROCESS. Any sales must be coordinated with an SRP land agent.
    - Do not record a plat or otherwise encumber the proposed new USA easement. The BOR will not accept the easement subject to a recorded plat. Please wait to record the plat until the easement has been conveyed to the USA and that conveyance deed recorded.

- Environmental Assessment(s): The BOR will require a Phase I or II Environmental Site Assessment (ESA) that is funded, in part, by the $7,500.00 initial SRP fee. Both the existing and new USA easements will need to be staked for the environmental assessment field inspection. Prior to the site inspection, the ESA Owner Questionnaire must be completed and sent to Environment Consultant. The environmental assessment report is generally completed within six (6) weeks from the date of the site inspection. The environmental assessment report is valid for 180 days. There will be an additional charge of $2,000.00 for any new reports required thereafter.

- Projects impacting over ½ mile or more of USA land rights may require more than one ESA, resulting in additional fees. SRP may charge additional fees for complex or multiple ESA reports (ex. projects involving multiple sections).

- The proposed USA property cannot be encumbered after receipt of requirement letter.

- SRP requires a right of way license to be issued to the City for any improvements planned within the USA Fee property and Land will NOT be released for construction until City has executed such license. Applicant will need to contact City for processing fees. All improvements will need to be approved by Water Engineering prior to licensing.

- **No linear/parallel utilities shall be located within USA right of way (crossings only).**

- The Field Solicitor for the Department of the Interior will verify compliance. SRP will coordinate execution and recording of the Contract and Grant of Easement. Once the BOR has received the recorded document and final approved title policy, the BOR will notify SRP that the job can be released for construction.

- After the job has been constructed and SRP has approved the relocation of the facility, the BOR will execute the conveyance document and release the original USA easement to the underlying fee owner.

- Landscaping: If the new easement area is to be landscaped, SRP will need to review and approve the landscaping plans prior to installation. No trees or oleanders may be planted within the easement.

2. If SRP easement is required for any tie-ins, applicant is responsible to provide the vesting deed, legal description and to acquire the easement. SRP will prepare the easement document. A redesign may be required if the adjacent property owner does not agree to convey an easement.
3. **Claimed Prior Rights, Land Rights and status of ADOT acceptance**
   - SRP Land department will provide prior rights documentation.
   - For any prior rights adjustments, all materials shall be subject to the requirements of the Buy America Act.
   - Some of the laterals, if not all, may have USA land rights. A replacement easement will be necessary in which to relocate these facilities. It can take twelve to eighteen months to complete an exchange of USA easement land, and no ground disturbing activities may occur on the existing or proposed easement areas until the exchange is completed.

- Parallel utilities are not allowed inside the USA easement corridors.
- A Scoping or Pre-Meeting will be scheduled to review how crossing statutes will be applied.

Water Technical Provisions

A. Design, Construction & General Requirements

1. SRP-W forces, or SRP Water on-call firms, will design and construct all needed relocations or adjustments to the SRP-W system.
2. SRP-W must have 24/7 access to water facilities. Developer shall provide safe access for SRP operation and maintenance for irrigation control structures. Developer to provide a minimum of 20 ft. industrial driveway for access to SRP gate structures, See Appendix for MAG Detail 250.
3. Developer shall provide landscaping plans for review and comments to ensure the SRP Right-of-Way Guidelines are being followed.
4. Thanksgiving to Feb 1st is the best time for shutdowns that may be required. Shutdowns may be possible on certain facilities at other times of the year. All shutdowns are at SRP- W's sole discretion dependent on water user or operational demands.
5. All SRP-W agreements will be with ADOT, not with third parties.
6. No SRP-W facilities will be deactivated.
7. If a facility is abandoned in place, SRP will execute a transfer agreement with ADOT to transfer ownership of facility. ADOT will be responsible for future blue staking of this facility. Developer shall be responsible for removing any portions of the abandoned facility in conflict with the proposed improvements in accordance with these Technical Provisions.
8. ADOT's contractor is responsible for removing the existing irrigation facilities once the new ones are operational.
9. All new pipe installed will be class 5 RGRCP, unless otherwise noted by SRP-W.
10. SRP-W will not accept collar extensions of the existing pipe crossings of the freeway and roadways. A new pipe crossing the freeway will need to be installed from ADOT R/W to ADOT R/W following SRP and ADOT specifications on utilities in casing under the freeway.
11. Any existing irrigation facility that runs parallel with the new roadway will not be allowed to stay under a traffic lane or installed under new traffic lanes.
12. SRP-W has an existing master maintenance agreement for facilities within ADOT ROW. Any new or replaced siphons will need to be incorporated into the ADOT agreement.
13. Siphons require a gate connection to the ADOT storm drain system for annual maintenance purposes. Developer will be responsible for tying the SRP drain into the ADOT storm drain system.
14. For pipes 36" or less in diameter, manhole spacing cannot exceed 500'. For pipes greater than 36" in diameter there is no restriction, but are generally placed at ¼ mile intervals or at changes in direction or grade.
15. Developer will be responsible for setting final top elevations for all of SRP manholes. Once top elevations are set by Developer and manhole is constructed, if adjustments are necessary Developer will be responsible for cost. Developer must determine if manhole will be within concrete or asphalt roadway surface if manhole will be located within the roadway cross-section.
16. SRP-W does not design or construct private irrigation facilities. Adjustments needed to the private systems that are beyond the SRP-W point of delivery will have to be done by the Developer if necessary.
17. During design, SRP-W will develop a list of potholes needed, and Developer will be responsible for performing those potholes, unless SRP-W decides to do them at the Developer's cost.

18. Within project construction limits, where SRP-W is currently in open ditch, the ditch will need to be piped through the conflict area.
19. Cost to repair any damage to an existing, new, or partially completed facility, including survey markers and staking, will be the responsibility of Developer. All repairs will be done by SRP forces.
20. Developer will need to acquire an SRP license to undercross any of the SRP irrigation facilities.
21. Any budget estimates provided to ADOT or Developer without accompanying an executed agreement are just that – budget only and SRP will not be held to performing work against those numbers.
22. Buy America compliant material will be purchased once the plans have been reviewed and accepted by Developer. Some materials may have long lead times. SRP had design guidelines and specifications for bridge crossings of SRP canal available online at www.srpnet.com/water. See Appendix for SRP Right of Way guidelines and Utility Crossing or Parallel to SRP Irrigation Pipe.

Transmission Technical Provisions

SRP Power (SRP-P) is responsible for transmission and distribution line engineering design, construction, and maintenance of SRP's transmission and distribution assets. The five groups within SRP-P are Transmission Line Asset Management (TLAM), Transmission Line Design (TLD), Transmission Line Construction (TLC), Transmission Line Maintenance (TLM), and Distribution Design, Construction, & Maintenance (DIST).

Transmission Line Asset Management (TLAM)

SRP TLAM works with the SRP Land Department to provide conflict review for ADOT roadway construction projects. Plans for development or improvement that may impact SRP easements/ROW or any SRP asset should be submitted to the SRP Land Department via the Initial Plan Review (IPR) process. Please see Section A, Improvements within SRP's Transmission Easements/ROW, below in this document.

Additionally, as needed SRP Safety Services may be reached at (602) 236-8117 or Safety@srpnet.com for more information.

Please contact SRP Transmission Line Support at (602) 236-3080 or TransmissionLineSup@srpnet.com for more information on the topics included in this section of the documentation.

Easements adjacent to ADOT Roadway Construction Projects

SRP must have 24/7 access to SRP electric facilities. Developer shall provide safe access for SRP operation and maintenance for all SRP electric facilities.

ADOT, at all times, shall permit SRP to access and maintain any SRP electric facilities. ADOT shall provide SRP all requested easements before beginning construction, including any easements required from third parties for SRP to access and maintain the electric facilities using SRP's standard form(s) of easement.

SRP General Design Guidelines for ADOT Roadway Projects

A. Improvements within SRP's Transmission Easements/ ROW
B. Electrical Clearance Calculations
C. Tree and Ground Cover Restrictions
D. Storm Water Retention Basin
E. 69kV Setup Areas
F. Extra High Voltage (EHV) Setup Areas
G. Excavation near Transmission Structures
H. Blasting
I. Gates and Fence
J. Maintenance Practices
K. Construction Activities
L. Damage Claims

A. Improvements within SRP's Transmission Easements/ROW

Any improvements within Salt River Project's Transmission easement/ROW must have written approval which is given by SRP in the form of the *Consent to Use Agreement*.

To obtain a *Consent to Use Agreement,* plans must be submitted to the SRP Land department where they will undergo a process of review, revision (if necessary), and approval. The review process should begin early in the design process to obtain approval of plans prior to construction. Upon approval of the final plans, a *Consent to Use Agreement* will be drafted by the SRP Land Department and sent to the Landowner for signature. The *Consent to Use Agreement* including an exhibit will be recorded at the County Recorder's Office. The approved plans are retained by SRP. *Consent to Use Agreements* are conditional and subject to future SRP expansion requirements within the SRP easements/ROW in the future.

Note: SRP has a process with ADOT to issue Clearance Letters to supplement the use of *Consent to Use Agreements.*

General guidelines for the *Consent to Use Agreement* process are as follows:

1. All plans submitted to SRP must be drawn "to scale". Plans should be submitted to the SRP Land Department via the Initial Plan Review (IPR) process which may be started at https://www.srpnet.com/about/land/secure/plansubmittal.aspx , please contact (602) 236-3117 or Workflow@srpnet.com for more information.

2. All plans must show SRP easements/ROW boundaries. If any applicable SRP easements/ROW is not shown the plans may be rejected by SRP and submittal of revised plans will be required.

3. All plans must show SRP facilities, including structures and overhead wire locations. Additionally, they must show compliance with structure/wire setup areas per *SRP Transmission ROW Maintenance Setup Areas* diagrams for appropriate voltages. If applicable SRP facilities are not shown the plans may be rejected by SRP and submittal of revised plans may be required.

4. Plans must show all proposed improvements within SRP easements/ROW, including utilities, paving, grading, drainage, lighting, landscaping, etc.

   Note: Plans may be rejected for review if they do not meet items 1-4 listed above.

5. Lighting structures must meet SRP electrical clearances with respect to the overhead conductors and towers/structures. In general, lighting structures 12 feet high or less should not violate SRP electrical clearances. Proposed lighting plans need to be reviewed and approved by SRP. SRP may require the land owner to provide a Survey of SRP wires and structures as part of calculating clearances and approving lighting within SRP easements/ROW. SRP does not provide transmission outages for lighting maintenance.

6. In general, trees are prohibited within SRP easements/ROW. In special cases some landscaping, including low growing type trees, may be allowed provided it does not interfere with the maintenance of existing or future transmission lines. All proposed landscaping in SRP easements/ROW plans shall be reviewed and approved. A copy of the *SRP Approved Trees* and *SRP Approved Ground Cover* lists is included in the appendix.

7. SRP does not allow buildings (temporary or long term) or other structures, dumpsters, or drywells within SRP easements/ROW.

8. Retention basins will need to be designed by the customer to adhere to the *Storm Water Retention Basin Design Guidelines*. The *Storm Water Retention Basin Guidelines* provide general direction but each situation is unique and may include site-specific plans review comments from SRP. A copy of the *Storm Water Retention Basin Design Guidelines* is included in the appendix.

9. In general, SRP requires maintenance roads (with a maximum slope of 20:1) along the length of the SRP easements/ROW, parallel to the transmission line. Multiple maintenance roads may be required to maintain multiple wires/circuits. The appropriate offset for the maintenance road with respect to each of the transmission line wires is determined by SRP. The roads are generally 20 feet wide, not including the width required for setup areas at towers/structures and at specific intervals along the wires. SRP maintenance roads shall be accessible from public ROW. Due to the complexity of issues involved, maintenance roads will need to be designed by the landowner's consultants based upon input from SRP. A copy of the *SRP Transmission ROW Maintenance Setup Areas* diagrams is provided in the appendix. (The *SRP Storm Water Retention Basin Design Guidelines* diagram also contains general design information for pole and wire setup areas.)

10. Maintenance equipment/crane setup areas (with a maximum slope of 20:1) are required at towers/structures and at intervals parallel to the wires. The setup area at a tower/structure differs depending upon the voltage of the line. The Extra High Voltage (EHV) (*e.g.* 115kV, 230kV and 500kV) tower/structure setup area is generally defined as, a length of approximately 50 feet in each direction from the structure, by the width of the SRP easements/ROW. The 69kV structure setup area is generally defined as, a length of approximately 30 feet in each direction from the structure, by the width of the SRP easements/ROW. Depending upon the transmission line voltage, the distance between setup areas along the wires and the size of the setup areas will vary. Due to the complexity of issues involved, tower/structure setup areas and wire setup areas will need to be designed by the landowner's consultants based upon input from SRP. A copy of the *SRP Transmission ROW Maintenance Setup Areas* diagrams is provided in the appendix. (The *SRP Storm Water Retention Basin Design Guidelines* diagram also contains general design information for pole and wire setup areas.)

11. Parking may be acceptable use of SRP easements/ROW for EHV transmission lines upon SRP evaluation for compatibility and written notice. There are specific requirements for orientation with respect to traffic flow. Maintenance roads and crane setup areas will need to be incorporated into the parking design based upon input from SRP. Any vehicles parked within SRP easements/ROW must be able to be relocated, 24 hours a day and seven days a week, at the request of SRP.

    Note: SRP easements/ROW for 69kV transmission lines does not allow for parking.

12. All pipes, manholes, or other proposed facilities to be located at or below grade in SRP easements ROW must be designed to withstand a minimum of 320 psi on a 27 inch diameter outrigger pad. Load calculations sealed by an Arizona licensed Civil Engineer must be provided along with plan and profile views for all underground installations for SRP review and approval. No paralleling utilities within the SRP easements/ROW will be allowed. Underground utilities may be allowed to perpendicularly cross/encroach upon SRP

easements/ROW with SRP written approval.

13. No grade changes/cut or fill is permitted within SRP easements/ROW without prior written approval. SRP has specific requirements for excavations near SRP towers, structures and facilities.

14. Public Utility Easements (e.g. PUE, MUFE, PUFE, etc.) shall not be platted and approved in SRP easements/ROW. A city or municipality approval of a PUE does not supersede SRP land rights.

15. For Transmission pole bracing, pole relocations, or transmission line conflict checks, plans should be submitted to the SRP Land Department via the Initial Plan Review (IPR) process.

B. Electrical Clearance Calculations

Electrical clearance calculations are an additional submittal requirement that is not part of the Internal Plans Review (IPR) process that is separately submitted to SRP-P. Clearances are important for maintaining access where we "give like for like" unless NESC requires more clearance. Any clearance calculations will need to be stamped and signed by a Professional Engineer. Any review of the proposed improvements will require survey data.

Survey Data

Using the same survey datum as SRP Transmission Line Design (TLD) (SRP TLD's survey datum is described later in this document in the TLD section under the Survey topic), please provide the following survey data:

1. The "point of attachment" elevations for the lowest wire on each transmission pole/tower for the spans that are affected by your improvements.

2. The elevation of grade at the base of the pole/tower for the spans that are affected by your improvements.

3. The elevation of the lowest wire exactly at each midspan. (Midspan is half the distance between the two points of attachment surveyed above).

4. The horizontal distance (with no incline) between these attachment points.

Engineering Data

Develop two separate drawings as described below using the survey data above.

Plan Drawing

1. Dimension all horizontal distances from the nearest attachment point (surveyed above) to the proposed improvement(s) involved.

2. If applicable, dimension all horizontal offset distances (perpendicular from the wire) to the proposed improvement(s).

Profile Drawing

1. Dimension all elevations of the attachment points, midspan points (surveyed above) and the elevations of the proposed improvements.

2. Clearances based on NESC for both RS and FE need to be provided.

C. Tree and Ground Cover Restrictions

Approval or Disapproval of all trees/ground cover regardless of whether they are on the approved list is dependent upon electrical clearances to conductors based on voltage, as well as locations that do not hinder SRP maintenance crew access/setup. Any tree located under or near any electric lines is subject to trimming or removal by SRP. Trimming may result in the tree having an unnatural appearance. A copy of the *SRP Approved Trees* and *SRP Approved Ground Cover* lists is provided in the appendix.

D. Storm Water Retention Basin

The following list of minimum criteria is required by anyone wishing to use SRP transmission easements for storm water retention basins. They must obtain specific written approval from the SRP Land Department before any construction may proceed within the easement property. A copy of the SRP *Storm Water Retention Basin Design Guidelines* diagram is provided in the appendix.

1. The property in question must be owned, in fee, by the developer or other requestor of multiple use in the easement.

2. The retention basin design must provide for continuous vehicular access and crane set-up areas along each edge of the easement (10:1 maximum longitudinal slope) above high water. Typically, this will require 35 feet wide access roads along each edge. An option is 20 feet wide access with 35 feet x 60 feet crane set-up pads centered at 110 feet.

3. As a crane set-up area and to protect the integrity of each pole or tower, a rectangular, level area of ground (above high water) must be provided measuring a minimum of 50 feet in each direction from the outside edge of any foundation. Typically, this cleared area will need to extend all the way across the easement (transverse) and tie to the access roads. Clean fill is acceptable, provided the grades remain 6 inches below the top of foundations.

   Note: Any proposed cuts or fills within the ROW are to be reviewed by SRP. This area must drain away from foundations, with 20:1 maximum slope.

4. The retention basin may have side slopes of 4:1 (maximum), but must provide 20 foot wide access ramps (10:1 maximum slope) into basin from each structure location. All areas must be protected from soil erosion with erosion protection method approved by SRP.

5. Approval or disapproval of all trees/ground cover regardless of whether they are on the approved list is dependent upon electrical clearances to conductors based on voltage. As well as locations that do not hinder SRP maintenance crew access/setup. Any tree located under or nearby electric lines is subject to trimming or removal by SRP. Trimming may result in the tree having an unnatural appearance.

6. If a water flow is required across the roadways or the 50-foot areas around structures, it must be constructed of pipe capable of withstanding a concentrated load from a crane outrigger with 320 psi on a 27 inch diameter pad. Calculations must be submitted to SRP showing the anticipated loading and strength analysis.

7. No drywells within easement. If required, drywells must be located outside the SRP easement area with a catch basin inside the retention basin area. Design and location of catch basin, piping & drywell to be reviewed by SRP prior to any construction.

8. 20 feet wide openings or gates (in approved locations and perpendicular to access) must be provided in any fences or walls crossing the easement. Fences need to be grounded and must have shared lock access.

9. An engineered design of the proposed retention with the proposed time for it to drain must be submitted to SRP for review and approval.

E. 69kV Setup Areas

A copy of the *SRP Transmission ROW Maintenance Setup Areas* diagrams is provided in the appendix.

1. Structure setup areas for 69kV transmission lines are defined as a rectangular area 30 feet on each side of the face of structure by the width of the easement. Setup areas and wire setup areas must be clear of above
grade improvements. SRP requires unobstructed "high and dry" maintenance roads that are 15 feet wide with a 20:1 maximum slope which run parallel to the conductor for the entire length of the easement on both sides of the towers/structures. Those maintenance roads require access 24 hours a day and 7 days a week.

2. Wire setup areas for 69kV transmission lines are defined as a rectangular area 35 feet long by the width of the easement, repeated every 50 feet between the structure setup areas.

   Note: Structure setup areas and wire set up areas for the 69kV transmission lines are reviewed during the SRP Initial Plan Review Process.

3. Below grade improvements within structure setup areas for 69kV transmission line are reviewed on a case by case basis. Prior written consent by SRP is required.

   Note: Improvements within SRP easements/ROW for 69kV transmission lines must meet 320 psi point load on 27 inch diameter pad.

4. Certain 69kV structures are required to meet Extra High Voltage (EHV) setup area requirements. In addition, any pole height for 69kV design that exceeds 80 feet above grade requires consultation with SRP Transmission Line Asset Management (TLAM) and agreement on the design. Highway crossings and other special cases may require taller poles. In these cases, larger setup areas, maintenance roads, and easements will be required.

5. Parking is not an acceptable use of SRP easements/ROW for 69kV transmission systems.

F. Extra High Voltage (EHV) Setup Areas

A copy of the *SRP Transmission ROW Maintenance Setup Areas* diagrams is provided in the appendix.

1. Tower/structure setup areas for Extra High Voltage (EHV) transmission lines (e.g. 115kV, 230kV and 500kV) are defined as a rectangular area 50 feet on each side of the outside tower legs or face of structure by the width of the easement. Setup areas and wire setup areas must be clear of above grade improvements. SRP requires unobstructed "high and dry" maintenance roads that are 20 feet wide with a 20:1 maximum slope which run parallel to the conductor for the entire

length of the easement on both sides of the towers/structures. Those maintenance roads require access 24 hours a day and 7 days a week.

2. Wire setup areas for EHV transmission lines are defined as a rectangular area 60 feet long by the width of the easement, repeated every 100 feet between the tower/structure setup areas.

   Note: Tower/structure setup areas and wire set up areas for EHV transmission lines are reviewed during the SRP Initial Plan Review Process.
3. Below grade improvements within structure setup areas for EHV transmission line are reviewed on a case by case basis. Prior written consent by SRP is required.

   Note: Improvements within SRP easements/ROW for EHV transmission lines must meet 320 psi point load on 27 inch diameter pad.

4. Parking may be an acceptable use of SRP easement/ROW for EHV transmission lines. There are specific requirements for orientation with respect to traffic flow. Maintenance roads and crane setup areas will need to be incorporated into the parking design based upon input from SRP. Any vehicles parked within SRP easements/ROW must be able to be relocated, 24 hours a day and 7 days a week, at the request of SRP.

G. Excavation near Transmission Structures

Drawing Submittal Guidelines Required for Review/Approval

Engineered drawings of proposed excavation must be submitted to SRP for review at the early stages of the customer's design process. Excavation within 100 feet near SRP transmission structures or anywhere within the SRP ROW, whichever is greater, requires approval from SRP prior to construction.

The customer may employ consulting engineers to perform pole stability/excavation analysis and should contact SRP to obtain requirements. SRP reserves the right to accept or reject consultant methodology and conclusions based on the quality of the work and demonstrated knowledge of electric system structures/foundations.

Please provide the following information on your drawings:

1. An engineering scaled plan view with a cross section at each pole location, showing the existing grades and the proposed excavation. Plan should include general site location information such as adjacent streets or other geographic features.

2. The cross section should be perpendicular to the excavation through the center of the pole, showing all dimensions with respect to the edge of the pole foundation. Dimensions should at least include depth and width of excavation, and the horizontal distance from edge of excavation to nearest edge of pole foundation.

3. Cross section should also show the dimension from the existing grade to the top of the pole foundation. Note the diameter of the pole foundation and indicate the SRP pole number.

4. The excavation cross section should show the side slope or bench planned for construction that meets OSHA/ADOSH safety standards.

5. All work will need to be stamped and signed by a professional engineer.

6. Any additional information describing the construction process will aid in establishing reliable temporary structure safety factors for the analysis. This includes work items such as time period from start of excavation to end of backfill, time of year planned for work, and distance of cut to active traffic vibration. Also, submitting soils reports performed for the planned work may reduce the time required by SRP to evaluate this information.

General Analysis Guidelines for Excavations adjacent to SRP Electric Power Poles

1. The purpose of this analysis guideline is to provide general information for analyzing the stability of electric transmission power pole and tower foundations adjacent to temporary utility or construction excavations. The information contained herein covers data required for the analysis, the responsibility of entities both gathering data or performing analysis, load causes and criteria, models to be used for analysis and reporting for analysis results.

2. Analysis of the impact of excavations on adjacent foundations is a complex soil-structure interaction problem. Since there are no standard soils, excavation dimensions or power line configurations, there can be no standard distances or depths for safe excavations. The problem is also time dependent since a higher standard is required for long-term wind and weather conditions than would be for short-term situations.

Analysis Elements

1. Structures: SRP Transmission Line Design and Maintenance departments are responsible for providing information
   on the structure elements. These structural elements include:

   a. Pole material, length, dimensions, wall thickness (if steel).

   b. Foundation embedded depth, type (direct embed or drilled pier concrete), backfill material and quality, dimensions.

   c. Conductor configuration, type diameter, length to adjacent poles, quantity, location on pole, angles from tangent, tensions.

   d. Other equipment on pole (transformers, street lights, capacitors, comm. & cable).

2. Soils: A registered professional geotechnical engineer must determine all soils elements. This may require a subsurface investigation, laboratory testing and soils analysis. Alternately, the geotechnical engineer may be able to rely on file data from other work performed in the area if it is of sufficient quality and quantity and representative of the pole and excavation location. These soil elements include:

   a. Description of subsurface strata to full depth of trench or pole foundation (whichever is deeper).

   b. Soil strength properties (friction angle, cohesion, unit weight).

c. Soil deformation properties.

d. Caving potential when excavated (based on soil and adjacent environmental conditions).

e. Reaction to water inundation (or protection from saturation).

3. Excavations: The excavation contractor in conjunction with the designer of the new underground facility will determine the excavation elements. SRP requires excavation and conduit/pipe drawings show a cross-section of excavation geometry (width and depth of excavation) in relation to SRP pole or tower foundation/embedded pole (example attached). These excavation elements include:

   a. Excavation geometry (depth, width, side slopes – final excavated condition).

   b. Clear distance from edge of excavation to face of pole foundation.

   c. Ground elevations between excavation and pole.

   d. Personnel protection or shoring methods.

   e. Backfill materials and methods.

   f. Time excavation will remain open.

Loading and Structural Performance

The analysis on the impact of excavations to adjacent pole foundations must address the following concerns:

1. Wind forces on pole expected during the time that the excavation will remain open.

2. Acceptable short and long-term wind and tension load safety factors.

3. Acceptable structure movement (rotation and deflection) as a result of the open excavation.

4. Evaluate all modes of pole movement: over-rotation near surface, kick-out of pole foundation bottom, loss of ground for excavation below bottom of foundation.

Load and Performance Criteria

The following load and performance criteria has been used for previous evaluations. These may need to be adjusted by SRP depending upon the electric line location and importance. (Note: wind pressure is in psf is equal to 0.00256 x velocity^2, velocity in mph):

Case: “Long-Term”

Long-Term Wind: NESC Rule 250B (Combined Ice and Wind) using “Light” district (9 psf wind (60 mph), safety factor of 0.05 lb. /ft., no ice). Use 60 mph wind on conductor and 60 mph wind on pole. The following overload condition factors are applied to the determined loads; wind load upon conductor, wire, and structures increased by 2.50, tension on conductor and wire increased by 1.65, vertical wire load and weight of structures increased by 1.50.

Long-Term Line Tension: NESC Rule 250C (Extreme Wind Loading). Based on ASCE 7-05 for 50 year return period, exposure category “C”, not applicable to structures and facilities below 60 feet, load factors with change in grade of construction. Use 100 mph wind load on conductor, wire, and structures. Apply overload condition factor of 1.10 to conductor, wire, and structures for wind, 1.10 to conductor and wires for tension, 1.10 to vertical load and weight of conductor, wire, and structure load.

Structures supporting high voltage electric transmission lines (115kV and higher): Maximum top of foundation ground line deflection no greater than 4% of foundation diameter and rotation no greater than 1 degree at maximum loads,

Structures supporting electric sub-transmission and distribution lines (69kV and lower): Maximum top of foundation ground line deflection no greater than 5% of foundation diameter and rotation no greater than 2 degrees at maximum loads.

If the “Long Term” case doesn’t work then additional cases may be reviewed or pole bracing may need to be provided by SRP at the cost of the applicant.

Soil-Structure Interaction Analysis

1. Engineering analysis must initially determine loads transferred to the top of the pole foundation or direct embedment pole at ground line for each load case. Typically, a static analysis is used to determine ground line moment and shear. Load cases to be evaluated include long-term, temporary and short-term conditions.

2. Once ground line forces are determined, the analysis must evaluate each load case to ensure that structures perform within the defined performance criteria and the adjacent excavation wall will not fail from loads induced into the soil from the structure foundation. Soil-structure interaction modeling can include the following methods:

    a. 3-dimensional finite element model.

    b. For lateral load analysis, a combination of a model that can estimate pole movement and

    c. resulting soil pressures (LPILE, FAD, etc.) with a model that then takes those loads and applies them to the soils on the backside of the excavation from the loads.

    d. For uplift or compression load analysis, a model that can estimate pole movement and the associated soil mass required to resist uplift/compression forces while superimposing the ground loss resulting from the open excavation.

Reports

An engineering report shall be prepared and sealed by a professional engineer registered in the State of Arizona who is qualified to perform both soil and structure analysis. The report must document the following items:

1. A description of the project, including the SRP power line and pole numbers involved.

2. All structure, soil and excavation data/configurations for each pole being analyzed.

3. All work required to obtain data and source of data.

4. The performance criteria for the analysis.

5. Analysis model and methodology.

6. Results of the analysis for each structure and each load case, with appropriate loads directed both toward the excavation and away from the excavation.

7. A summary of the impact for critical load conditions on each structure in relation to pole performance criteria and excavation slope stability.

8. Actions required (if any) to insure pole stability for each load case (trench shoring, structure bracing/guying, relocation of trench, modification of the trench dimensions, horizontal bore installation of the new underground facility).

9. Recommendations for new underground facility installation that will least impact the electric power structures (use of short-term or temporary excavation and backfill conditions, improved backfill materials, specialty shores to provide additional trench wall stability and resist pole forces).

10. Other trench construction recommendations in the vicinity of structures (trench backfill specifications, trench protection from storm water, shoring specifications, traffic/equipment/spoil restrictions between trench and structure.

11. Appendixes with all data, calculations, surveyed cross section at each pole location, site map, etc.

H. Blasting

Pre-Blast Survey

A pre-blast survey of all SRP facilities and structures within 500 feet of all blast events to be performed by independent, qualified third party. Final, complete report to be submitted to SRP a minimum of 10-days prior to commencement of blasting. Purpose of survey is to document any distress including existing cracks within SRP structures. The third party may exclude condition of conductor, attachments, and insulators of SRP structures as SRP will conduct own pre-blast survey of these items.

Blasting Plan

A Blasting Plan for **each** proposed event that is to occur within 500 feet of an SRP facility (includes, but not limited to, underground structures, above-ground structures, structures supporting overhead electric power, overhead conductor, overhead equipment and materials, substation equipment and walls, underground electric ducts, underground conduit, underground irrigation pipeline, manholes, and box culverts) must be submitted to SRP for approval.

Blasting Contractor shall fully comply with the requirements of the approved Blasting Plan. SRP approval is focused on the protection of nearby SRP facilities, and SRP approval of the Blasting Plan should not be interpreted as SRP dictating or approving safety and method used by the Blasting Contractor. The Blasting Contractor is solely responsible to ensure that his method is safe, that all

statutory and imposed requirements and limitations are followed, and to obtain approval from all relevant authorities and follow their requirements.

Submitted Blasting Plan is to provide details of the proposed event including, as a minimum, the following information:

1. Project name, shot/event identification, and submittal date.

2. Location (include map and show SRP facilities including horizontal distance from blast area to facilities, and include location of drill holes in relation to SRP overhead conductor and provide elevations of top of
drill rig and overhead conductor when inside SRP right-of-way).

3. Provide sketch showing where blast monitoring equipment for SRP facilities will be placed, and show distance from blast.

4. Scaled distance, anticipated PPV, and anticipated maximum air overpressure at nearest SRP facility.

5. Production diameter, spacing, total depth, total number, inclination, and map of location of holes.

6. Bench height, sub-drill height, stemming height, burden height, and loaded height.

7. Type and size of explosives used including specific gravity.

8. Quantities of explosives used/hole and total quantity of explosive.

9. Sequence of blasting and planned time delays. Include holes/delay and maximum explosive pounds/delay. Sketch showing anticipated movement of shot relative to SRP facilities including anticipated direction of throw of blasted rock.

10. Comment on throw of rock blasted rock and its impact on SRP facilities (including overhead conductor) and any measures used to control fly rock, if required.

11. Detailed description of fly rock control method, where required (i.e., overburden thickness, overburden material type, overburden footprint, compactive effort used to place overburden, type of blasting mat/strip, size of blasting mat/strip, detail of blasting mat/strip placement including any anchoring, mat/strip weight, composition of mat, and any special blasting techniques used such as delays and development of free faces away from the structure provisions to control fly rock).

The Contractor's blasting event shall generally be considered satisfactory and in conformity with these specifications when the unstable rock mass is cleanly split from the stable rock mass in such a way that subsequent site activities do not shatter or loosen adjacent rock that is not to be removed. All drilling and blasting shall be done in such a manner as to bring the cliff face as close as possible to a stable profile and to disturb as little as possible the material to be left in place.

Event Report

Blasting Contractor shall provide the **SRP Designated Blasting Representative** an Event Report for each blasting event. Event Report must be submitted prior to performing any future blasting event that requires SRP approval, or within 24-hours from the most recent blast event, whichever is the shorter period. The time required to provide the Event Report may be adjusted by SRP should accurate verbal reporting regarding blasting event data be provided to SRP Blasting Representative soon after completion of the blasting event.

A. The Event Report shall contain all pertinent information of the blast event, and shall use English units. Event reports shall provide, as a minimum, the following information:

B. Blast Date and Time.

C. Blast Identification.

D. Duration of Record Time.

E. Operator Name.

F. Set-Up Identification/Location.

G. Serial Number of Seismograph.

H. Seismograph Most Recent Calibration Date and by Source of Calibration.

I. File Name.

J. Maximum Pounds of Explosive per Delay.

K. Peak Velocity for Each Component (Transverse, Vertical, Longitudinal).

L. Zero Crossing (ZC) Frequency for Each Component.

M. Time Relative to Trigger for Each Component.

N. Peak Acceleration for Each Component.

O. Peak Displacement for Each Component.

P. Peak Sound Pressure Level (PSPL).

Q. Zero Crossing (ZC) Frequency for Air Overpressure.

R. Plot of Data with OSMRE and USBM RI8507 Limits.

S. Vibration and Microphone Data Time Histories (Plot, Tape, or Other Data Presentation Method).

T. Drawing, Map, and/or Scaled Image of Blast Location and Monitoring Locations, and Any Other Pertinent Information.

Monitoring Equipment and Set-Up

Each blast event shall be monitored for blast induced ground vibration and air overpressure by a qualified independent testing consultant or agency well experienced in that type of work.

SRP Blasting Requirements near SRP Facilities Including Overhead Conductor

Blast events must be planned and performed so as not to generate fly rock that may impact any SRP facility, this includes but is not limited to structures, structures supporting overhead electric power, insulators, conductor, hardware, attachments, and arms of structures.

SRP will not permit blasting events within 20 feet (horizontal distance) of any SRP structure supporting overhead electric power, and any other underground and above-grade structure. A special review process may be requested for blasting closer than 20 feet with the understanding that SRP review of this process may require several weeks, and it is likely that this review would not allow blasting at the closer distance. Blasting may be conducted directly beneath SRP overhead conductor upon approval by SRP.

SRP requires that any blasting within 50 feet (horizontal distance) of an SRP structure, structure supporting overhead electric power, or overhead conductor be designed to control fly rock. This design, as a minimum, must include covering of loaded holes using non-conductive blasting mats, non-conductive rubber strips, and/or overburden. Additionally, specialized blasting techniques such as use of delays and controlling development of free faces away from the conductor should be incorporated into the design.

Method proposed by Blasting Contractor to control fly rock must be proofed to the satisfaction of SRP by at least one test blast or one production blast located outside the 50 foot distance. Success of the proof would dictate requirement for adjustment of method and further proof testing.

Metal blasting mats and any other conductive blasting mats are not permitted within 200 feet (horizontal distance) of overhead conductor. Blasting mats must be anchored to prevent the mat or other material from being thrown into the overhead conductor. Leading wires shall be placed at right angles to the overhead conductor alignment and shall be securely anchored to prevent the blasting circuit conductor from being thrown into the overhead conductor.

Placement of overburden (including but not limited to thickness, compactive effort, material type, and area) is to be determined by the Blasting Contractor.

SRP Right to Delay or Cancel Blasting Work

SRP has the right to postpone or cancel a blast event due to operation concerns of the electric power system. These concerns would include items such as high load through conductor, or the in-ability to shed load rapidly in case of damage. The **SRP Designated Blasting Representative** would communicate any required cancellation or postponement to the Blasting Contractor as soon as possible.

SRP has the right to postpone or cancel future blast events should a preceding blast event not have performed as designed, or the event had the appearance of possibly damaging existing at-grade or underground structures, overhead conductor, or structures supporting overhead electric power. Items such as PPV or air overpressure values being above limits stated herein, fly rock encroaching structures or conductor, and the **SRP Designated Blasting Representative** observing any possible damage to structures and conductor would be considered a reasonable cause for shutdown.

Blasting Work would be shut down until SRP has had the opportunity to observe and assess competency of structures and overhead conductor, and SRP has completed all necessary repairs (if required). Also, Blasting Work would be shut down until SRP approves submittal presenting reason(s) that blast event was not as anticipated, and corrective action(s) that will be taken to prevent such occurrence from repeating.

SRP has the right to modify requirements of this Specification should damage occur to their facilities due to blasting events that meet all requirements stated within.

SRP Representatives and Submittal Confirmation

SRP will have two (2) to four (4) representatives to accept the submittal of a scheduled blasting event or Blasting Plan. These representatives are identified as "SRP Blasting Representatives." Initial contact of the SRP Blasting Representative of a scheduled blasting event or submittal of a Blasting Plan by the Blasting Contractor must be by e-mail to the SRP address TransmissionLineSup@srpnet.com.

I. Gates and Fence

When gates and/or fencing is required the following outlines the minimum criteria required by anyone wishing to install them within or adjacent to SRP easements/ROW. They must obtain specific written approval from the SRP Land Department before any construction may proceed within the easement property.

Gates

1. Gates need to be self-closing and set parallel to the slope of road.
2. Where cattle guard is used, cattle guard shall be aligned with road.
3. Steel poles and braces shall be galvanized or painted with a baked-on asphalt base enamel.
4. Set fence posts and braces in concrete. Concrete shall be 2000 psi at 28 days.
5. Standard 20 feet gate shall be 42 inch high minimum with 1 3/8 inch O.D. galvanized iron tubular frame. All fittings shall be galvanized. Gate shall have a diagonal adjustable sag-rod or wire. Minimum weight of gate shall be 70lbs.
6. G. I. Mesh Fence filler to be 11 gauge farm fence filler or equivalent.
7. Install sign. Sign to read "Keep Gate Closed".
8. Install copper braided strap. Typically 12 feet (BURNDY BD12 or equal) bonded for proper grounding.

Fence, Galvanized Chain-Link

1. Fences need to be grounded and must have shared lock access.
2. Install grounds at points not to exceed 500 feet apart in any fence that parallels the transmission line for more than 1000 feet as directed by the purchaser.

3. Install one ground at each edge of the right of way in fences that cross the transmission line (total of 2 rods).

4. Where a gate has been installed in the fence that crosses the transmission line, install a ground rod on each side of the gate opening.

5. Fill all clamps with conducting grease prior to crimping or bolting.

6. Deform the threads on the U-bolt grounding clamp with a chisel after installation to prevent removal of the nuts.

J. Maintenance Practices

Hardware and framing shall be designed to allow maintenance of each individual 69kV circuit in a double circuit configuration without affecting the operation of the adjacent circuit.

Conflict Reviews performed by SRP TLD and TLAM shall include NESC, maintenance access, and maintenance equipment setup areas. NESC clearances include but are not limited to: Streetlights, buildings, grading changes (cuts / fills at poles & at mid-spans).

K. Construction Activities

All construction activities (e.g. haul roads, laydown yards, etc.) that will impact SRP easements/ROW or any SRP asset must be reviewed and approved by SRP. Additionally, roadway construction project task work in the SRP easements/ROW that involves a crane and/or derrick must have oversight by SRP Safety Services. Please contact SRP Safety Services at (602) 236-8117 or Safety@srpnet.com for more information.

L. Damage Claims

Any damage to existing, new or partially completed SRP-P facilities, including survey markers and staking, by the Contractor's forces or equipment will be the responsibility of the Contractor. No excavation shall take place without Blue Stake.

Transmission Line Design (TLD)

Transmission Line Design (TLD) is responsible for the design and engineering of the transmission system, voltages 69kV and above. Some of the primary functions in TLD are to perform and evaluate electrical line clearance calculations, structural strength analysis, job scoping, estimating and detailed engineering and design. Transmission Line Design manages their projects from inception through construction, including route selection, public involvement, environmental/biological assessments, permitting, land rights acquisition and construction coordination, etc.

Design Information

Contractor will provide TLD with their design files. All files need to be geo-referenced and aligned with TLD's survey requirements (described in the Survey section below).

1. 3D design models at 30%, 60% and 90% milestone deliverables. Models need to have existing and proposed grade elevations, as well as all facilities such as roadway, walls, bridges, curb, gutter, driveways, drainage channels etc. These files will need to be provided in either a

.dxf or .dgn file format

2. Above ground obstructions such as lighting, signals, signs etc. that are not captured by 3D model at 30%, 60% and 90% milestone deliverables will also need to be provided in either a .dxf or .dgn file format.

3. Geotechnical reports.

4. Light Detection and Ranging (Lidar) topographic survey of existing SRP-P lines within the project area will be required to ensure accuracy of the wire sag information.

5. Other facilities that will be relocated due to this project such as COX Communications, CenturyLink, Southwest Gas, RWCD, Municipal water, sewer, storm drain, SRP-W and DIST will need to be coordinated with SRP-P and provide their design documents. Underground information for all existing facilities will need to be *CI/ASCE 38-02 utility quality level A, B, C, D.*

Survey

TLD survey requirements for design.

1. Horizontal Datum: North American Datum of 1983 (NAD83)

2. Zone: Arizona Central 202

3. Unit: International Foot

4. Vertical Datum: North American Vertical Datum of 1988 (NAVD88)

5. Coordinate Projection: Grid

6. LiDAR Point Load Cloud classification per SRP Feature Code (Feature Code can be provided upon request).

7. Typical recording of environmental data should include but not limited to date, time, temperature, and wind velocity.

Buy America Material

Buy America compliant material will be purchased after the SRP-P design plans have been reviewed and accepted by the Contractor. If the Contractor changes the design after the materials have been ordered, there is a potential for the construction schedule to adjust and/or the supplementary materials will be added to the variance list. Critical material items such as steel poles and wire typically have a long lead delivery time, in some cases up to approximately 36 weeks.

Reimbursable Items

Pole braces, line clearance markers, line outages and shoo-flies of SRP-P facilities to aid Contractor during their construction will require a separate Reimbursable Contract with SRP-P. SRP-P Services will be based on the information provided by Contractor. SRP reserves the right to request additional information from the Contractor during the course of the Service(s). If the Contractor modifies its request or the information provided therein is modified, the schedule to complete the Service(s) may

be extended and Contractor shall pay SRP for any additional Service costs that may be incurred as a result of such modification.

Project Changes - Any changes, amendments, or modifications to this Agreement must be in writing and signed by both parties.

Billing and Payment - SRP's delivery of this Agreement to Contractor constitutes an offer to perform the Service(s) on the terms and conditions set forth in this Agreement. Contractor may accept this offer by signing this Agreement (with no additions, deletions, or modifications) and returning it to SRP with the above Service(s) fee. SRP shall provide an invoice to the Contractor for the Service(s) with this Agreement.

Prior to the work being scheduled, Contractor must return a signed contract and submit payment. Approximate turnaround time frames in the table below begin once payment has been received.

Install line guards (tattletale)	1-3 Business day(s)
69kV line outage request	Minimum 30 business days notification
Pole brace w/ poles	4-5 Business day(s)
Pole brace w/ truck	1-4 Business day(s)

All outages are subject to loading conditions, weather, and critical customer load.
69kV Outages between May 1st and October1st are difficult to obtain.

Transmission Line Construction (TLC)

Transmission Line Construction is responsible for constructing new and existing 69kV, 115kV, 230kV, and 500kV lines throughout SRP's service territory. TLC also provides technical guidance to various departments throughout SRP.

Construction Schedule

a. SRP-P will scheduled a construction crew after the following applicable steps are completed:

- All permits are approved
- ADOT has returned the executed Agreement, approving all SRP costing documents
- ADOT has provided SRP-P with the appropriate right-of-way or easements
- All of the project material is in stock

b. All 230kV, 69kV and 12kV work is contingent on obtaining outages. All 230kV line outages must be requested at least 120 working days in advance of planned construction activities. All 69kV line outages must be requested at least 30 working days in advance of planned construction activities. All 12kV line outages must be requested at least 10 working days in advance of planned construction activities. All outages are subject to loading conditions, weather and critical Customer load. The sooner an outage can be scheduled the better. 230kV and 69 kV OUTAGES BETWEEN MAY 1st AND OCTOBER 1st ARE EXTREMELY DIFFICULT TO OBTAIN. All outages are subject to availability.

Distribution Technical Provisions

Distribution Design, Construction, & Maintenance (DIST) is responsible for the design and engineering of the distribution system voltages. Some of the primary functions in DIST are to perform and evaluate electrical line clearance calculations, structural strength analysis, job scoping, estimating and detailed engineering and design. DIST manages their projects from inception through construction, including route selection, public involvement, environmental/biological assessments, permitting, land rights acquisition and construction coordination, etc.

Design

Cost savings can be achieved if locations and electrical loading information for streetlights, traffic signals and landscaping associated with the project are provided prior to completion of relocation design work.

1. Joint Use-

   Applications will be evaluated on a case-by-case basis by SRP to avoid conflicts and ensure that the design meets NESC and other required codes. In order to perform the evaluation, 3rd Party Design and ADOT permit must be submitted simultaneously through SRP's IPR process for review and approval prior to construction or conduit installation.
2. Design Build Projects – Lock Down Sheets

   In order to keep the project on track, the use of Lock Down Sheets are encouraged whenever possible for all proposed improvements (i) in proximity to any SRP high voltage line or easement and/or (ii) in any area requiring an environmental site assessment.

Any design performed by others for, and on behalf of, DIST must be to DIST standards and specifications and reviewed and approved by DIST. All design and construction by others, including trench and conduit, must be done per DIST specifications (contact DIST for information).

Construction

All construction durations are subject to change depending upon final design approval, construction sequencing, final facility locations, access, permits, ADOT right of way and archeological release for construction, etc.

All sub-grades and final grades must be identified on ADOT design drawings at the locations of all SRP-P facilities such as; trench line, pad mounted equipment, pole location, etc. Horizontal and vertical controls must be established by ADOT in the immediate vicinity of the work for all grades and survey ties. DIST will require that SRP's field survey for trench center line and elevation and pole locations be confirmed by developer and/or contractor prior to start of work to insure correct survey data/datum. SRPP also requires a final legal description of ADOT's right of way in areas where ADOT has not installed right of way monuments.

After existing facilities are relocated and energized DIST will: 1) remove overhead (OH) lines that are in conflict and for underground (UG) lines, DIST will: 2) remove the above ground equipment and cable from existing conduits. Others must remove abandoned direct buried cable, pads and conduit that may be in conflict. DIST requires an executed service agreement contract before any electrical work will proceed.

DIST at its own discretion will determine if DIST will provide the Contractor(s) with paper copies or reproducible copies of any DIST drawings requested by the Contractor(s)

1. Right of Way

DIST will not proceed with any work until all ADOT right of way in the work area has been acquired, the work area for DIST's construction is clear and level, prior rights have been resolved, relocation alignments approved by the ADOT 's design consultant, the necessary contract/agreements have been executed, all affected DIST easements and prior rights transferred to the new relocated locations, all long lead materials (Steel Poles etc.) are available and all the required permits approved by the various municipalities, the railroad and ADOT including any required State Land permits.

2. Access

    a. DIST requires drivable access to all poles and equipment located in ADOT's ROW for maintenance, operation and construction of power lines.

    b. In order to operate and maintain its 12 kV equipment DIST requires a ten foot wide linear corridor to either side of the relocated facilities. Where ground level equipment is located a total of 12 feet of
    clearance is required in the front of equipment.

3. Shoo-flies

ADOT, the design consultant, or the contractor must review and approve any proposed shoo-fly locations. Shoo-flies required for construction will be paid for by others. DIST will design the most cost-effective shoo-fly that meets NESC and other required codes. Any requests for modification or relocation of a shoo-fly after initial installation will be at the expense of others.

4. Streetlights, Signal Lights, & Other ADOT Services

    a. If the conduits for streetlights, signal lights, or other ADOT service are not in an existing common trench with DIST, the designer will issue the job to ADOT and five copies to DIST's inspection group. Per DIST's Customer Policies and Procedures, the applicant and/or commercial customer is responsible for providing the trench and conduit. ADOT is responsible for installation of trench and conduits, as well as the conduit and lead from the streetlight or the signal light control cabinet to SRP's point of delivery. When ADOT has completed this work, DIST inspection must be contacted. Any inspection by DIST does not constitute acceptance of the trench and conduit until DIST has installed the cable and terminated and energized the service. DIST's inspector must be present to observe mandrelling of the conduit and pass the work as "Completed" before SRP-P will schedule the installation of cable to energize the lights or signals.

    b. No streetlight, signal light, or other ADOT service wire will be installed or connected until all required inspections have passed. A minimum of five days' notice is required to schedule a crew for installation or connection. If the crew shows up and if either the inspection was not scheduled or the inspection did not pass, a minimum of five additional days' notice must be given for a crew to return to the job site.

    c. If the streetlights are to be removed, DIST will only remove its cable from any conduit to the point of delivery and abandon the conduit and any direct buried cable. The contractor

should confirm ownership of lights before any removal and disposal. The party requesting the disconnect or reconnect will be responsible for the cost. Streetlights and the interconnections are not the property of DIST.

d. For all bridge lighting, if any, DIST will provide service to J-boxes adjacent to, but off of, the bridge. All on-bridge conduits, wire fixtures, etc., shall be the responsibility of others.

Inspection

A DIST inspector must inspect any construction performed by others for, and on behalf of, DIST. Any conduit installation or other work that is performed by others for and on behalf of DIST including street lights that is backfilled, covered or closed before being inspected by DIST will be exposed for inspection at the contractor's expense. Also, after covering the conduit, final approval of any conduit installation requires the contractor to "blow" a mandrel through the conduit in the presence of the DIST inspector to demonstrate there is no blockage or deformity. A pre-construction meeting shall take place prior to construction. Pre-scheduling of inspection may be available after construction starts. The present phone number for scheduling inspection is 602-236- 0436 (Distribution Improvements). This number may change and will be appropriately updated.

Excavation near Structure

Do not excavate within a 25-foot radius or fill within a 15' radius of any power pole without prior approval by DIST. Power poles have not been designed for adjacent excavation or fill. Contractors must submit plans to DIST for approval at least ten (10) working days prior to start of work if construction requires any excavation within a 25-foot radius of a power pole.

Review by DIST does not relieve the Contractor of responsibility for protecting structures from impacts of adjacent excavations. Any bracing, guying or other special provision required to allow contractors to excavate next to DIST structures will be prepaid by the contractor.

Damage Claims

Any damage to existing, new or partially completed SRP-P facilities, including survey markers and staking, by the Contractor's forces or equipment will be the responsibility of the Contractor. No excavation shall take place without Blue Stake.

Buy America Material

Buy America compliant material will be purchased after the DIST design plans have been reviewed and accepted by the Contractor. If the Contractor changes the design after the materials have been ordered, there is a potential for the construction schedule to adjust and/or the supplementary materials will be added to the variance list. Critical material items such as steel poles and wire typically have a long lead delivery time, in some cases up to approximately 36 weeks.

Reimbursable Items

Line outages and shoo-flies of DIST facilities to aid Contractor during their construction will require a separate Reimbursable Contract with SRP-P. SRP-P Services will be based on the information provided by Contractor. SRP reserves the right to request additional information from the Contractor during the course of the Service(s). If the Contractor modifies its request or the information provided therein is modified, the schedule to complete the Service(s) may be extended and

Contractor shall pay SRP for any additional Service costs that may be incurred as a result of such modification.

Project Changes - Any changes, amendments, or modifications to this Agreement must be in writing and signed by both parties.

Billing and Payment - SRP's delivery of this Agreement to Contractor constitutes an offer to perform the Service(s) on the terms and conditions set forth in this Agreement. Contractor may accept this offer by signing this Agreement (with no additions, deletions, or modifications) and returning it to SRP with the above Service(s) fee. SRP shall provide an invoice to the Contractor for the Service(s) with this Agreement.

Prior to the work being scheduled, Contractor must return a signed contract and submit payment. Approximate turnaround time frames in the table below begin once payment has been received.

A disconnect is only the removal of the meter. If total removal of electrical equipment is required, a written request to remove or abandon equipment is required from the owner of the facilities. All removals are at the expense of the owner and/or applicant.

69kV line outage request	Minimum 30 business days notification
12kV line outage request	Minimum 10 business days notification
Street Light Inspection	Minimum 5 business days notification
Street Light Disconnect Letter	Minimum 10 business days notification
Other Customer Requested Work	Minimum 20 business days notification

All outages are subject to loading conditions, weather, and critical customer load. 69kV Outages between May 1st and October1st are difficult to obtain.

SRP Safety Services Technical Provisions

We appreciate the opportunity to assist you with your construction project, and would like to take this occasion to provide you with important information about safety regulations which apply to all work performed near overhead or underground power lines.

Prior to start of construction, you should be familiar with several clearance requirements regarding work performed near overhead and underground power lines. These include, but are not limited to, (i) Arizona law regarding high voltage overhead power lines and safety restrictions, (ii) Arizona law requiring underground facilities safe excavation practices, (iii) The National Electrical Safety Code, and (iv) regulations promulgated by the Occupational Safety and Health Administration (OSHA).

By taking a few moments now to review these safety requirements, you should be better able to complete your project in a safe and timely manner and reduce the possibility of accidents. Your compliance with these requirements in cooperation with SRP will not only help you maintain project safety, but reduce the expense of project delays and damage claims.

Overhead Power Lines

Arizona law regarding "High Voltage Power Lines and Safety Restrictions" (A.R.S. §40-360.41 through 45) requires that a minimum clearance of ten (10) feet be maintained between an energized power line of up to 50 kV and a piece of mechanical equipment, its load and any attachments such as "tag lines." Energized power lines with higher voltages require even greater distances. New OSHA regulations regarding the use of cranes may require even greater clearance distances.

The Arizona law states that, "A person or business entity shall not…operate any mechanical equipment or hoisting equipment or any load of such equipment, **any part of which is CAPABLE OF vertical, lateral or swinging motion closer to any high voltage overhead lines than**" the minimum clearance distance, "unless prior arrangements have been made with the utility company to make sure that the work can be performed safely."

This means that before doing any work near overhead power lines, you must: (1) consult with SRP regarding the specific work you have planned near overhead power lines, and the specific date you plan to do the work; and (2) you must make specific arrangements with APS so that the work can be done safely.

If you anticipate your project "work" will require activity closer to overhead power lines than these minimum standards allow, you must call SRP and ask for an SRP Representative to meet with you at the construction site to address your construction plans so that appropriate safety precautions can be made. **No work can be done until safe work arrangements have been made with SRP.** Failure to comply with this statute may not only be hazardous to your employees, but could result in damage claims against you. Violations of this statute could also subject you to a five thousand dollar ($5,000) fine from the State as well as applicable fines from OSHA.

The National Electrical Safety Code "NESC" specifies clearances that must be maintained between power lines and buildings, signs and other structures. These clearances vary with the voltage of the line, activity expected near the line and the structure that may be near the line. If you construct buildings, signs or other structures nearer to existing power lines than the NESC authorizes, such construction activity may not only be hazardous to your employees (and a violation of OSHA and Arizona safety laws), but it may also subject you to the cost of correcting NESC code violations.**Underground Power Lines**

Arizona law regarding “Underground Facilities” (A.R.S. §40-360.21 through 32) requires that you arrange for locating the position of underground facilities before beginning any excavation, and that you take necessary measures (including only hand digging within two feet of underground facilities) to ensure that the facilities are not cut or damaged. Failure to do so may not only be hazardous to your employees, but could result in damage claims against you. Violation of this statute may also subject you to a five thousand dollar ($5,000.00) fine from the state. You may make arrangements for locating underground power lines free of charge by contacting Arizona 811 by calling (602) 263-1100 in Maricopa County, outside Maricopa County, call 811 (1-800-782-5348)or create a ticket online at least two (2) full working days excluding holidays prior to performing any excavation. Monday through Friday excluding holidays from 6:00 a.m. through 5:00 p.m. Please remember these safety standards and requirements along with applicable city ordinances when planning and constructing your project. For a more complete statement of the law, refer to the attached brochure and the referenced statutes. If your specific needs require assistance from SRP, please call the number listed below or email. Thank you for your interest in safety.

Safety Services: (602) 236-8117

Email: publicsafety@srpnet.com

https://www.srpnet.com/safety/contractor.aspx

APPENDIX

- MAG Detail 250
- WES – ROWGUIDE. SRP Right-of-way Guidelines
- WES – 02604-001. Utilities Crossing of Parallel to SRP
- Irrigation Pipe
- Tree List
- Ground Cover Restrictions
- Storm Water Retention Basin
- 69kV Setup Areas
- Extra High Voltage (EHV) Setup Areas
- Gate Detail
- Fence Detail
- Equipment Turning Radius –To Be Added at Later Date.
  Applicant Safety Acknowledgement Form (Example)
- Occupation Safety and Health Administration General
- Industry Regulations (29 CFR 1910)
    - Subpart S – Electrical
- Occupation Safety and Health Administration Construction Industry Regulations (29 CFR 1926)
    - Subpart CC – Crane and Derricks in Construction

Contractor Sign-off Sheet

SRP: Technical Provisions:

RE: TRACS No.: F0072 01D I-10, I17 to SR202L (SANTAN) Project No.: NHPP-10-C(220)T
LOCATION: I-10, I17 to SR202L (SANTAN) AGREEMENT NO.: 3704-19-SRP

ADOT's contractor may contact SRP Safety Department at 602-236-8117 to discuss safety issues related to working near energized overhead lines. One group presentation could be conducted prior to construction. The contractor will pay for individual contractor or additional subcontractor meetings.

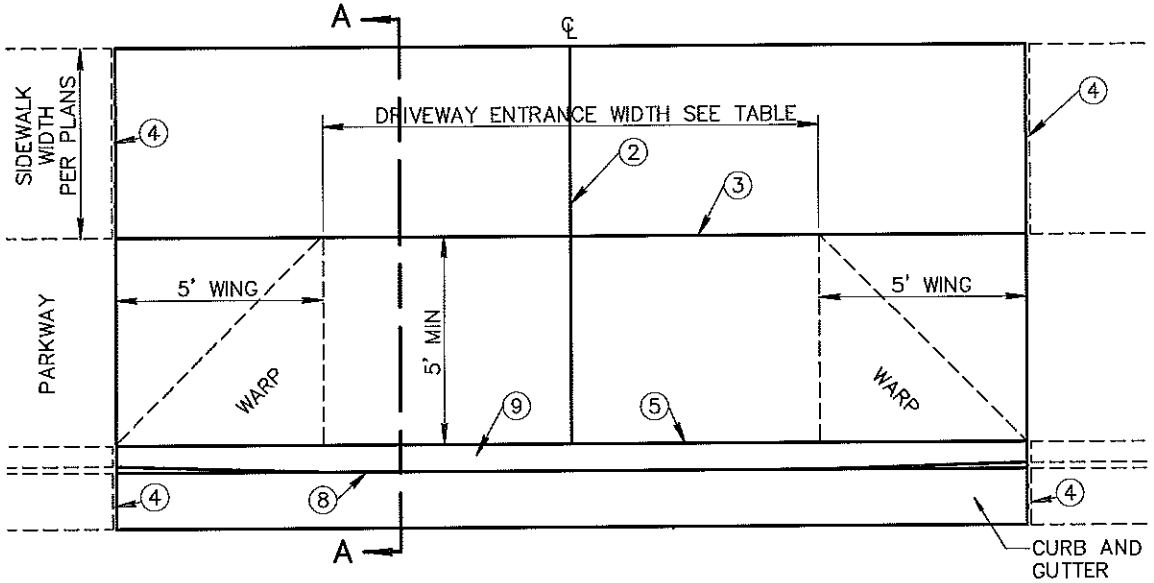
Please address any comments regarding the above to the undersigned at P. O. Box 52025, Phoenix, AZ 85072-2025, Mail Station XCT 400. Email Brad.Hawn@SRPnet.com or phone at 602-236-8654.

Contractor acknowledgement

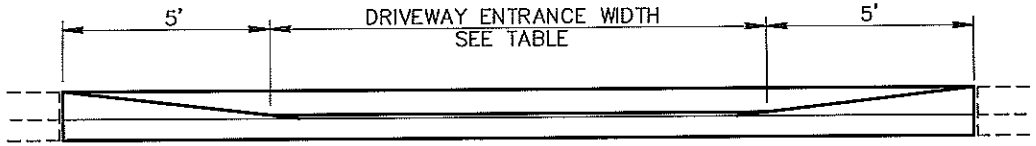
Date:_____ Company:_____

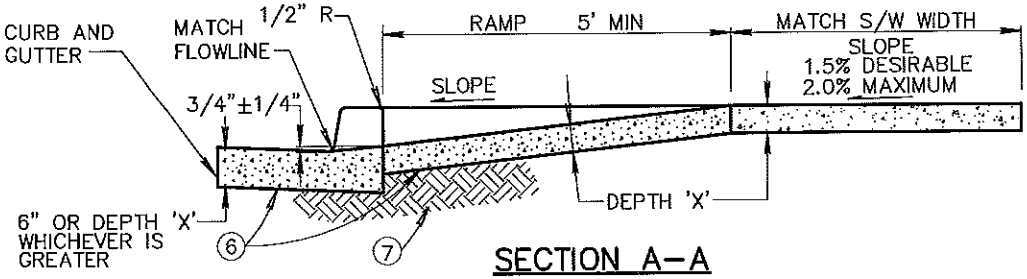
Print:_____ Sign:

_____



DRIVEWAY WITH DETACHED SIDEWALK





SECTION A–A

NOTES:

1. DEPRESSED CURB SHALL BE PAID FOR AT THE CONTRACT UNIT PRICE FOR THE TYPE OF CURB USED AT THAT LOCATION.
2. CONTRACTION JOINT ON D/W CENTERLINE.
3. CONTRACTION JOINT.
4. 1/2–INCH EXPANSION JOINTS SHALL COMPLY WITH SECTION 340.
5. BACK OF CURB – CONSTRUCTION JOINT.
6. CONCRETE CLASS AS NOTED IN TABLE. CONCRETE PER SECTION 725.
7. SUBGRADE PREPARATION, SECT. 301.
8. FLOW LINE OF GUTTER.
9. DEPRESSED CURB.
10. SECT. A–A AND ELEVATION: D/W SHOWN WITH VERTICAL CURB AND GUTTER, ROLL TYPE CURB AND GUTTER TREATED SIMILARLY.
11. ROUGH BROOM FINISH FULL WIDTH OF RAMP AND WINGS.
12. TROWEL AND USE LIGHT HAIR BROOM FINISH FOR WALKWAY AREA.
13. 'DRIVEWAY ENTRANCE WIDTH' IS THE DRIVEWAY WIDTH PLUS ADDITIONAL WIDENING REQUIRED BY THE LOCAL JURISDICTION.
14. ELEVATION AT TOP OF DRIVEWAY RAMP SHALL BE EQUAL TO OR HIGHER THAN NORMAL CURB ELEVATION.

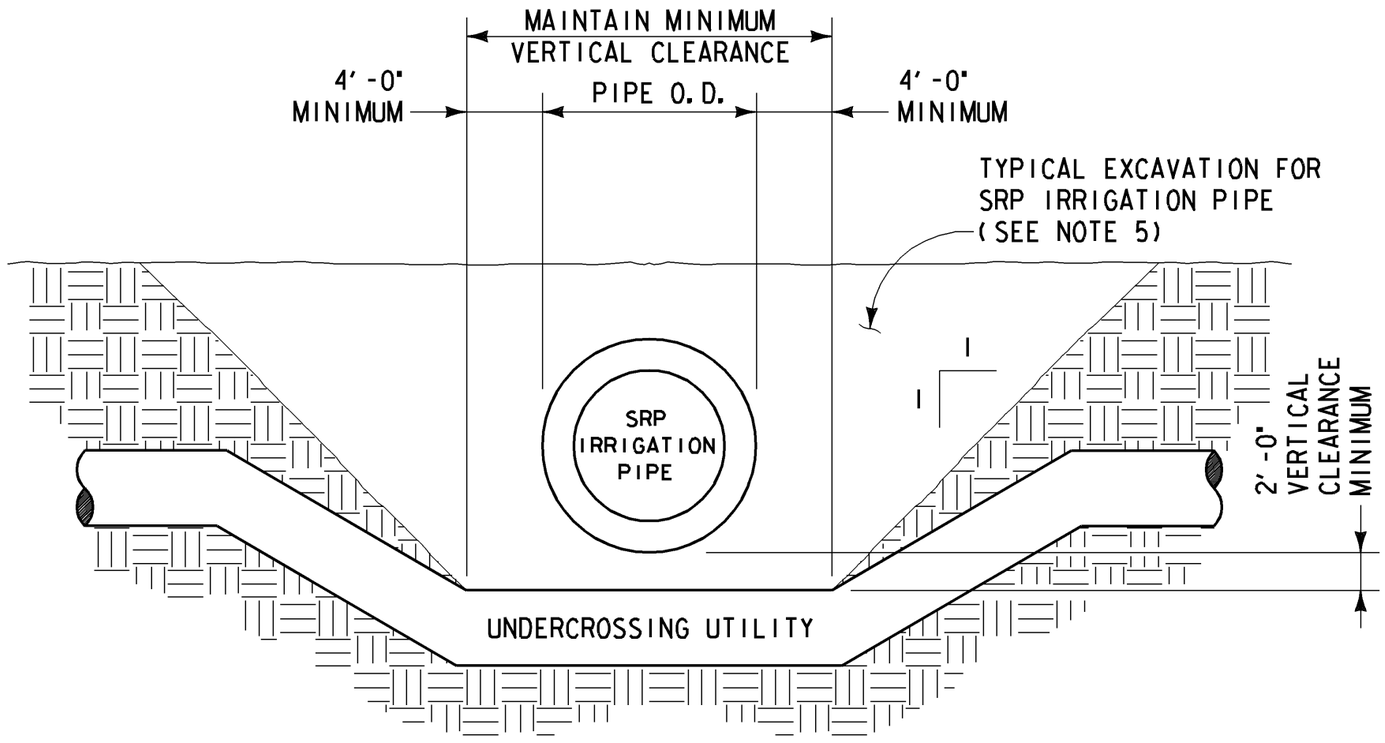
COMMERCIAL AND INDUSTRIAL

DRIVEWAY ENTRANCE WIDTH	MIN.	MAX.	CLASS	DEPTH 'X'
COMMERCIAL	✳ 16'	40'	A	9"
INDUSTRIAL	✳ 16'	40'	A	9"
✳24' MIN. FOR TWO WAY TRAFFIC				

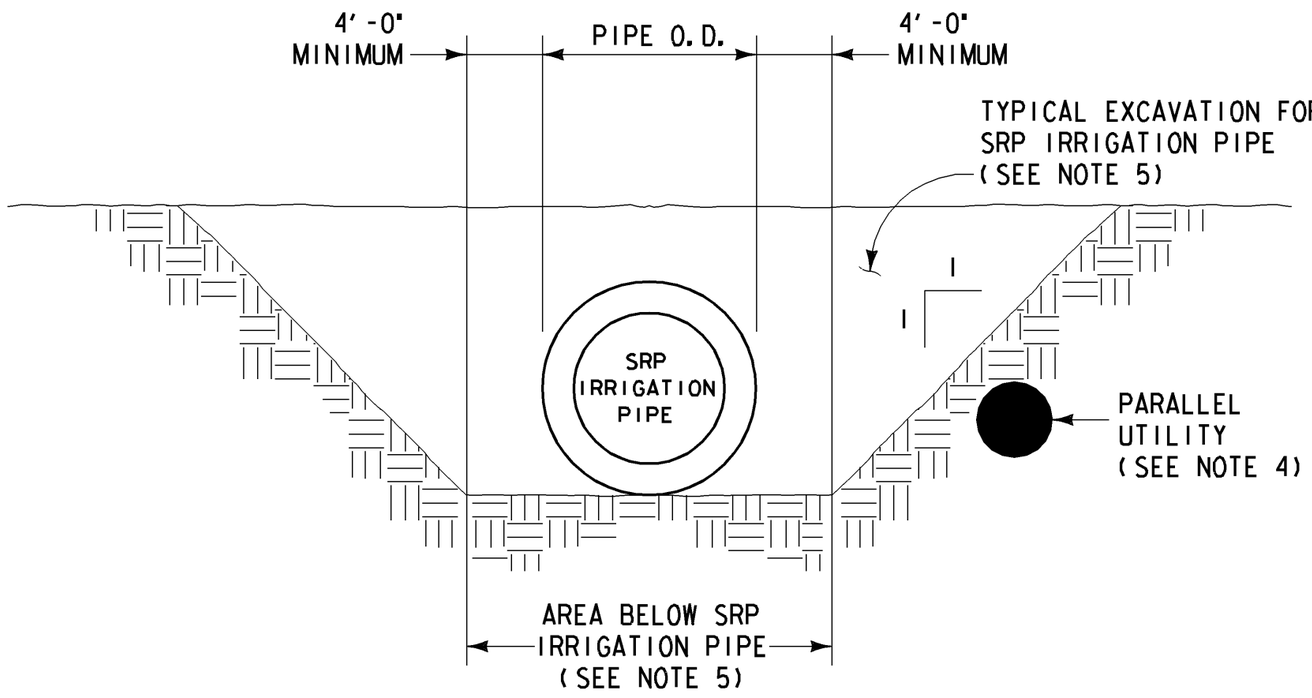
RESIDENTIAL

DRIVEWAY ENTRANCE WIDTH	MIN.	MAX.	CLASS	DEPTH 'X'
MAJOR STREET	16'	30'	B	5"
COLLECTOR STREET	✳ 12'	30'	B	5"
LOCAL STREET	12'	30'	B	5"
✳16' DESIRABLE				

DETAIL NO.			REVISED	DETAIL NO.
250–1	MARICOPA ASSOCIATION of GOVERNMENTS STANDARD DETAIL ENGLISH	DRIVEWAY ENTRANCES WITH DETACHED SIDEWALK	01–01–2014	250–1



PIPELINE - UNDERCROSSING

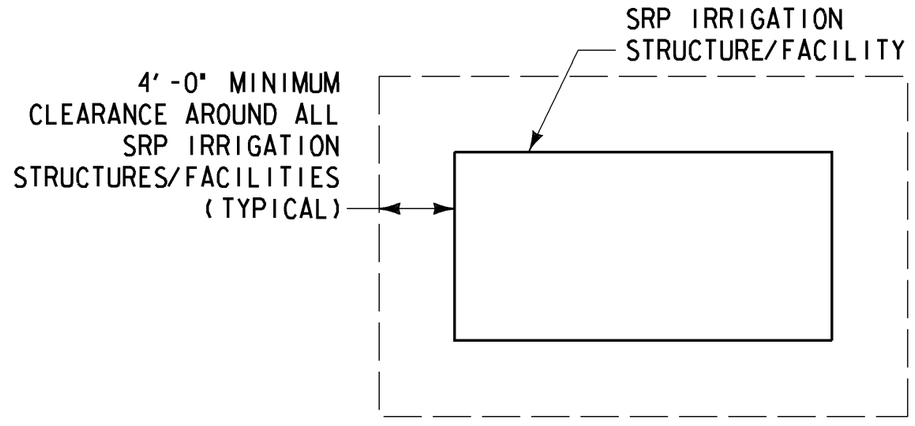


PIPELINE - PARALLEL UTILITY

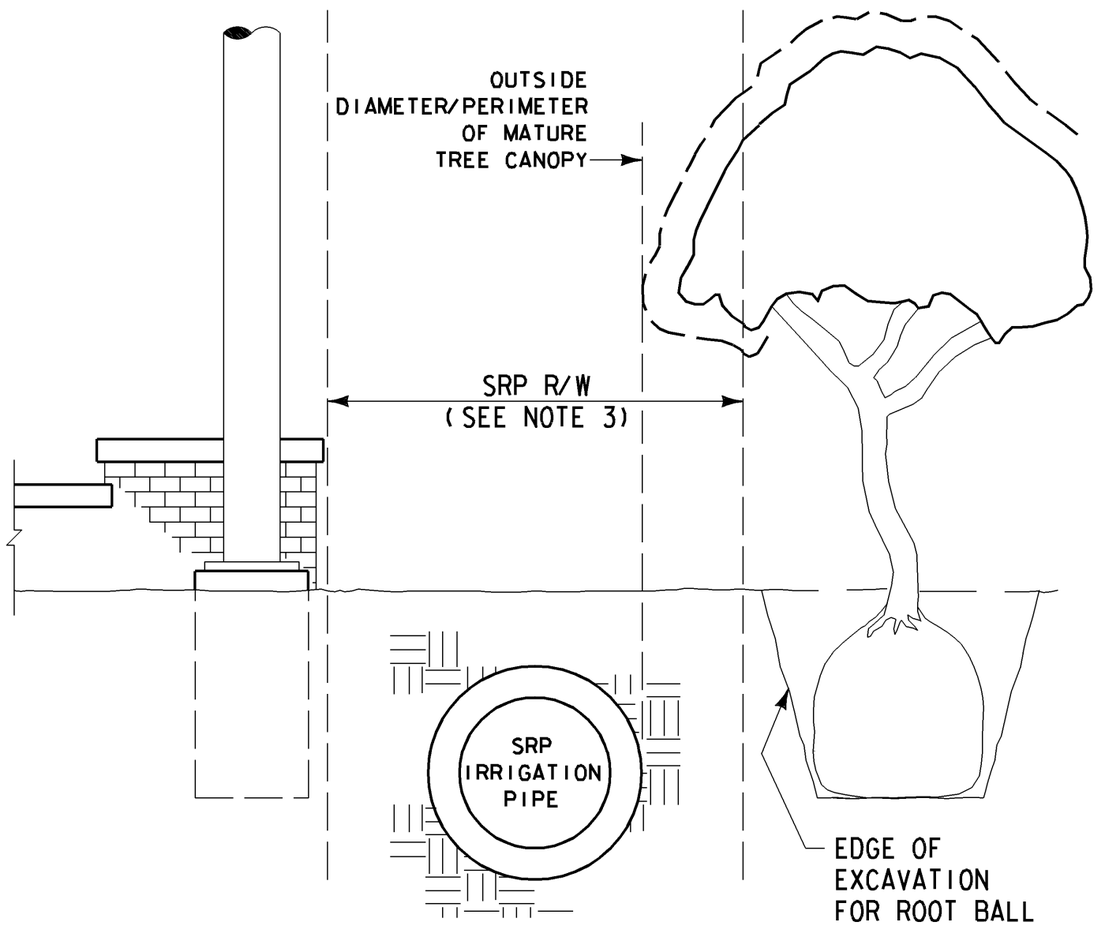
PIPELINES - RETENTION BASIN

NOTES

1. THESE GUIDELINES ARE PROVIDED AS A GENERAL AID TO PLANNING. ACTUAL SRP REQUIREMENTS MAY VARY BASED ON SITE-SPECIFIC CONDITIONS, OPERATIONAL CONSIDERATIONS, ETC.
2. AN SRP LICENSE IS REQUIRED FOR UTILITIES CROSSING/PARALLEL TO SRP IRRIGATION PIPE IN SRP RIGHT-OF-WAY. SRP REQUIRES ENGINEER DESIGNED UTILITY CROSSING/LOCATION AND EXCAVATION PLAN.
3. SRP MAY LICENSE LIMITED USES OF ITS RIGHT-OF-WAY SUCH AS PARKING, SIDEWALK, LAWN, ETC. POLES, STRUCTURES AND TREES ARE TYPICALLY NOT PERMITTED IN SRP RIGHT-OF-WAY. INCLUDE DESIGN DRAWINGS FOR PROPOSED USE WHEN SUBMITTING REQUEST TO SRP FOR LICENSE.
4. UTILITIES PARALLEL TO SRP IRRIGATION PIPE ARE REVIEWED ON A CASE-BY-CASE BASIS. LOCATE PARALLEL UTILITY OUTSIDE OF AREA SRP EXCAVATES WHEN MAINTAINING IRRIGATION PIPE, OR 4' -0" BEYOND THE SIDE OF THE OUTSIDE BELL DIAMETER OF THE SRP IRRIGATION PIPE, WHICHEVER IS GREATER. TYPICAL EXCAVATION INCLUDES AREA ABOVE AND TO EACH SIDE OF SRP IRRIGATION PIPE. SIDE EXCAVATION INCLUDES AREA ABOVE A LINE EXTENDING UPWARD AND OUTWARD AT A ONE-TO-ONE SLOPE FROM A POINT LEVEL WITH THE BOTTOM OF AND 4' -0" BEYOND THE SIDE OF THE OUTSIDE BELL DIAMETER OF THE SRP IRRIGATION PIPE.
5. OTHER UTILITIES ARE NOT PERMITTED IN THESE AREAS.



IRRIGATION STRUCTURE/FACILITY CLEARANCE



PIPELINES - LANDSCAPING

REFERENCES

UTILITIES CROSSING OR PARALLEL TO SRP IRRIGATION PIPE _____ WES-02604-001

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
REVISED DETAIL CLEARANCES & RENUMBERED NOTES 3 TO 5, AND 4 TO 3. ADDED NOTE 4.					
6	JWS	-	-	REL	12/05/18
	JWS	-	-	REL	
INITIAL ISSUE.					
0	MOD	CWT	CWT	REL	04/07/98
	MOD	CWT	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

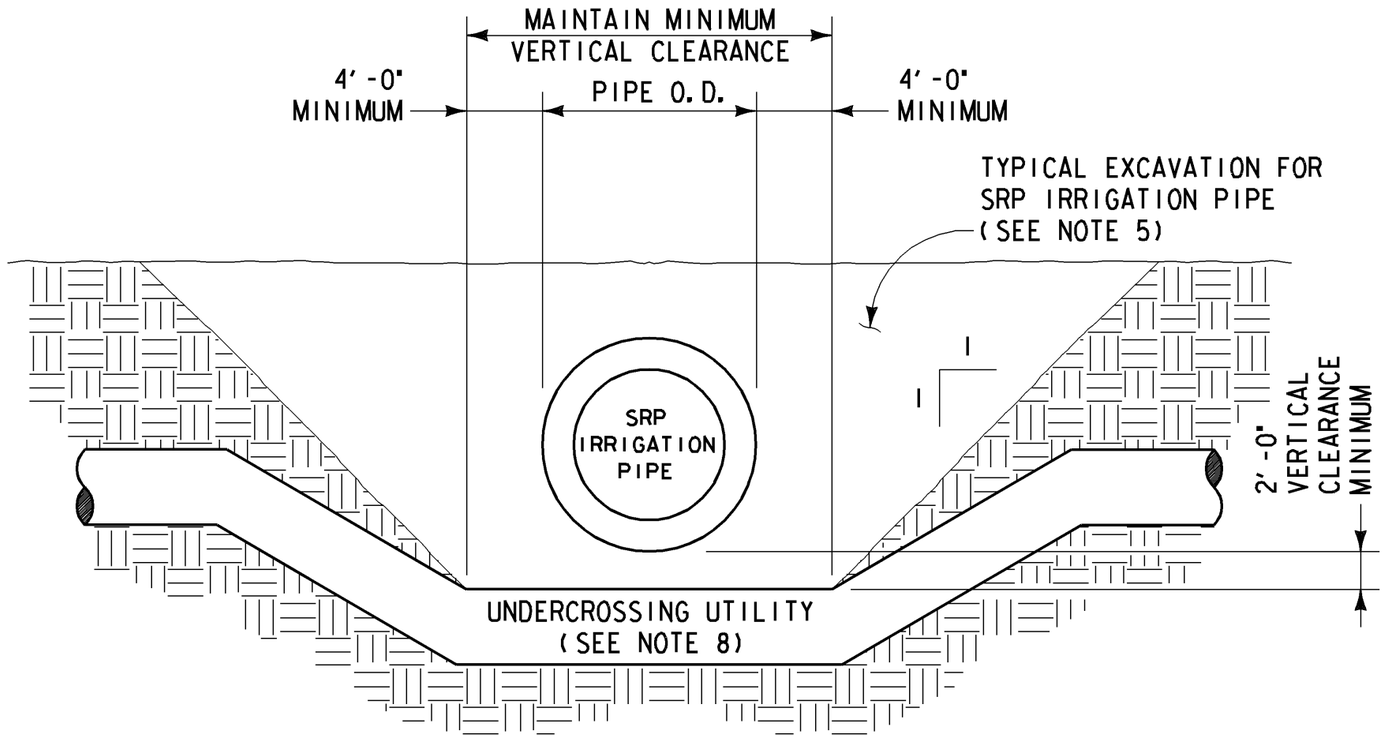
SALT RIVER PROJECT RIGHT-OF-WAY GUIDELINES

SCALE: NONE

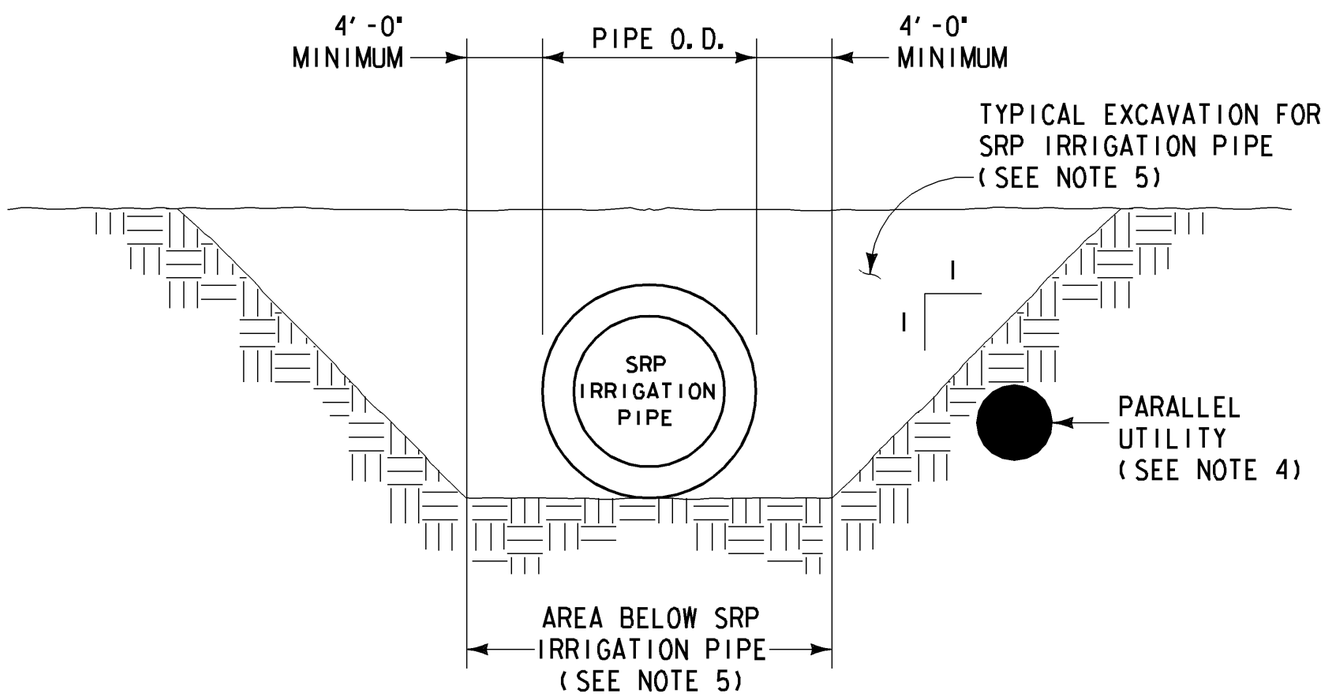
ROWGUIDE.WES

DWG SIZE
17X22

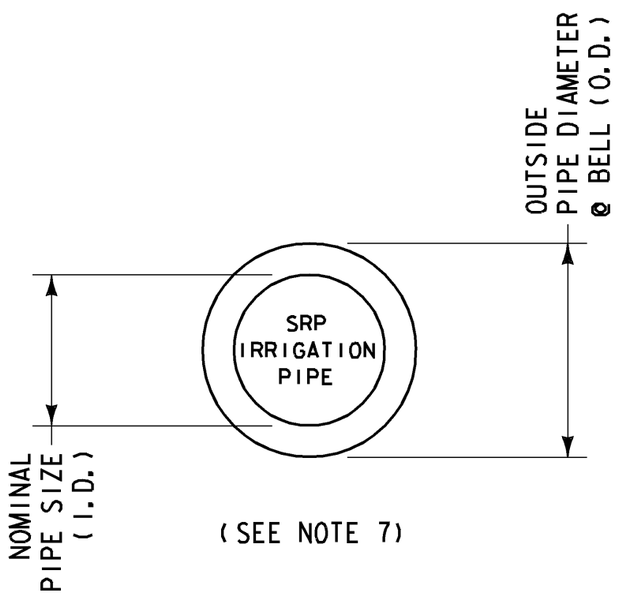
WES-ROWGUIDE



PIPELINE - UNDERCROSSING



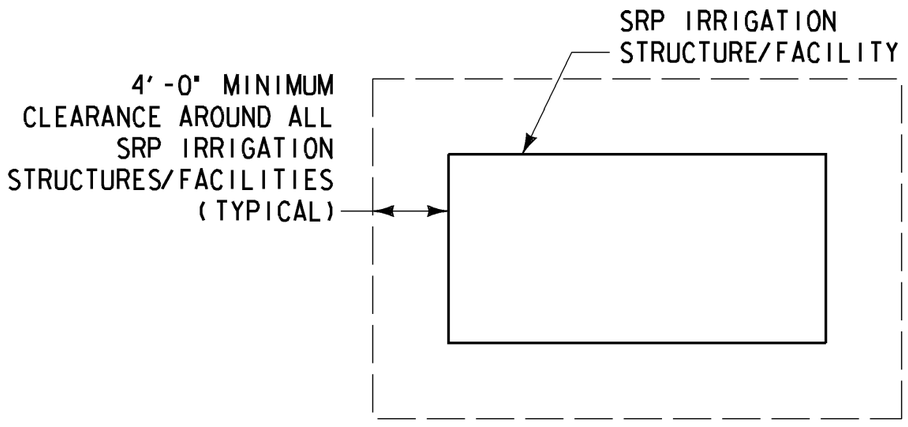
PIPELINE - PARALLEL UTILITY



(SEE NOTE 7)

NOMINAL PIPE SIZE (I.D.)	OUTSIDE PIPE DIAMETER AT BELL (O.D.)
24"	37"
30"	45"
36"	53"
42"	60"
48"	68"
54"	75"
60"	82"
66"	89"
72"	91"

OUTSIDE DIAMETER SRP IRRIGATION PIPE



IRRIGATION STRUCTURE/FACILITY CLEARANCE

NOTES

1. OVERCROSSINGS OF SRP IRRIGATION PIPE ARE REVIEWED ON A CASE-BY-CASE BASIS. EXCEPT FOR THOSE CASES SPECIFICALLY IDENTIFIED BELOW, OVERCROSSINGS ARE TYPICALLY NOT ALLOWED.
2. MAINTAIN MINIMUM 12" CLEARANCE BETWEEN SRP IRRIGATION PIPE AND OVERCROSSING ELECTRICAL CABLE/CONDUIT (1" DIA. OR LESS).
3. MAINTAIN MINIMUM 12" CLEARANCE BETWEEN SRP IRRIGATION PIPE AND CLOSEST POINT OF OVERCROSSING SCUPPER. SCUPPER SHALL CONFORM TO MAG STANDARD DETAIL 203 OR 206.
4. UTILITIES PARALLEL TO SRP IRRIGATION PIPE ARE REVIEWED ON A CASE-BY-CASE BASIS. LOCATE PARALLEL UTILITY OUTSIDE OF AREA SRP EXCAVATES WHEN MAINTAINING IRRIGATION PIPE, OR 4' -0" BEYOND THE SIDE OF THE OUTSIDE BELL DIAMETER OF THE SRP IRRIGATION PIPE, WHICHEVER IS GREATER. TYPICAL EXCAVATION INCLUDES AREA ABOVE AND TO EACH SIDE OF SRP IRRIGATION PIPE. SIDE EXCAVATION INCLUDES AREA ABOVE A LINE EXTENDING UPWARD AND OUTWARD AT A ONE-TO-ONE SLOPE FROM A POINT LEVEL WITH THE BOTTOM OF AND 4' -0" BEYOND THE SIDE OF THE OUTSIDE BELL DIAMETER OF THE SRP IRRIGATION PIPE.
5. OTHER UTILITIES NOT PERMITTED IN THESE AREAS.
6. CLEARANCE IS MEASURED FROM OUTSIDE BELL DIAMETER OF SRP IRRIGATION PIPE. OUTSIDE BELL DIAMETER IS SIGNIFICANTLY LARGER THAN NOMINAL PIPE SIZE (INSIDE DIAMETER) NOTED ON PLAN/PROFILE DRAWINGS. SEE TABLE FOR NOMINAL PIPE SIZES AND OUTSIDE BELL DIAMETERS.
7. SPECIFIED CLEARANCES ARE FOR USE WITH RUBBER GASKETED REINFORCED CONCRETE PIPE (RGRCP) UP TO AND INCLUDING 72" NOMINAL PIPE SIZE. GREATER CLEARANCE OR REPLACEMENT IS REQUIRED FOR LARGER DIAMETER RGRCP, CAST-IN-PLACE PIPE (CIPP) AND NON-REINFORCED CONCRETE PIPE.
8. ASSURE CONTINUOUS SUPPORT AND PROTECTION OF SRP IRRIGATION PIPE. DAMAGE TO SRP IRRIGATION PIPE/SYSTEM WILL BE REPAIRED BY SRP. ALL DIRECT AND INDIRECT COSTS SHALL BE BORNE BY OTHER UTILITY/LICENSEE.
9. TRENCH BACKFILL COMPACTION SHALL BE MARICOPA ASSOCIATION OF GOVERNMENTS (MAG) TYPE I OR TYPE III, EXCEPT THAT 95 % COMPACTION SHALL BE REQUIRED FROM 1' -0" ABOVE TOP OF PIPE TO BOTTOM OF TRENCH. WATER CONSOLIDATION IS NOT PERMITTED.
10. COMPLY WITH MAG UNIFORM STANDARD SPECIFICATIONS AND STANDARD DETAILS UNLESS OTHERWISE NOTED IN PROJECT SPECIFIC SRP DOCUMENTS. MOST STRINGENT REQUIREMENTS SHALL APPLY UNLESS SPECIFICALLY NOTED OTHERWISE IN SRP DOCUMENTS.
11. COMPLY WITH ALL APPLICABLE STATUTES, ORDINANCES AND REGULATIONS INCLUDING BLUE STAKE LAW (A.R.S. SEC. 40-360-21 ET SEQ.).
12. THESE GUIDELINES ARE PROVIDED AS A GENERAL AID TO PLANNING. ACTUAL SRP REQUIREMENTS MAY VARY BASED ON SITE-SPECIFIC CONDITIONS, OPERATIONAL CONSIDERATIONS, ETC.
13. AN SRP LICENSE IS REQUIRED FOR UTILITIES CROSSING/PARALLEL TO SRP IRRIGATION PIPE IN SRP RIGHT-OF-WAY. SRP REQUIRES ENGINEER DESIGNED UTILITY CROSSING/LOCATION AND EXCAVATION PLAN.
14. NOTIFY SRP INSPECTOR A MINIMUM OF 72 HOURS BEFORE STARTING CONSTRUCTION IN OR AROUND SRP IRRIGATION FACILITIES. AN IRRIGATION OUTAGE AGREEMENT MUST BE COMPLETED BY THE CONTRACTOR IF A DRY-UP OF ANY PART OF THE IRRIGATION SYSTEM WILL BE NECESSARY DURING CONSTRUCTION. ISSUANCE OF A LICENSE DOES NOT PROVIDE FOR A CONSTRUCTION DRY-UP.

REFERENCES

SALT RIVER PROJECT
RIGHT-OF-WAY GUIDELINES____WES-ROWGUIDE

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
REVISED DETAIL CLEARANCES AND NOTE 4. ADDED IRRIGATION CLEARANCE DETAIL.					
6	JWS	-	-	REL	12/05/18
	JWS	-	-	REL	
INITIAL ISSUE.					
0	MOD	CWT	CWT	REL	04/06/98
	MOD	CWT	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

UTILITIES CROSSING OR PARALLEL TO SRP IRRIGATION PIPE

SCALE: NONE | 02604001.WES
DWG SIZE: 17X22

WES-02604-001

Tree List*

Acceptable	Common Name	Scientific Name	Mature Height x Width (feet)
Yes	Mulga	*Acacia aneura*	20 x 20
Yes	Guajillo	*Acacia berlandieri*	15 x 15
Yes	White Thorn, Mescat Acacia	*Acacia constricta*	20 x 20
Yes	Desert Acacia	*Acacia craspedocarpa*	20 x 10
Yes	Knife Acacia	*Acacia cultriformis*	20 x 20
Yes	Twisted Acacia	*Acacia schaffneri*	20 x 20
Yes	Sweet Acacia	*Acacia smallii*	30 x 25
Yes	Palo Blanco	*Acacia willardiana*	25 x 20
Yes	Paurotis Palm	*Acoelorrhaphne wrightii*	25 x 15
Yes	Hong Kong Orchid Tree	*Bauhinia blakeana*	30 x 30
Yes	Brazilian Butterfly Tree	*Bauhinia forficata*	30 x 35
Yes	Chihuahuan Orchid Tree	*Bauhinia macranthera*	20 x 15
Yes	Pindo Palm	*Butia capitata*	25 x 15
Yes	Cascalote	*Caesalpinia cacalaco*	20 x 20
Yes	Bird of Paradise	*Caesalpinia gilliesi*	10 x 10
Yes	Mexican Bird of Paradise	*Caesalpinia mexicana*	20 x 20
Yes	Red Bird of Paradise	*Caesalpinia pulcherrima*	10 x 12
Yes	Pink Powder Puff	*Calliandra haematocephala*	15 x 15
Yes	Trinidad or Brazilian Flame Bush	*Calliandra tweedii*	10 x 10
Yes	Foothills Palo Verde	*Cercidium microphyllum*	25 x 25
Yes	Mexican Redbud	*Cercis mexicana*	20 x 20
Yes	Texas (Western) Redbud	*Cercis occidentalis*	25 x 25
Yes	Costa Rican Parlor Palm	*Chamaerops costaricana*	10 x 6
Yes	Mediterranean Fan Palm	*Chamaerops humilis*	25 x 20
Yes	Desert Willow	*Chilopsis linearis*	30 x 25
Yes	Bouquet Orange	*Citrus aurantium "Bergamia"*	20 x 15
Yes	Tangerine/Mandarin Orange	*Citrus reticulata*	20 x 15
Yes	Tangelo	*Citrus paradisi X C. reticulata*	20 x 15
Yes	Robertson Orange	*Citrus sinensis*	20 x 15
Yes	Texas Olive, Anacahuita	*Cordia boissieri*	15 x 15
Yes	Sago Palm	*Cycas revoluta*	10 x 5
Yes	Dioon	*Dioon edule*	10 x 5
Yes	Swamp Malee	*Eucalyptus spathulata*	25 x 25
Yes	Square-Fruited Malee	*Eucalyptus tetraptera*	25 x 20
Yes	Coral Gum	*Eucalyptus torquata*	25 x 20
Yes	Pineapple Guava	*Feijoa sellowiana*	15 x 15
Yes	Texas Lignumvitae	*Guaiacum angustifolium*	20 x 15
Yes	Lignumvitae	*Guaiacum sanctum*	15 x 15
Yes	Peregrina, Firecracker	*Jatropha integerrima*	15 x 15
Yes	Juniper	*Juniperis chinensis*	25 x 10
Yes	Goldenball Leadtree	*Leucaena retusa*	25 x 20
Yes	Japanese Privet	*Ligustrum juponicum texanum*	25 x 10
Yes	Desert Fern	*Lysiloma thornberi*	25 x 25
Yes	Barbados Cherry	*Malphigia glabra*	20 x 15
Yes	Orange Jasmine	*Murraya paniculata*	20 x 15

Tree List*

Acceptable	Common Name	*Scientific Name*	Mature Height x Width (feet)
Yes	Mock Orange	*Philadelphus lewisii*	15 x 10
Yes	Pygmy Date Palm	*Phoenix roebelenii*	10 x 5
Yes	Fraser's Photinia	*Photinia fraseri*	20 x 20
Yes	Dwarf Swiss Stone Pine	*Pinus cembra 'Nana'*	25 x 10
Yes	Mexican Piñon Pine	*Pinus cembroides*	25 x 20
Yes	Mastic	*Pistacia lentiscus*	20 x 15
Yes	Willow Pittosporum	*Pittosporum phillyraeoides*	25 x 20
Yes	Frangipani	*Plumeria rubra*	25 x 25
Yes	American Plum	*Prunus americana*	25 x 20
Yes	Flowering Peach	*Prunus persica*	20 x 15
Yes	Flowering Almond	*Prunus triloba var. multiplex*	20 x 15
Yes	Strawberry Guava, Cattley Guava	*Psidium littorale*	25 x 20
Yes	Pomegranate 'Wonderful'	*Punica granatum*	20 x 20
Yes	Texas Mountain-Laurel, Mescal Bean	*Sophora secundiflora*	25 X 15
Yes	Arizona Yellow Bells	*Tecoma stans var stans*	25 x 15
Yes	Yellow Tree Oleander	*Thevetia peruviana*	20 x 15
Yes	Cut-Leaf Chaste Tree	*Vitex negundo 'Heterophylla'*	20 x 20
Yes	Xylosma	*Xylosma congestum*	20 x 15

Tree List*

Acceptable	Common Name	Scientific Name	Mature Height x Width (feet)
No	Abyssinian Acacia	*Acacia abyssinica*	30 x 30
No	Giraffe Thorn	*Acacia erioloba*	45 x 40
No	Australian Ironwood	*Acacia estrophiolata*	45 x 40
No	Weeping Acacia	*Acacia pendula*	40 x 25
No	Willow Acacia	*Acacia salicina*	45 x 30
No	Shoestring Acacia	*Acacia stenophylla*	30 x 30
No	Bismarck Palm	*Bismarckia nobilis*	70 x 25
No	Pecan	*Carya illinoensis*	100 x 70
No	Carob, St John's Bread	*Ceratonia siliqua*	45 x 40
No	Lemon Bottlebrush	*Callistemon citrinus*	25 x 25
No	Blue Palo Verde	*Cercidium floridum*	35 x 35
No	Palo Brea	*Cercidium praecox*	30 x 25
No	Italian Cypress	*Cupressus sempervirens*	60 x 10
No	Sissoo, Indian Rosewood	*Dalbergia sissoo*	60 x 45
No	Coolibah	*Eucalyptus microtheca*	40 x 30
No	Ghost Gum	*Eucalyptus papuana*	60 x 30
No	Ficus	*Ficus spp.*	80 x 90
No	Fantex Ash	*Fraxinus velutina 'Rio Grande'*	80 x 70
No	Silk Oak	*Grevillea robusta*	80 x 35
No	Jacaranda	*Jacaranda mimosifolia*	50 x 50
No	Oleander	*Nerium oleander*	20 x 15
No	Olive	*Olea europaea*	40 x 40
No	Swan Hill Olive	*Olea europaea 'Swan Hill'*	40 x 40
No	Ironwood	*Olneya tesota*	35 x 35
No	Desert Museum Palo Verde	*Parkinsonia aculeata x Cercidium floridum x Cercidium microphyllum*	35 x 35
No	Canary Island Date Palm	*Phoenix canariensis*	60 x 50
No	Date Palm	*Phoenix dactylifera*	80 x 35
No	Eldarica, Afghan, Mondell Pine	*Pinus eldarica*	70 - 100 x 40
No	Aleppo Pine	*Pinus halepensis*	60 x 40
No	Chinese Pistache	*Pistacia chinensis*	60 x 50
No	Texas Ebony	*Pithecellobium flexicaule*	50 x 30
No	Mexican Ebony	*Pithecellobium mexicanum*	35 x 25
No	Hybrid Mesquite	*Prosopis spp.*	40 x 40
No	Chilean Mesquite	*Prosopis chilensis*	30 x 30
No	Texas, Honey Mesquite	*Prosopis glandulosa*	30 x 40
No	Native (Velvet) Mesquite	*Prosopis velutina*	40 x 35
No	Texas Red Oak	*Quercus buckleyi*	60 x 60
No	Live Oak	*Quercus virginiana*	80 x 120
No	African Sumac	*Rhus lancea*	35 x 35
No	Brazilian Pepper Tree	*Schinus terebinthifolius*	30 x 30
No	Queen Palm	*Syagrus romanzoffium*	50 x 30
No	Windmill Palm	*Trachycarpus fortunei*	45 x 10
No	Chinese Elm	*Ulmus parviflora*	60 x 70
No	Christmas Palm, Manila Palm	*Veitchia merrillii*	25 x 15

Tree List*

Acceptable	Common Name	*Scientific Name*	Mature Height x Width (feet)
No	Monk's Pepper Tree	*Vitex agnus-castus*	25 x 25
No	California Fan Palm	*Washingtonia filifera*	60 x 20
No	Mexican Fan Palm	*Washingtonia robusta*	120 x 25
No	Foxtail Palm	*Wodyetia bifurcata*	30 x 20

*Approval or Disapproval of all Trees/Ground cover regardless of whether they are on the approved list is dependent upon electrical clearances to conductors based on voltage, as well as location that do not hinder SRP maintenance crew access/setup. Please refer to the ***SRP General Design Guidelines for Proposed Improvements inside the Transmission ROW for Plan Submittal & Approved Procedure***.

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
Yes	Desert Ageratrum	*Ageratum corybosum*	1x3; a perennial with light blue flowers, dormant in the winter
Yes	Bursage	*Ambrosia deltoidea*	1 – 2x1 – 3; also called Triangle leaf bursage & Rabbit bush
Yes	Purple Threeawn	*Aristido purpurea*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Arizona Threeawn	*A,Purpurea var. arizonica*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Fendler's Threeawn	*A,Purpurea var. fendleriana*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Fendler Threeawn	*A.Purpurea var. logiseta*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Blue Threeawn	*A.Purpurea var. nealleyi*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Parish's Threeawn	*A.Purpurea var. parishii*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Purple Threeawan	*A.Purpurea var. purplexa*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Purple Threeawan	*A.Purpurea var. purpurea*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Wright's Threeawn	*A.Purpurea var. wrightii*	2 – 3x1 -2; perennial bunch grass; purple summer & fall flowers
Yes	Prostrate Dutchman's Pipe	*Aristolochia fibriata*	1x3 – 4; heart shaped leaves & inconspicuous flowers. Moderate to rapid spring growth but dormant in summer. A preferred host plant for swallowtail butterfly larvae. Drought tolerant
Yes	Mediterranean Beach Daisy	*Asteriscus maritimus*	1x1.5; low-mounding perennial herb with dense green, hairy leaves. Has bright yellow flowers late winter – spring. Declines in health with extreme sun, heat and cold.
Yes	Desert Marigold	*Baileya multiradiata*	1+x1+; evergreen perennial bears bright yellow flowers all year with adequate moisture. Short-lived but reseeds easily so there are always new plants to replace dead ones. **Native to AZ**
Yes	Needle Grama Grass	*Bouteloua aristidoides*	1.5-2.5 x 1.5-2.5; perennial bunchgrass; foliage browns in fall
Yes	Bulbine	*Bulbine frutescens*	1.5x1.5; Tough, clumping evergreen succulent with bright green leaves & yellow flowers. Orange flower variety called "Hallmark" is more compact. Both bloom over long periods of the year.
Yes	Daminiata Daisy	*Chrysactinia mexicana*	1-2x3; mounding, evergreen shrub with aromatic leaves that emit pleasant aroma when crushed or brushed. Vibrant yellow, daisy like flowers spring-fall.
Yes	African Daisy	*Dimorphotheca sinuate*	1x1; also called Cape Marigold. Annual with bright orange to yellow daisy flowers in winter and spring. Plant goes to seed & dies after flowing. New flowers arise from seed next winter.

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
Yes	Rosea Ice Plant	*Drosanthemum floribundum*	.5-1.5' evergreen groundcover forms a low dense mat with light pink flowers late spring to summer
Yes	Golden Dyssodia	*Dyssodia pentachaeta*	1x1; low growing perennial with bright yellow small daisy like flowers. Reseeds annually
Yes	Brittle Bush	*Encelia farinose*	3x3; woody perennial mounding shrub with bright yellow daisies in spring; **Native to AZ**
Yes	Outback Sunrise Emu Bush	*Eremphila prostrate "Outback Sunrise"*	6" x 8-9''; evergreen shrub with show tubular flowers spring/summer
Yes	California Poppy	*Eschscholzia californica*	2x2; orange, yellow flowers late winter to early spring
Yes	Mexican Poppy	*Eshscholzia mexicana*	1x1; similar to California poppy; **Native to AZ**
Yes	Gopher Plant	*Euphorbia rigida*	2x3; mounding perennial shrub; easily driven over
Yes	Pink Guara	*Guara lindheimeri*	1x1; perennial with white flowers that fade to pink but some varieties have flowers that open pink from bud. Summer blooms
Yes	Clumping Gazania	*Gazania rigens hybrids*	1x1; forms non-spreading mound of foliage with daisy like flowers in brilliant colors with decorative marking spring to fall.
Yes	Trailing Gazania	*Gazania rigens leucolaena*	1x1.5; perennial prostrate groundcover with daisy like orange, yellow, white or bronze flowers spring to fall
Yes	Sororan Hechtia, Mesclito	*Hechtia montana*	1x3; ground-hugging plants with succulent leaves in rosettes
Yes	Texas Hechtia	*Hechtia texana*	1.5x3; similar to Sonoran Hechtia; also called False Agave
Yes	Hertia Daisy	*Hertia chirifolia*	1.5x4; gray-green mound of foliage has yellow daisy like flowers. Bloom late winter to spring
Yes	Angelita Daisy	*Hymenoxys acaulis*	1x1; resembles Desert Marigold (Baileya multiradita) but has green instead of gray foliage & deeper yellow flowers
Yes	Trailing Ice Plant	*Lampranthus spectabilis*	1x2; succulent groundcover with trailing habit. Vibrant red, pink, purple spring flowers
Yes	Purple Trailing	*Lantana montevidensis*	1x6; woody trailing shrub
Yes	White Trailing	*Lantana montrevidensis var. alba*	1x6; woody trailing shrub
Yes	Yellow Trailing	*Lantana montevidensis*	1x6; woody trailing shrub
Yes	Arizona Lupine	*Luminus arizonicus*	To 16" tall; pinkish purple flowers
Yes	Mojave Lupine; Coulter's Lupine	*Lupinus sparsiflorus*	To 16" tall; violet blue flowers
Yes	Gray Ice Plant	*Malephora crocea*	1x6; evergreen perennial succulent with trailing growth habit. Forms dense mat with reddish-yellow to orange daisy like flowers mostly in spring
Yes	Yellow Malephora	*Malephora luteola*	1x6; trailing succulent has bright yellow spring flowers
Yes	Blackfoot Daisy	*Melampodium leucanthum*	2x2; low mounding perennial has white daisies with yellow centers spring- fall; **NATIVE to AZ**

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
Yes	Nashville Muhly Grass	*Muhlenbergia rigida "Nashville"*	2x2; small, low growing clumps of grass
Yes	Trailing Myoporum	*Myoporum parvifolium*	0.5x9; mat-forming evergreen spreads by trailing stems that root as fast as they grow. White spring flowers then purple berries
Yes	Mexican Evening Primrose	*Oenothera berlandieri*	1x3; spreads to form low open cover. Has bell-shaped white to rosy pink spring flowers
Yes	White or Evening Primrose	*Oenothera caespitosa*	1x2; Perennial forms a low-mounding clump with fragrant white flowers abundant in spring that open in evening & turn pink by midmorning the next day. **NATIVE to AZ**
Yes	Chihuahuan Primrose	*Oenthera stubbei*	0.5x4; herbaceous perennial with heavy bloom yellow flowers in spring that open in evening
Yes	Trailing African Daisy	*Osteopermum fruticosum*	1x2-4;low spreading evergreen perennial with light purple daisy like flowers late winter-spring
Yes	Rock Penstemon	*Penstemon baccarifolius*	1-2x1' ; shrub with beautiful flowers on flower stalks
Yes	Parry's Penstemon	*Penstemon parryi*	1-3x1-3; shrub with vibrant pink flowers on flower stalk February-April. **NATIVE to AZ**
Yes	Superb Penstemon, Coral Penstemon	*Penstemon superbus*	4-6x4; Coral red spring flowers; low water use plant; Susceptible to root rot- especially when overwatered
Yes	Karoo Bush	*Pentzie incana*	1x3; forms a compact evergreen shrub with time yellow button flowers in spring
Yes	Scorpioneed, Desert Phacelia	*Phacelia centulata*	6-24" tall; violet blue spring flowers; **can cause severe rash & blistering in sensitive people**
Yes	Indian Wheat	*Plantago insularis*	12-20" tall; similar to Plantago ovata
Yes	Dessert Indian Wheat	*Plantago ovate*	Also known as Read Threeawn or Purple Threeawn; can be weedy
Yes	Paper Flower, Yellow Paper Daisy	*Psilostrophe cooperi*	1.5x1.5; clump forming perennial with bright yellow flowers that turn papery & hold color as they dry
Yes	Katie Trailing Ruellia	*Ruellia brittoniana "Katie"*	1x1
Yes	Desert Chia	*Salvia columbariae*	.5-1.5' fall
Yes	Sonoran Ice Plant	*Sesuvium verrucosum*	0.5x3; prostrate succulent forms dense network or trailing branching stems & leaves; small pink flowers spring - fall
Yes	Setcreasea, Purple Heart Plant	*Setcreassea pallida*	1.5x4; sprawling herbaceous perennial with succulent leaves bearing small pink, lavender or purple flowers throughout summer; leaf color varies from green to rich purple such as in variety "Purple Heart"

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
Yes	Singapore Daisy	*Sphagneticola trilobata "Yellow Dot"*	½-1x4-6; bright yellow-orange daisy like flowers' bright glossy green lance-shaped leaves usually 3-lobed with toothed edges and arranged in pairs along stem. Vigorous, spreading creeper that invades native vegetation, creek beds & disturbed areas. *Not currently listed on AZ Invasive Weed list
**Yes	**Arizona Yellow Bell	***Tecoma stans var. agustata*	15x10; shrub has relatively small flowers & lacy foliage made up of narrow deeply toothed leaves *****This plant may be used depending on location due to concern for Condor & Line Trucks.***
Yes	Gooding Verbena	*Verbena gooddingii*	1.5x3; perennial short-lived ground covering yields short spikes of tiny pink-lavender flowers in spring/summer. **NATIVE to AZ**
Yes	Peruvia Verbena	*Verbena peruviana & Preuvia Hybrids*	0.5x3; perennial ground hugging mat of dark green leaves bearing small brick red flowers during warm season; hybrids exist in white, pink, red or purple
Yes	Moss Verbena	*Verbena pulchalla gradillor*	1x5; evergreen flat growing perennial with dark green leaves & small blue-purple flower clusters (sometimes violet, pink or white) blooming late in winter to fall
Yes	Sandpaper Verbena	*Verbena rigida*	2x4; evergreen perennial has dark green leaves & clusters of deep purple flowers summer/fall
Yes	Creeping Daisy; yellow Dot; Rabbit's Paw	*Wedelia trilobata*	1'x spreading; daisy like flowers
Yes	Twisted Leaf Yucca	*Yucca ripicola*	2x2-3 with a 5' tall flower stalk
Yes	California Fuchsia	*Zauschneria californica lotifolia*	0.5x3; similar to Hummingbird Trumpet bush but California Fuchsia has wider leaves & clearly visible lateral veins opposing arranged; similar flowers
Yes	Fairy Lily	*Zephyranthes candida*	1x1
Yes	Desert Zinnia	*Zinnia acerosa*	1x1; small herbaceous perennial bears clusters of white to pale yellow flowers marked with green veins below petals; flowers intermittently spring/fall with moisture. **NATIVE to AZ**
Yes	Rocky Mountain Zinnia, Plains Zinnia	*Zinnia grandiflora*	1x1; low spreading evergreen shrub with bright green foliage & bears clusters of small zinnia-like yellow daisies summer/fall

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
NO	Prostrate Acacia	*Acacia redolens*	2-6x15; woody, fast growing sprawling shrub with small yellow puffball spring flowers
NO	Desert Carpet Prostrate Acacia	*Acacia redolens "Desert Carpet"*	1 -2x10 – 12; Woody, fast growing sprawling shrub
NO	Smooth Agave	*Agave desmetiana*	3x3; fast growing and spreading agave; blooms once then dies; blooms on tall flower stalks
NO	Parry's Agave	*Agave parrryi*	2 - 3 x 3+; Clump-forming succulent. Leaf tips bear stout spikes.
NO	Huachuca agave	*Agave parryi huachucensi*	Leaf edges of Huachuca agave also bear thorns.
NO	Gentry's agave	*Agave parryi truncata*	Flower stalks of these agaves rise 20 ft tall.
NO	Medicinal Aloe	*Aloe barbadenis*	2-3 Ft tall with 3 ft flower stalk
NO	Blue Elf	*Aloe "Blue Elf"*	2 x 2; clumps at base spreading to 4 ft wide; easily spreads; spikes of orange flowers attract hummingbirds
NO	Coral Aloe	*Aloe striata*	2-3 ft tall with flower stalk 2-3 ft tall
NO	Red Chihuahuan Honeysuckle	*Anisacanthus puperulus*	3+ x 3 - 4; fairly compact shrub that's mostly evergreen with firecracker red tubular summer flowers
NO	Flame Anisacanthus	*Anisacanthus quadrifolius wrightii*	3-4 x 3-4; a mounding deciduous shrub has orange-red tubular flowers summer to fall
NO	Prickly Poppy	*Argemone platyceras*	1.5-3 x 1-2; Upright, spiny annual or biennial with prickly stems & leaves and bearing large 4 in diameter white flowers having a cluster of orange stamens at the center
NO	Sagebrush	*Aristolochia fimbriata*	4-8 x6
NO	Pineleaf milkweed	*Asclepias linaria*	3 x 3; also called Thread leaf milkweed it is native to AZ. It gets woody at its base but withstands traffic well. Greenish or white flowers spring to fall
NO	Desert milkweed	*Asclepias subulata*	3-4 x 2-4; Many slender herbaceous leafless upright stems grow in dense cluster from woody base & withstands traffic well. Native to AZ
NO	Four-Wing Saltbrush	*Atriplex canescens*	3-8x6
NO	Quailbush	*Atriplex lentiformis*	3-10 x 12
NO	Desert saltbush	*Atriplex polycarpa*	6x6
NO	Centennial coyote bush	*Baccharis* hybrid 'Centennial' AKA *Baccharis pilularis x B. sarothroides*	1-3 x 6-8; also called Desert broom. Hybrid is bright green & spreading. Heat tolerant & tolerates traffic. Regular pruning or topping of mature plants keeps them fresh & vigorous. Not particularly long-lived & subject to spider mites
NO	Harrison Barberry	*Berberis harrisoniana*	30 x 30 but more commonly 15 x 10; Rapid growing; blooms almost continuously; thorny
NO	Bougainvillea	*Bougainvillea spp.*	12 - 20 x 6 - 8; Climbing thorny vine that may be trained as a groundcover. May be invasive or a noxious weed
NO	Barbara Karst Bougainvillea	*Bougainvillea spp. 'Barbara Karst'*	5 x 6; evergreen mounding shrub

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
NO	Raspberry Ice Bougainvillea	*Bougainvillea brasiliensis 'Raspberry Ice'*	30 x 30 but more commonly 15 x 10
NO	Red Bougainvillea	*Bougainvillea glabra*	30 x 30 but more commonly 15 x 10; Rapid growing; blooms almost continuously; thorny
NO	Purple Bougainvillea	*Bougainvillea spectabilis* (*same as Bougainvillea. brasiliensis*)	
NO	Buffalo Grass	*Buchloe dactyloides*	**Warning**: **DO NOT** confuse this with Buffel Grass (*Cenchrus ciliaris*) which is NOT acceptable as it's non-native, aggressively invasive, & destructive of native plants
NO	Red Bird of Paradise	*Caesalpinia pulcherrima*	10 x 6; Woody, fast growing shrub with thorn-like prickles along stems. Orange-red flowers with long red stamens in warmer months. **Bean pods are poisonous**
NO	Baja Fairy Duster	*Calliandra californica*	5 x 5; has stiff, grey stems; tassel shaped flower heads with bright red stamens attract butterflies/hummingbirds; flowers most abundant in spring
NO	Fairy Duster	*Calliandra eriophylla*	3 x 4; also known as False mesquite; shrubby groundcover
NO	Calylophus	*Calylophus harwegii*	1.5 x 3; Woody perennial forms a sprawling clump bearing narrow evergreen leaves & butter yellow spring flowers
NO	Desert Senna	*Cassia covesii*	See *Senna covesii*
NO	Silver Cassia	*Cassia phyllodenia*	6x6; shrub
NO	Buffel Grass	*Cenchrus ciliaris*	A non-native, aggressively invasive grass that destroys native plants
NO	Dusty Miller	*Centaurea cineraria*	1-3 x 1-3; Whitish to silvery foliage. Flowers are purple or yellow & most abundant in summer
NO	Cutleaf Dusty Miller	*Centaurea gymnocarpa*	1-3 x 1-3; Similar to Dusty miller but flowers are violet or purple
NO	Bush Morning Glory	*Convolvulus cneorum*	1-2 x 3; Sprawling evergreen shrubby perennial forms mound of silky foliage covered with morning glory blossoms late spring to fall
NO	Silver Dalea	*Dalea bicolor argryea*	3-4 x 3-4; Silvery-white leaves & clusters of small fall blooming rose-purple flowers; Native to AZ
NO	Golden Dalea	*Dalea capitata*	1 x 3; Small evergreen shrub with golden blooms late spring to fall. 'Sierra Gold' variety available at most nurseries
NO	Trailing Indigo Bush	*Dalea greggii*	2 x 9; clusters of small lavender to purple flowers in spring to early summer. Doesn't tolerate foot or vehicle traffic. Low, spreading groundcover must be cut back every few years to prevent woody growth
NO	Yellow-flowered Daisy Bush	*Dalea lutea*	3 x 3; mounding semideciduous shrub with small gray-green leaves & pea shaped yellow flowers in warm season with moisture

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
NO	Wislizenii's Daisy	*Dalea wislizenii*	1.5-4 x 3-4; AZ native. Open, slender branched shrub yields rose-purple flowers at branch tips spring/fall
NO	Desert Spoon	*Dasylirion wheeleri*	6 x 6; Flower stalks reach 15' tall
NO	Turpentine bush	*Eracameria laricifolia*	3 x 3; mounding shrub with pine needle-like leaves & tiny yellow flower clusters in fall. **NATIVE to AZ**
NO	Emu bush, Poverty bush	*Eremophila hygrophana*'Blue Bells'	2-3 x 3; evergreen shrub has purple flowers with silvery foliage
NO	Valentine bush, Native Fuschia, Spotted Emu bush	*Eremophila maculata*	2 - 9 x 2 - 9; evergreen shrub has colorful red flowers in winter / spring that attract hummingbirds
NO	Candelilla Wax Plant	*Euphorbia antisyphilitica* 'Candelilla'	3 x 3; shrub with densely clustered, erect stems; spreads via rhizomes
NO	Giant Hesperaloe; False Yucca	*Hesperaloe funifera*	3 - 6 x 6; evergreen succulent
NO	Red Yucca	*Hesperaloe parviflora*	3 x 4; evergreen succulent forms a grass like clump; easily spreads
No	Brakelights Red Yucca	*Hesperaloa parviflora "Perpa"*	2x2' evergreen succulent forms grass like clump; easily spread; flower stalks 3-5 with vibrant red flowers; no spines or sharp edges on leaves
NO	Yellow yucca	*Hesperaloe parviflora* Yellow	3 x 4; evergreeen succulent forms a grasslike clump; easily spreads; spines/sharp edges on leaves; pale yellow flowers spring-summer
NO	Arabian jasmine	*Jasminium sambac*	6 - 10 x 6 - 10; woody shrub
NO	Lantana	*Lantana camara*	upright shrub fast-growing to 5x10
NO	Lantana American Red	*Lantana camara* 'American Red'	upright shrub fast-growing to 3x4
NO	Lantana Confetti	*Lantana camara* 'Confetti'	upright shrub fast-growing to 3x4
NO	Lantana Cream Carpet	*Lantana camara* 'Cream Carpet'	upright shrub fast-growing to 3x7
NO	Lantana Dwarf Yellow	*Lantana camara* 'Dwarf Yellow'	upright shrub fast-growing to 4x3
NO	Lantana Gold Mound	*Lantana camara* 'Gold Mound'	upright shrub fast-growing to 4x4
NO	Lantana Gold Trailing	*Lantana camara* 'Gold Trailing'	upright shrub fast-growing to 1x6
NO	Lantana Irene	*Lantana camara* 'Irene'	upright shrub fast-growing to 3x4
NO	Lantana New Gold	*Lantana camara* 'New Gold'	upright shrub fast-growing to 2x3
NO	Lantana Patriot Rainbow	*Lantana camara* 'Patriot Rainbow'	upright shrub fast-growing to 3x4
NO	Lantana Radiation	*Lantana camara* 'Radiation'	upright shrub fast-growing to 5x10
NO	Lantana Yellow Spreading	*Lantana camara* 'Yellow Spreading'	upright shrub fast-growing to 3x7
NO	Lantana Dwarf White	*Lantana montevidensis* 'Dwarf White'	4x6: Evergreen perennial often called trailing lantana; Woody Trailing Shrub
NO	Lantana Tangerine Trailing	*Lantana montevidensis* 'Tangerine Trailing'	3x7: Evergreen perennial often called trailing lantana; Woody Trailing Shrub
NO	Lantana White Lightning	*Lantana montevidensis* 'White Lightning'	3x7: Evergreen perennial often called trailing lantana; Woody Trailing Shrub
NO	Creosote	*Larrea tridentata*	woody shrub
NO	Cenizo	*Leucophylum candidum*	3 x 3; evergreen rounded shrub also called Violet silver leaf

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
NO	Purple Sage	*Leucophylum frutescens*	4-8 x 3-6; evergreen rounded shrub with purple flowers
NO	Green Texas Ranger	*Leucophylum frutescens* 'Green Cloud'	6 - 9 x 6; woody shrub, moderate to fast growth rate has green leaves & red-violet flowers
NO	White Texas Ranger	*Leucophylum frutescens* 'White Cloud'	6 - 9 x 6; woody shrub, moderate to fast growth rate has grey foliage & pure white flowers
NO	Heavenly Cloud Texas Sage	*Leucophylum frutescens 'Heavenly Cloud'*	5 x 5; woody, dense, rounded shrub
NO	Langman's Sage	*Leucophyllum langmaniae*	5 x 5; woody, dense, rounded shrub
NO	Lynn's Legacy Sage	*Leucophylum langmaniae* 'Lynn's Legacy'	5 x 5; woody, dense, rounded shrub
NO	Rio Bravo Sage	*Leucophylum langmaniae* 'Rio Bravo'	5 x 5; woody, dense, rounded shrub
NO	Chihuahuan Sage	*Leucophyllum laevigatum*	5 x 5; woody, dense, rounded shrub; aka Blue Texas Ranger
NO	Texas Ranger	*Leucophyllum zygophyllum* 'Cimarron'	3 x 3; woody, dense, rounded shrub
NO	Pink Mulhy	*Muhlenbergia capillaris* 'Pink Muhly'	3-4 x 3-4; perennial lush clump of grass
NO	Regal Mist Pink Muhly	*Muhlenbergia capillaris* 'Regal Mist'	4 x 4: lush clump of grass
NO	Bull Grass	*Mulhenbergia emersleyi*	5 x 5; **Native to AZ**
NO	Autumn Glow	*Muhlenbergia lindheimeri*	4 x 2; large mounding clumps of grass
NO	Nashville Deer Grass	*Muhlenbergia rigens 'Nashville'*	4 x 4; large mounding clumps of grass
NO	Mexican Feather Grass	*Nassella tenuissima*	Also called Mexican Needle Grass; this is a non-native, aggressively invasive clump-forming grass that destroys native plants
NO	Dwarf Oleander	*Nerium oleander*	6 x 6; woody shrub
NO	Petite Pink Dwarf Oleander	*N. oleander* 'Petite Pink'	6 x 6; woody shrub
NO	Bear Grass	*Nolina microcarpa*	3 x 6; AZ native clump-forming grass
NO	Indian Fig Prickly Pear	*Opuntia ficus-indica*	10 - 15 x 10; upright, trunk-forming segmented cactus; also called tuna cactus or mission cactus
NO	Purple Prickly Pear	*Opuntia violacea santarita*	Cactus

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
NO	Eaton's Penstemon, Firecracker Penstemon	*Penstemon eatonii*	3 x 3; AZ native shrub with scarlet flowers on flower stalks with distinct red-purple markings blooming late winter to summer
NO	Arrow weed	*Pluchea sericea*	15 ft tall, forms dense thickets; willow-like shrub native to AZ typically found along desert waterways; thorn less. **Protected as Traditional Cultural Properties (TCPs) for SRPMIC, Gila River Indian Community, Ak-Chin Indian Community, & Tohono O'Odham Nation** *****For SRPMIC: Contact Shane Antone at 480-850-4708 or shane.antone@srpmic-nsn.gov within 10 business days prior to the date in which plant will be maintained. 1 known location is surrounding the poles on the SW corner of Indian School Rd & Center St on SRPMIC**
NO	Plumbago	*Plumbago species*	10 x 10; woody, mounding shrub
NO	Cape Plumbago	*Plumbago auriculata*	10 x 10; woody, mounding shrub
NO	Prostrate rosemary, Trailing rosemary	*Rosemarinus officinalis* 'Prostratus'	3 x 4-8; shrub with trailing habit & light blue flowers
NO	Prostrate rosemary, Collingwood Ingram	*Rosemarinus officinalis* 'Collingwood Ingram'	2.5 x 4-8; this cultivar has vivid blue flowers
NO	Prostrate rosemary, Huntington Blue	*Rosemarinus officinalis* 'Huntington Blue'	1.5 x 4-8; this cultivar has blue flowers
NO	Prostrate rosemary, Lackwood de Forest	*Rosemarinus officinalis* 'Lockwood de Forest'	Similar to 'Prostratus' but with lighter colored flowers & foliage
NO	British Ruellia	*Ruellia brittoniana* 'British Ruellia'	3 x 4; purple blooms
NO	Dwarf Pink Ruellia	*Ruellia brittoniana* 'Dwarf Pink'	2 x 2; has some branches
NO	Baja Ruellia	*Ruellia peninsularis*	2-4 x 2-4; dense, evergreen, rounded shrub with blue-purple trumpet-shaped flowers spring to fall
NO	Firecracker Plant	*Russelia equisetiformis*	3-5 x 6-12
NO	Wild Coral Fountain	*Russelia polyedra*	1.5-3 x 1.5-3; small firecracker red flowers bloom in warm season with adequate moisture
NO	Blue Chihuahuan Sage	*Salvia chamaedryoides*	2 x 2; evergreen shrub with gray green leaves & summer to fall blooming blue flowers
NO	Mojave Sage	*Salvia dorrii*	3 x 3; sprawling evergreen shrub has small silvery leaves & bold blue-purple flowers late spring
NO	Mealy Cup Sage	*Salvia farinacea*	1.5-3 x 3; herbaceous perennial with gray green leaves & dark or violet blue to white flowers summer & fall
NO	Red Chihuahuan Sage	*Salvia greggii*	3 x 3; evergreen shrub bearing bright red to red-purple flowers spring - fall

Ground Cover List*

Acceptable	Common Name	*Scientific Name*	Ht x W (ft) Comments
NO	Lavender Cotton	*Santolina chamaecyparissus*	2 x 3; dense mounding evergreen shrub with aromatic silvery gray leaves; bright yellow buttonlike summer flowers
NO	Green-leaved Lavender Cotton, Green Santolina	*Santolina virens*	2 x 3; dense rounded evergreen shrub with bright green aromatic leaves & creamy yellow buttonlike spring flowers
NO	Dusty Miller	*Senecio cineraria*	2.5 x 2.5; evergreen dense mounding shrubby perennial with silvery wooly leaves & yellow to cream flowers all year
NO	Desert Senna, Green Feathery Senna	*Senna covesii*	3 x 3; shrubby perennial that may act like an annual if not enough moisture received; gray green compound leaves & yellow flowers summer/fall
NO	Lindheimeriana Senna, Velvet-leaf Senna	*Senna lindheimeriana*	3 x 2; perennial shrub bears yellow flowers in summer; Seed pods follow bloom; AZ native
NO	Globe Mallow	*Sphaeralcea ambigua*	3 x 3; perennial shrub with gray green to almost white deeply lobed leaves; Flowers may be red, orange, rose, pink or white depending on variety & bloom mostly in spring
NO	Alkali sacaton	*Sporobolus airoides*	4 x 3; **Native to AZ** NOTE: **CANNOT** be planted where SRP vehicles must drive to access ROW
NO	Sand Dropseed	*Sporobolus cryptandrus*	3x3 grass
NO	Texas Betony, Scarlet Betony	*Stachys coccinea*	2 x 2; mounding evergreen herb with bright two-lipped flowers bloom spring/fall; Native to AZ
NO	Anise Marigold, Mexican Tarragon (Santa Maria)	*Tagetes lucida*	3 x 2; perennial marigold that under cultivation may be treated as an annual; Leaves have anise scent; Small yellow fall flowers
NO	Orange Jubilee	*Tecoma alata*	12 x 8 - 10; shrub to small tree with yellow-orange flowers spring/fall
NO	Arizona Yellow Bells	*Tecoma stans var. agustata*	2 x 2; mounding evergreen herb with bright two-lipped flowers bloom spring/fall; **Native to AZ** ****Yes, depending on location due to concern for Condor & Line Trucks**
NO	Cape Honeysuckle	*Tecomaria capensis*	As an evergreen, woody shrub it can reach 10 x 6 but may spread 25 ft or more; As a vine, it is 20-30 ft tall; Has tubular orange flowers Fall/Winter that attract hummingbirds; Not a good plant for allergy sufferers
NO	Sierra Apricot Tecoma	*Tecoma 'Sierra Apricot'*	2-3 x 3-4; similar to other Tacoma spp
NO	Golden eye	*Viguiera deltoidea*	3 x 3; AZ native; Sprawling evergreen shrub with small yellow daisy-like spring flowers
NO	Xylosma	*Xylosma congestum*	20 x 15; woody shrub to small tree
NO	Compact Xylosma	*Xylosma congestum* 'Compacta'	6 x 6; woody, mounding shrub
NO	Hummingbird Trumpet Bush	*Zauschneria californica*	2 x 2; herbaceous perennial has gray green alternate leaves that may turn red in fall; brilliant red trumpet shaped flowers summer/fall; **Native to AZ**

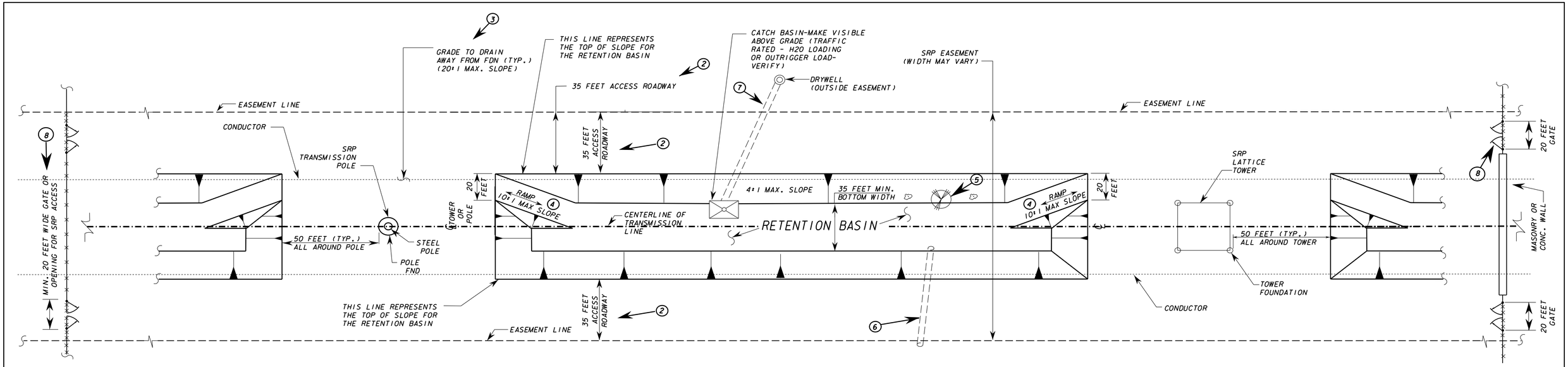
Ground Cover List*

*Approval or Disapproval of all Trees/Ground cover regardless of whether they are on the approved list is dependent upon electrical clearances to conductors based on voltage, as well as location that do not hinder SRP maintenance crew access/setup. Please refer to the ***SRP General Design Guidelines for Proposed Improvements inside the Transmission ROW for Plan Submittal & Approved Procedure***. Plants may damage SRP equipment if SRP states plants as **NO.**

This plant may be used depending on location due to concern for Condor & Line Trucks.

Bibliography Referenced

Jones, Warren & Sacamanto, Charles. Landscape Plants for Dry Regions. Fisher Books. Tucson, AZ. c2000.
Editors of Sunset Books & Sunset Magazine. Sunset Western Garden Book. Sunset Publishing Corporation. Menlo Park, CA c1995.
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Various internet sites

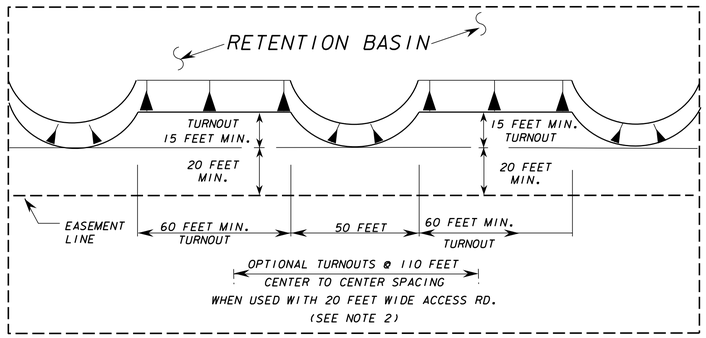


PLAN VIEW OF STORM WATER RETENTION BASIN WITHIN SRP TRANSMISSION LINE RIGHT OF WAY N.T.S.

STORM WATER RETENTION BASIN GUIDELINES:

THE FOLLOWING LIST OF MINIMUM CRITERIA IS REQUIRED BY ANYONE WISHING TO USE SRP TRANSMISSION LINE EASEMENTS FOR STORM WATER RETENTION BASINS.
THEY MUST OBTAIN SPECIFIC WRITTEN APPROVAL FROM THE SRP LAND DEPARTMENT BEFORE ANY CONSTRUCTION MAY PROCEED WITHIN THE EASEMENT PROPERTY.
PLANS SHOULD BE SUBMITTED TO THE SRP LAND DEPARTMENT VIA THE INITIAL PLAN REVIEW (IPR) PROCESS WHICH MAY BE STARTED AT https://www.srpnet.com/about/land/secure/plansubmittal.aspx ,
PLEASE CONTACT (602) 236-3117 OR workflow@srpnet.com FOR MORE INFORMATION.

1. THE PROPERTY IN QUESTION MUST BE OWNED, IN FEE, BY THE DEVELOPER OR OTHER REQUESTOR OF MULTIPLE USE IN THE EASEMENT.
2. THE RETENTION BASIN DESIGN MUST PROVIDE FOR CONTINUOUS VEHICULAR ACCESS AND CRANE SET-UP AREAS ALONG EACH EDGE OF THE EASEMENT (10:1 MAXIMUM LONGITUDINAL SLOPE) ABOVE HIGH WATER. TYPICALLY, THIS WILL REQUIRE 35 FEET WIDE ACCESS ROADS ALONG EACH EDGE. AN OPTION IS 20 FEET WIDE ACCESS WITH 35 FEET x 60 FEET CRANE SET-UP PADS CENTERED AT 110'.
3. AS A CRANE SET-UP AREA AND TO PROTECT THE INTEGRITY OF EACH POLE OR TOWER, A RECTANGULAR, LEVEL AREA OF GROUND (ABOVE HIGH WATER) MUST BE PROVIDED MEASURING A MINIMUM OF 50 FEET IN EACH DIRECTION FROM THE OUTSIDE EDGE OF ANY FOUNDATION. TYPICALLY, THIS CLEARED AREA WILL NEED TO EXTEND ALL THE WAY ACROSS THE EASEMENT (TRANSVERSE) AND TIE TO THE ACCESS ROADS. CLEAN FILL IS ACCEPTABLE, PROIVDED THE GRADES REMAIN 6 INCHES BELOW THE TOP OF FOUNDATIONS. NOTE: ANY PROPOSED CUTS OR FILLS WITHIN THE ROW TO BE REVIEWED BY SRP. THIS AREA MUST DRAIN AWAY FROM FOUNDATIONS, WITH 20:1 MAXIMUM SLOPE.
4. THE RETENTION BASIN MAY HAVE SIDE SLOPES OF 4:1 (MAXIMUM), BUT MUST PROVIDE 20-FOOT WIDE ACCESS RAMPS (10:1 MAXIMUM SLOPE) INTO BASIN FROM EACH STRUCTURE LOCATION. ALL AREAS MUST BE PROTECTED FROM SOIL EROSION WITH EROSION PROTECTION METHOD APPROVED BY SRP.
5. APPROVAL OR DISAPPROVAL OF ALL TREES/GROUND COVER REGARDLESS OF WHETHER THEY ARE ON THE APPROVED LIST IS DEPENDENT UPON ELECTRICAL CLEARANCES TO CONDUCTORS BASED ON VOLTAGE, AS WELL AS LOCATIONS THAT DO NOT HINDER SRP MAINTENANCE CREW ACCESS/SETUP. ANY TREE LOCATED UNDER OR NEARANY ELECTRIC LINES IS SUBJECT TO TRIMMIMNG OR REMOVAL BY SRP. TRIMMING MAY RESULT IN THE TREE HAVING UNNATURAL APPEARANCE
6. IF A WATER FLOW IS REQUIRED ACROSS THE ROADWAYS OR THE 50-FOOT AREAS AROUND STRUCTURES, IT MUST BE CONSTRUCTED OF PIPE CAPABLE OF WITHSTANDING A CONCENTRATED LOAD FROM A CRANE OUTRIGGER WITH 320 PSI ON A 27 INCH DIAMETER PAD. CALCULATIONS MUST BE SUBMITTED TO SRP SHOWING THE ANTICIPATED LOADING AND STRENGTH ANALYSIS.
7. NO DRYWELLS WITHIN EASEMENT. IF REQUIRED, DRYWELLS MUST BE LOCATED OUTSIDE THE SRP EASEMENT AREA WITH A CATCH BASIN INSIDE THE RETENTION BASIN AREA. DESIGN AND LOCATION OF CATCH BASIN, PIPING & DRYWELL TO BE REVIEWED BY SRP PRIOR TO ANY CONSTRUCTION.
8. 20 FEET WIDE OPENINGS OR GATES (IN APPROVED LOCATIONS AND PERPENDICULAR TO ACCESS) MUST BE PROVIDED IN ANY FENCES OR WALLS CROSSING THE EASEMENT. FENCES NEED TO BE GROUNDED AND MUST HAVE SHARED LOCK ACCESS.

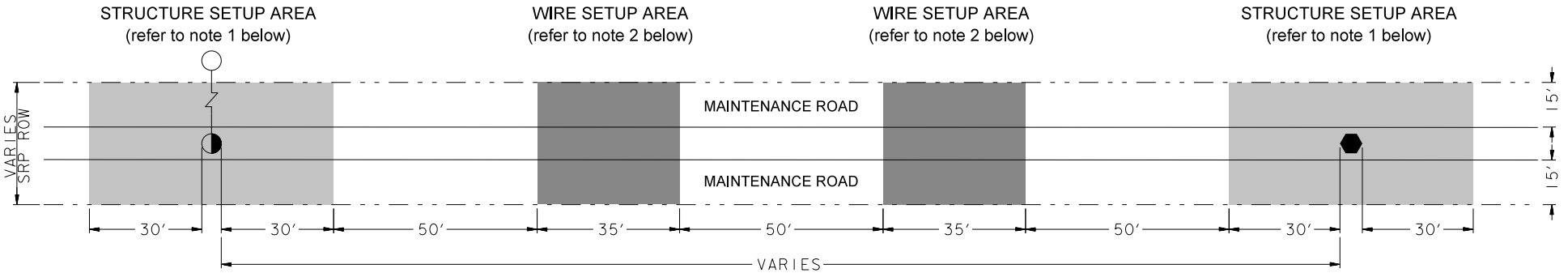


PLAN VIEW OF OPTIONAL TURNOUT @ 110' CENTERS

REVISIONS						
REV NO	DATE	DFTR	CHKR	ENGR CHK	SUPV APPD	ISSUE AUTH
PRELIMINARY ISSUE						
0	04/05	DMG	---	WRS	WRS	WRS

SRP®
TRANSMISSION LINE DESIGN STANDARDS
TRANSMISSION LINE (500kV, 230kV, 115kV) DESIGN STANDARD
STORM WATER RETENTION BASIN DESIGN GUIDELINES
DWG SIZE 30X42
TE-52030

SRP TRANSMISSION ROW MAINTENANCE SETUP AREAS APPLICABLE TO 69kV TRANSMISSION LINES



LEGEND

STRUCTURE

STUB POLE

ROW BOUNDARY

CONDUCTOR

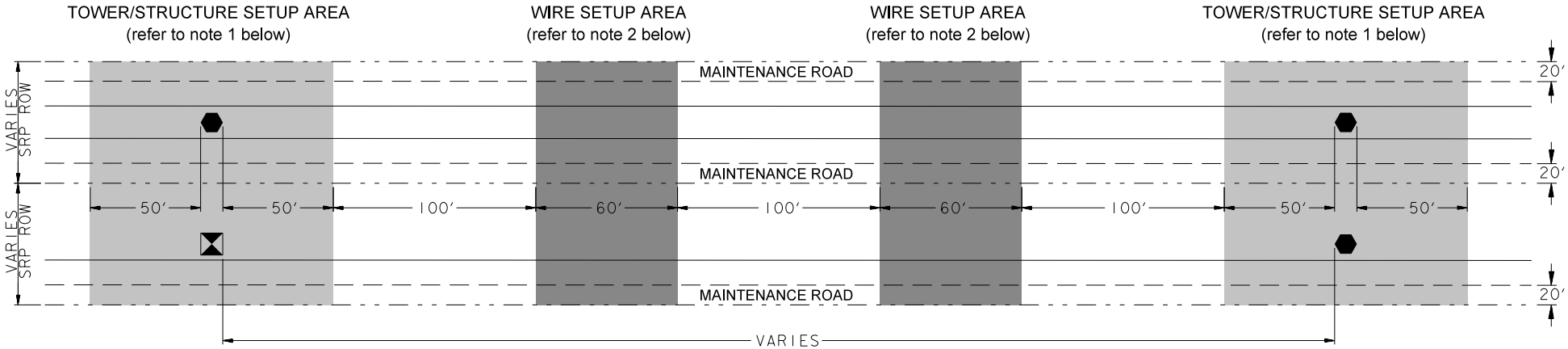
NOTES:

1. STRUCTURE SETUP AREAS FOR 69kV TRANSMISSION LINES ARE DEFINED AS A RECTANGULAR AREA 30 FEET ON EACH SIDE OF THE FACE OF STRUCURE BY THE WIDTH OF THE EASEMENT. SETUP AREAS AND WIRE SETUP AREAS MUST BE CLEAR OF ABOVE GRADE IMPROVEMENTS. SRP REQUIRES UNOBSTRUCTED "HIGH AND DRY" MAINTENANCE ROADS THAT ARE 15 FEET WIDE WITH A 20:1 MAXIMUM SLOPE WHICH RUNS PARALLEL TO THE CONDUCTOR FOR THE ENTIRE LENGTH OF THE EASEMENT ON BOTH SIDES OF THE TOWERS/STRUCTURES. THOSE MAINTENANCE ROADS REQUIRE ACCESS 24 HOURS A DAY AND 7 DAYS A WEEK.
2. WIRE SETUP AREAS FOR 69kV TRANSMISSION LINES ARE DEFINED AS A RECTANGULAR AREA 35 FEET LONG BY THE WIDTH OF EASEMENT, REPEATED EVERY 50 FEET BETWEEN THE STRUCTURE SETUP AREAS. *NOTE: STRUCTURE SETUP AREAS AND WIRE SETUP AREAS FOR 69kV TRANSMISSION LINES ARE REVIEWED DURING THE SRP INITIAL PLAN REVIEW PROCESS.
3. BELOW GRADE IMPROVEMENTS WITHIN STRUCTURE SETUP AREAS FOR 69kV TRANSMISSION LINES ARE REVIEWED ON A CASE BY CASE BASIS. PRIOR WRITTEN CONSENT BY SRP IS REQUIRED. *NOTE: IMPROVEMENTS WITHIN SRP EASEMENTS/ROW FOR 69kV TRANSMISSION LINES MUST MEET 320 PSI POINT LOAD ON 27 INCH DIAMETER PAD.
4. CERTAIN 69kV STRUCTURES ARE REQUIRED TO MEET EXTRA HIGH VOLTAGE (EHV) SETUP AREA REQUIREMENTS. IN ADDITION, ANY POLE HEIGHT FOR 69kV DESIGN THAT EXCEEDS 80 FEET ABOVE GRADE REQUIRES CONSULTATION WITH SRP TRANSMISSION LINE ASSET MANAGEMENT (TLAM) AND AGREEMENT ON THE DESIGN. HIGHWAY CROSSINGS AND OTHER SPECIAL CASES MAY REQUIRE TALLER POLES. IN THESE CASES, LARGER SETUP AREAS, MAINTENANCE ROADS, AND EASEMENTS WILL BE REQUIRED. PLANS SHOULD BE SUBMITTED TO THE SRP LAND DEPARTMENT VIA THE INITIAL PLAN REVIEW (IPR) PROCESS WHICH MAY BE STARTED AT https://www.srpnet.com/about/land/secure/plansubmittal.aspx, PLEASE CONTACT (602) 236-3117 FOR MORE INFORMATION.
5. PARKING IS NOT ACCEPTABLE USE OF SRP EASEMENTS/ROW FOR 69kV TRANSMISSION SYSTEMS.

PLANS SHOULD BE SUBMITTED TO THE SRP LAND DEPARTMENT VIA THE INITIAL PLAN REVIEW (IPR) PROCESS WHICH MAY BE STARTED AT https://www.srpnet.com/about/land/secure/plansubmittal.aspx , PLEASE CONTACT (602) 236-3117 OR Workflow@srpnet.com FOR MORE INFORMATION.

REV: 1	10/4/2019

SRP TRANSMISSION ROW MAINTENANCE SETUP AREAS
APPLICABLE TO 115kV, 230kV, & 500kV TRANSMISSION LINES



LEGEND

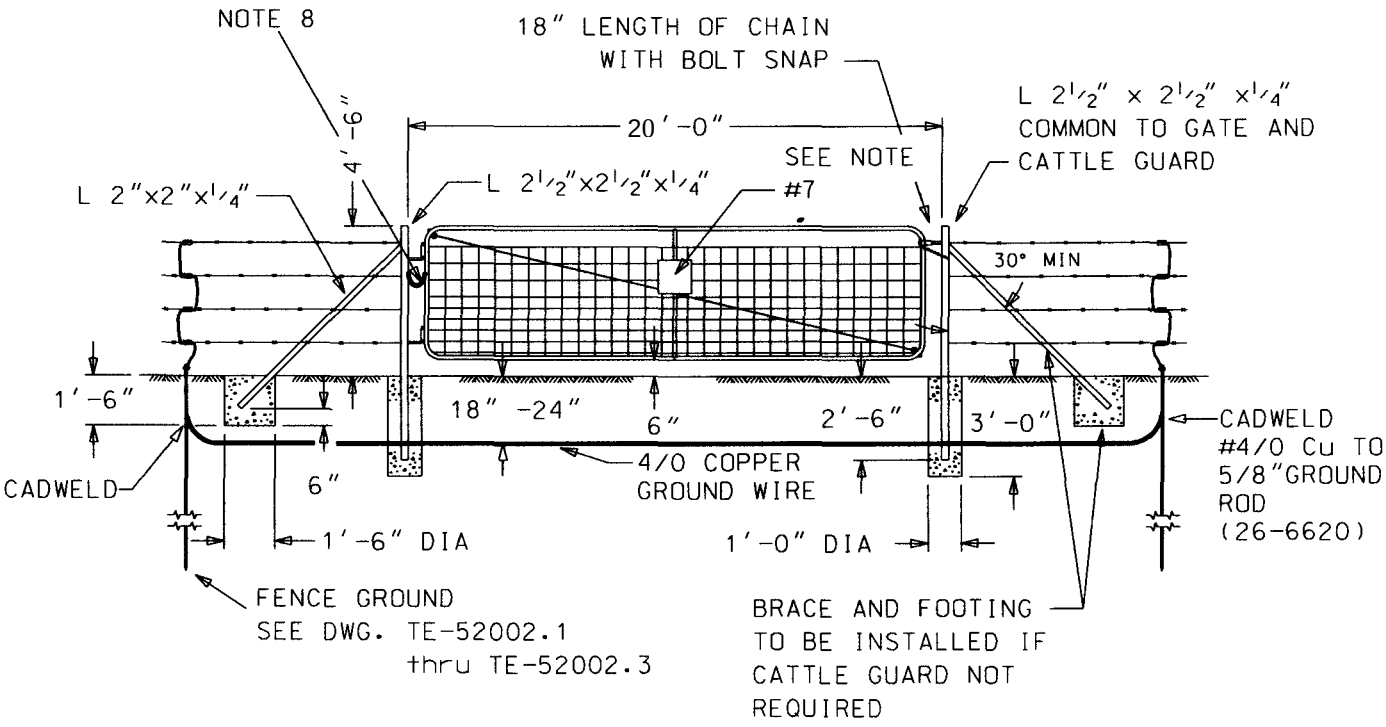
TOWER OR STRUCTURE — ROW BOUNDARY — CONDUCTOR

NOTES:

1. TOWER/STRUCTURE SETUP AREAS FOR EXTRA HIGH VOLTAGE (EHV) TRANSMISSION LINES (*e. g.* 115kV, 230kV, AND 500kV) ARE DEFINED AS A RECTANGULAR AREA 50 FEET ON EACH SIDE OF THE OUTSIDE TOWER LEGS OR FACE OF STRUCTURE BY THE WIDTH OF THE EASEMENT. SETUP AREAS AND WIRE SETUP AREAS MUST BE CLEAR OF ABOVE GRADE IMPROVEMENTS. SRP REQUIRES UNOBSTRUCTED "HIGH AND DRY" MAINTENANCE ROADS THAT ARE 20 FEET WIDE WITH A 20:1 MAXIMUM SLOPE WHICH RUNS PARALLEL TO THE CONDUCTOR FOR THE ENTIRE LENGTH OF THE EASEMENT ON BOTH SIDES OF THE TOWERS/STRUCTURES. THOSE MAINTENANCE ROADS REQUIRE ACCESS 24 HOURS A DAY AND 7 DAYS A WEEK.
2. WIRE SETUP AREAS FOR EHV TRANSMISSION LINES ARE DEFINED AS RECTANGULAR AREA 60 FEET LONG BY THE WIDTH OF EASEMENT, REPEATED EVERY 100 FEET BETWEEN THE TOWER/STRUCTURE SETUP AREAS. *NOTE: TOWER/STRUCTURE SETUP AREAS AND WIRE SETUP AREAS FOR EHV TRANSMISSION LINES ARE REVIEWED DURING THE SRP INITIAL PLAN REVIEW PROCESS.
3. BELOW GRADE IMPROVEMENTS WITHIN TOWER/STRUCTURE SETUP ARES FOR EHV TRANSMISSION LINES ARE REVIEWED ON A CASE BY CASE BASIS. PRIOR WRITTEN CONSENT BY SRP IS REQUIRED. *NOTE: IMPROVEMENTS WITHIN SRP EASEMENTS/ROW FOR EHV TRANSMISSION LINES MUST MEET 320 PSI POINT LOAD ON 27 INCH DIAMETER PAD.
4. PARKING MAY BE ACCEPTABLE USE OF SRP EASEMENT/ROW FOR EHV TRANSMISSION LINES. THERE ARE SPECIFIC REQUIREMENTS FOR ORIENTATION WITH RESPECT TO TRAFFIC FLOW. MAINTENANCE ROADS AND CRANE SETUP AREAS WILL NEED TO BE INCORPORATED INTO THE PARKING DESIGN BASED UPON INPUT FROM SRP. ANY VEHICLES PARKED WITHIN SRP EASEMENT/ROW MUST BE ABLE TO BE RELOCATED, 24 HOURS A DAY AND SEVEN DAYS A WEEK, AT THE REQUEST OF SRP.

PLANS SHOULD BE SUBMITTED TO THE SRP LAND DEPARTMENT VIA THE INITIAL PLAN REVIEW (IPR) PROCESS WHICH MAY BE STARTED AT https://www.srpnet.com/about/land/secure/plansubmittal.aspx, PLEASE CONTACT (602) 236-3117 OR WorkFlow@srpnet.com FOR MORE INFORMATION.

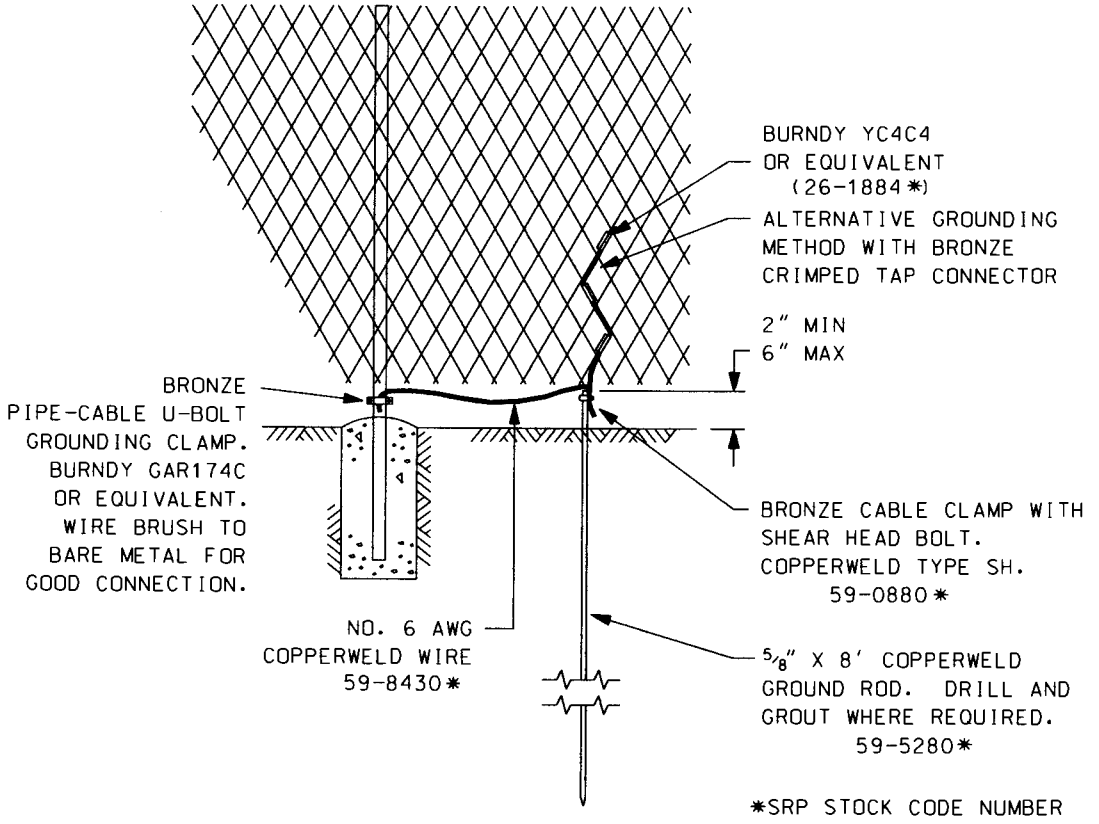
REV: 1	10/4/2019



NOTES:

1. GATE TO BE SELF-CLOSING AND SET PARALLEL TO SLOPE OF ROAD.
2. WHERE CATTLE GUARD IS USED, CATTLE GUARD SHALL BE ALIGNED WITH ROAD.
3. STEEL POLES AND BRACES SHALL BE GALVANIZED OR PAINTED WITH A BAKED-ON ASPHALT BASE ENAMEL.
4. SET FENCE POSTS AND BRACES IN CONCRETE. CONCRETE SHALL BE 2000 PSI AT 28 DAYS.
5. STANDARD 16' GATE SHALL BE 42" HIGH MINIMUM WITH $1\frac{3}{8}$" O.D. GALVANIZED IRON TUBULAR FRAME. ALL FITTINGS SHALL BE GALVANIZED. GATE SHALL HAVE A DIAGONAL ADJUSTABLE SAG-ROD OR WIRE. MINIMUM WEIGHT OF GATE SHALL BE 70 POUNDS.
6. G.I. MESH FENCE FILLER TO BE 11 GAUGE FARM FENCE FILLER, OR EQUIVALENT.
7. INSTALL SIGN. SIGN TO READ "KEEP GATE CLOSED."
8. INSTALL COPPER BRAIDED STRAP, TYPICAL 12" (BURNDY BD12 OR EQUAL) SRP STOCK NO. 26-2280.

OVERHEAD TRANSMISSION CONSTRUCTION STANDARDS SRP® *PROPRIETARY MATERIAL*	REV. FORMAT	8515E383.DGN
	METAL FRAME FENCE GATE	DATE: 07/11/00 REV. NO: 1 REV. DATE: 11/17/03 APPROVAL: AJK
		TE-52004



NOTES:

1. INSTALL GROUNDS AT POINTS NOT TO EXCEED 500 FEET APART IN ANY FENCE THAT PARALLELS THE TRANSMISSION LINE FOR MORE THAN 1000 FEET AS DIRECTED BY THE PURCHASER.
2. INSTALL ONE GROUND AT EACH EDGE OF THE RIGHT OF WAY IN FENCES THAT CROSS THE TRANSMISSION LINE. (TOTAL OF 2 RODS.)
3. WHERE A GATE HAS BEEN INSTALLED IN THE FENCE THAT CROSSES THE TRANSMISSION LINE, INSTALL A GROUND ROD ON EACH SIDE OF THE GATE OPENING.
4. FILL ALL CLAMPS WITH CONDUCTING GREASE PRIOR TO CRIMPING OR BOLTING.
5. DEFORM THE THREADS ON THE U-BOLT GROUNDING CLAMP WITH A CHISEL AFTER INSTALLATION TO PREVENT REMOVAL OF THE NUTS.

OVERHEAD TRANSMISSION CONSTRUCTION STANDARDS SRP® PROPRIETARY MATERIAL	REV. FORMAT	8515E386.DGN
	TRANSMISSION LINE FENCE GROUND, GALVANIZED CHAIN LINK	DATE: 04/00/93 REV. NO: 1 REV. DATE: 11/18/03 APPROVAL: AJK
		TE-52002.2

Delivering water and power™

Applicant Safety Acknowledgement Form

(To Acknowledge Receipt of Safety Letter and Safety Brochure)

This is to acknowledge that I have received from the SRP Representative a copy of SRP's Safety Letter and associated Safety Brochure which outline my responsibilities before and during any excavation, and inform me of minimum approach distances that must be maintained, when working near overhead power lines.

_____

Project Identifying Information

_____

Project Address

_____

Printed Name (Applicant or Applicant's Representative)

_____

Company Name (if applicable)

_____

Signature (Applicant or Applicant's Representative)

Date of Acknowledgement: _____/_____/_____

Delivering water and power™

29 CFR 1910 Occupation Safety and Health Administration General Industry Regulations Subpart S - Electrical

Part Number:
1910
Part Number Title:
Occupational Safety and Health Standards
Subpart:
1910 Subpart S
Subpart Title:
Electrical
Standard Number:
1910.333
Title:
Selection and use of work practices
GPO Source:
e-CFR

1910.333(c)(3)(i)
"Unqualified persons."

1910.333(c)(3)(i)(A)
When an unqualified person is working in an elevated position near overhead lines, the location shall be such that the person and the longest conductive object he or she may contact cannot come closer to any unguarded, energized overhead line than the following distances:

1910.333(c)(3)(i)(A)(1)
For voltages to ground 50kV or below - 10 feet (305 cm);

1910.333(c)(3)(i)(A)(2)
For voltages to ground over 50kV - 10 feet (305 cm) plus 4 inches (10 cm) for every 10kV over 50kV.

1910.333(c)(3)(i)(B)
When an unqualified person is working on the ground in the vicinity of overhead lines, the person may not bring any conductive object closer to unguarded, energized overhead lines than the distances given in paragraph (c)(3)(i)(A) of this section.

https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.333

Delivering water and power™

29 CFR 1926 Occupation Safety and Health Administration Construction Industry Regulations Subpart CC – Crane and Derricks in Construction

Part Number:
1926
Part Number Title:
Safety and Health Regulations for Construction
Subpart:
1926 Subpart CC
Subpart Title:
Crane and Derrick in Construction
Standard Number:
1926.1408
Title:
Power line safety (up to 350 kV) –equipment operations.
GPO Source:
e-CFR

1926.1408(a)(2)(i)
Option (1)--Deenergize and ground. Confirm from the utility owner/operator that the power line has been deenergized and visibly grounded at the worksite

1926.1408(a)(2)(ii)
Option (2)--20 foot clearance. Ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer than 20 feet to the power line by implementing the measures specified in paragraph (b) of this section.

1926.1408(a)(2)(iii)
Option (3)--Table A clearance.

The requirements of § 1926.1407 and § 1926.1408 apply to power lines over 350 kV except:

1926.1409(a)
For power lines at or below 1000 kV, wherever the distance \"20 feet\" is specified, the distance "50 feet" must be substituted; and

1926.1409(b)
For power lines over 1000 kV, the minimum clearance distance must be established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution.

https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1408
https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1409
For more information visit: https://www.srpnet.com/safety/contractor.aspx

August 7, 2019

TP Attachment 113-1 – Quality Assurance Program

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Arizona Department of Transportation

Quality Assurance Program

Projects Utilizing Contractor Performed Acceptance



November 24, 2020

DocuSign Envelope ID: C45ADE1E-5571-4362-BABC-433DB5325734

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Appendix A
Federal Regulations and Guidance:
Code of Federal Regulations Title 23 Part 637 Subpart B
Non-Regulatory Supplement NS 23 CFR Part 637B
FHWA Technical Advisory 6120.3
FHWA-HRT-12-039

Appendix B
Abbreviations and Definitions

Appendix C
Split Sample Tolerances

Appendix D
Independent Quality Firm Minimum Sampling Guide Schedule

Appendix E
Example Material Identification Codes

Appendix F
Owner Verification Levels of Testing Verification

Appendix G
Independent Assurance Test Methods

Appendix H
Independent Quality Firm Data Transfer Requirements

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Letter to Users

The Arizona Department of Transportation has developed this Quality Assurance Program for Projects utilizing Contractor performed acceptance. This Program addresses how ADOT will deliver construction quality assurance when the Contractor, or an Independent Quality Firm hired by the Contractor, performs frontline Quality Acceptance inspection and testing with ADOT performing Owner Verification. It provides a systematic and consistent approach to achieving quality on these Projects through the implementation of Contractor Quality Control, Contractor Quality Acceptance, ADOT Owner Verification, ADOT Independent Assurance, and ADOT referee functions on a Project.

Sincerely,
Jesús A. Sandoval-Gil, MS, PhD, PE
State Materials Engineer

Please Note: Information pertaining to updates, changes to this document and reference materials being hyperlinked throughout the document should be included here.

Formal references may be included in this document as needed.

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Approval

DocuSigned by: Jesus A Sandoval-Gil F9A6FBCB94A6460...	DocuSigned by: Ammon Heier FEF6E4414BAF4AE...
Signature	Signature
Jesús A. Sandoval-Gil, MS, PhD, PE	Ammon Heier, PE
Name	Name
State Materials Engineer	Area Engineer
Title	Title
ADOT	FHWA
Agency	Agency
11/24/2020	11/24/2020
Date	Date

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Chapter 1

Scope

1.1 General

The Arizona Department of Transportation (ADOT) has developed this Quality Assurance Program (QAP) for Projects utilizing Contractor performed inspection and testing in the acceptance decision. This Program has been established to be compliant with the Code of Federal Regulations (CFR) 23 CFR 637, Subpart B – "Quality Assurance Procedure for Construction", Federal Highway Administration (FHWA) Technical Advisory 6120.3, and other guidance documents listed in Appendix A.

This Program provides our customers with products and services that meet mutually agreed upon requirements. The intent of this Program is to ensure all materials and workmanship incorporated into ADOT Projects satisfy specification requirements and to provide the highest degree of confidence in the reliability of tests and inspections for ADOT Projects. The purpose of this Program is to provide statewide consistency for Projects when the Contractor's test results are used in the acceptance decision, regardless of how the Project is funded. It presents requirements relating to Quality Acceptance (QA) procedures and Owner Verification (OV) procedures.

This Program is administered by the ADOT Materials Group Quality Assurance Section through the authority of the ADOT State Materials Engineer. Revisions to this Program will be issued by the ADOT Materials Group Quality Assurance Section through the authority of the ADOT State Materials Engineer. Any modification to this QAP requires review and approval by the ADOT Materials Group Quality Assurance Section through the authority of the ADOT State Materials Engineer and FHWA.

Appendix B shows the list of abbreviations and definitions used in this Program.

1.2 Program Components

This Program is comprised of two major components. These are the Acceptance Program and the Independent Assurance (IA) program. The Acceptance Program includes QA performed by the Contractor and OV performed by ADOT, or its designee. The Program allows the use of Contractor performed QA as part of the Acceptance Program, when Contractor QA test results are verified by ADOT's OV test results. The IA program consists of IA performed by ADOT, or its designee, to evaluate the equipment and personnel performing acceptance testing.

23 CFR 637, Subpart B defines quality control as: All contractor/vendor operational techniques and activities that are performed or conducted to fulfill the contract requirements. 23 CFR 637, Subpart B also allows for quality control, as defined in the CFR, sampling and testing results to be used as part of the acceptance decision. This Program differentiates Contractor QA from

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Contractor Quality Control (QC). Within this Program, Contractor QC cannot be used as part of the Acceptance Program and is not subject to the IA program. Figure 1.2 shows the relationship between the different components of this QAP.

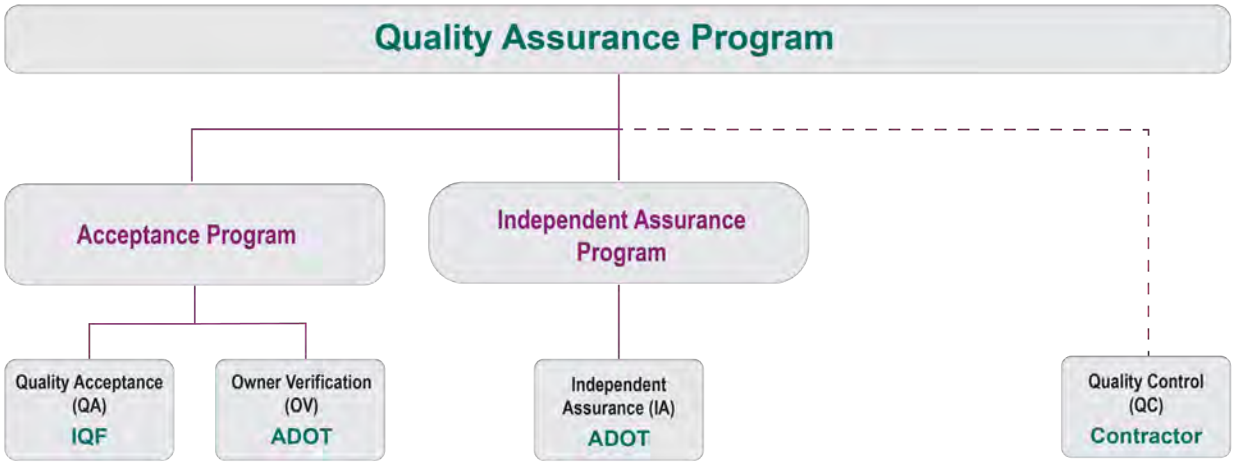


Figure 1.2: Components of this Quality Assurance Program

Chapter 2 addresses the Contractor QC and includes a brief description of the approach to QC. The Contract Documents will provide detailed QC requirements that shall be included in the Contractor's Construction Quality Management Plan (CQMP). Chapter 3 addresses the Acceptance Program and includes detailed Contractor QA requirements and the approach to ADOT OV. The Contract Documents will provide detailed Contractor QA requirements that shall be included in the CQMP. Chapter 4 provides detailed requirements for the ADOT IA program.

1.3 Construction Quality Management Plan

The Contractor shall create a CQMP that describes the policies, procedures, and staffing required to manage construction quality in accordance with the Contract Documents. The Contractor shall define all QC processes and procedures in the CQMP that will achieve compliance with the Contract Documents. The Contractor, or an Independent Quality Firm (IQF) hired by the Contractor, shall also define Contractor QA processes and procedures for both materials testing and comprehensive product inspection which will be used in acceptance decisions as described in this Program. The CQMP is required to be approved by ADOT prior to the start of any construction activities.

1.4 Owner Verification Testing and Inspection Plan

ADOT will develop an Owner Verification Testing and Inspection Plan (OVTIP) that describes the processes and procedures for ADOT to perform OV of the Contractor's QA inspection and testing. Detailed ADOT OV criteria are in section 3.11.

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1.5 Conflict of Interest

There are six functions identified in the QAP, these functions and the responsible parties are shown below:

- Production; Contractor
- Quality Control; Contractor
- Quality Acceptance; Contractor, or Independent Quality Firm
- Owner Verification; ADOT, or Owner Verification Firm
- Independent Assurance; ADOT
- Referee; ADOT

To avoid a conflict of interest, each Contractor function shall be performed by separate groups or entities, and each ADOT function will be performed by separate ADOT groups. Production, Quality Control, and Quality Acceptance shall be separated by reporting structure, and any additional requirements of the Contract Documents. The OV, IA, and referee functions will only be performed by an ADOT group or an entity contracted directly by ADOT.

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Chapter 2

Quality Control

2.1 General

The Contractor is responsible for the quality of the Work. Project quality will be enhanced through the daily efforts of all workers involved with the Work as described in the CQMP. The Contractor's entire workforce shall actively participate in quality efforts to minimize/eliminate re-Work.

The QC program shall be sufficient in scope to produce only Work compliant with the Contract Documents. The QC program shall also be sufficient in scope to avoid repeated discoveries of Nonconforming Work. Repeated discoveries of Nonconforming Work by the Contractor QA staff, the IQF, ADOT, or an excessive use of Engineering Judgment according to ADOT, will be considered a breakdown of the QC program. Corrective action shall be documented and implemented by the Contractor if there is a breakdown of the QC program. Corrective action may include the revision of existing QC procedures, addition of new QC procedures, re-training of QC personnel, removal and replacement of QC personnel, or other such actions necessary per ADOT, to restore the effectiveness of the QC program.

QC efforts are not part of the Acceptance Program.

2.2 Contractor's Quality Control Requirements

The Contractor's CQMP shall comply with the QC requirements of this Program and the Contract Documents.

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Chapter 3

Acceptance Program

3.1 General

The Acceptance Program includes both the Contractor's QA and ADOT's OV functions. Regarding materials testing, Contractor QA test results are only allowed to be used in the acceptance decision if they are verified by ADOT's OV test results. Regarding workmanship and other inspection-driven features of the Work, Contractor QA inspection observations and conclusions shall only be used in the acceptance decision if the processes, procedures, and documentation, per the approved CQMP, are verified by ADOT's OV functions. Only Contractor QA performed per the approved CQMP may be used in any acceptance decisions.

Contractor QA shall be performed by Contractor staff or an IQF hired by the Contractor as defined in the Contract Documents. Only an independent group of Contractor staff may perform the Contractor QA role. The independent group of Contractor staff is subject to approval by ADOT. In this Program, it is assumed that the Contractor has hired an IQF to perform the Contractor QA function and that firm is led by a Construction Independent Quality Manager (CIQM). If the Contractor QA is being performed in-house, then the same requirements would apply to the Contractor's in-house Contractor QA team and their in-house Contractor QA manager.

3.2 Qualification of Personnel

All personnel performing sampling and testing shall meet the qualification requirements shown below for the appropriate field in which sampling and testing is being performed.

Soils and Aggregate	
<u>Field</u> Arizona Technical Testing Institute (ATTI) "Field" certification.	<u>Laboratory</u> Arizona Technical Testing Institute (ATTI) "Laboratory Soils/Aggregate" certification.
Asphaltic Concrete	
<u>Field</u> Arizona Technical Testing Institute (ATTI) "Field" certification.	<u>Laboratory</u> Arizona Technical Testing Institute (ATTI) "Asphalt" certification.
Concrete	
<u>Field</u> American Concrete Institute (ACI) "Concrete Field Testing Technician Grade I" certification.	<u>Laboratory</u> American Concrete Institute (ACI) "Concrete Strength Testing Technician" certification.

All personnel performing sampling and testing shall be supervised by an individual meeting the

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requirements below for the appropriate field in which sampling and testing is being supervised.

Soils and Aggregate	
Field Arizona Technical Testing Institute (ATTI) "Field" certification plus one of (a) through (g) below	Laboratory Arizona Technical Testing Institute (ATTI) "Laboratory Soils/Aggregate" certification plus one of (a) through (g) below.
Asphaltic Concrete	
Field Arizona Technical Testing Institute (ATTI) "Field" certification plus one of (a) through (g) below.	Laboratory Arizona Technical Testing Institute (ATTI) "Asphalt" certification plus one of (a) through (g) below.
Concrete	
Field American Concrete Institute (ACI) "Concrete Field Testing Technician Grade I" certification plus one of (a) through (g) below.	Laboratory American Concrete Institute (ACI) "Concrete Strength Testing Technician" certification plus one of (a) through (g) below.

(a) Professional Engineer, registered in the State of Arizona, with one year of highway materials sampling and testing experience acceptable to ADOT.

(b) Engineer-In-Training, certified by the State of Arizona, with two years of highway materials sampling and testing experience acceptable to ADOT.

(c) Obtained a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology, Construction, or related field acceptable to ADOT; and with three years of highway materials sampling and testing experience acceptable to ADOT.

(d) Certified by the National Institute for Certification in Engineering Technologies (NICET) in the Construction Materials Testing field as an Engineering Technician (Level III) or higher in the appropriate subfield in which sampling and testing is being performed.

(e) Certified by NICET in the Transportation Engineering Technology field as an Engineering Technician (Level III) or higher in the Highway Materials subfield.

(f) Certified by NICET as a Certified Engineering Technologist, or higher, in Civil Engineering Technology with five years of highway materials sampling and testing experience acceptable to ADOT.

(g) An individual with eight years of highway materials sampling and testing, and construction, experience acceptable to ADOT.

In the absence of ATTI certification, individuals who currently possess active certification(s)

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under another state's certification program may be allowed to perform Project activities that would normally be covered by ATTI certification as part of the acceptance decision on a provisional basis. This provisional status requires prior approval by ADOT on a case-by-case basis, and is only applicable to the individual Project. To request provisional approval, the following information shall be submitted to ADOT a minimum of 14 Days before the individual starts sampling and testing on the Project:

- Name of the individual.
- Name of the appropriately certified person who will be supervising the individual's Work.
- Description of the Work to be performed by the individual, including the type of sampling and testing the individual is expected to perform.
- List of applicable certifications currently held under another state's certification program and expiration dates.
- Differences between the other state certifications and the corresponding ATTI certifications.
- Description of how these differences will be managed to avoid errors.

Any authorized provisional approval will be in effect for a maximum of six (6) months from the time the individual begins working on the Project. By the time this six-month period has elapsed, the individual shall have obtained the appropriate ATTI certification(s) to be allowed to continue sampling and testing or materials related inspection on the Project. While in provisional status, such individuals shall be under the direct supervision of someone who has the appropriate ATTI certification(s). The IQF shall obtain this provisional approval from ADOT, document the certification status of these individuals, and ensure the individuals obtain the appropriate ATTI certification(s) within the time allotted. Individuals receiving provisional allowance to perform acceptance Work shall be observed by ADOT's IA program within the first 14 days from the time the individual begins sampling and testing on the Project.

Inspectors performing acceptance inspections on precast concrete Elements shall have Precast Concrete Institute (PCI) Level II certification.

Inspectors performing acceptance inspections on either Freeway Management System (FMS), lighting, or signals shall have both International Municipal Signal Association (IMSA) Traffic Signals Technician Level II and IMSA Fiber Optic Technician Level II certifications.

Inspectors accepting traffic control set ups shall have American Traffic Safety Services Association (ATSSA) Traffic Control Supervisor (TCS) certification.

Any person accepting asphaltic concrete binder shall have the National Binder Technician Certification (NBTC).

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3.3 Qualification of Laboratories

All laboratories are required to be approved by ADOT prior to performing sampling and testing activities for an ADOT Project. The "ADOT System for the Evaluation of Testing Laboratories" details the requirements that laboratories shall satisfy in order to be considered for approval by ADOT. Laboratories which have been approved to perform sampling and testing activities on ADOT Projects are listed in the ADOT "Directory of Approved Materials Testing Laboratories". Included in that directory are the individual tests for which a laboratory has been approved. In addition to the R18 Quality Management System Criteria, laboratories performing sampling and testing activities for an ADOT Project under this Program shall also obtain American Association of State Highway and Transportation Officials (AASHTO) re:source accreditation for the following Quality Management Systems:

- C1077 (Aggregate)
- C1077 (Concrete)
- D3666 (Aggregate)
- D3666 (Asphalt Mixture)
- D3740 (Soil)
- E329 (Aggregate)
- E329 (Asphalt Mixture)
- E329 (Concrete)
- E329 (Soil)

Both AASHTO re:source accreditation and ADOT approval must be received for all test methods that are to be performed on an ADOT Project.

In this Program, laboratories are not required to participate in the ADOT Proficiency Sample Program. This is due to the already required AASHTO re:source and Cement and Concrete Reference Laboratory (CCRL) proficiency sample programs, as well as the ongoing ADOT verification per this Program.

3.3.1 ADOT Laboratory Inspection

All independent, Contractor, materials supplier, government, and other testing laboratories desiring to perform testing activities for ADOT shall submit to an ADOT inspection as specified in the "ADOT System for the Evaluation of Testing Laboratories". The inspection considers those elements of service that the respective laboratory proposes to offer to ADOT. This requirement includes laboratories submitting asphaltic concrete mix designs and those performing acceptance and referee testing for ADOT. A current (within 18 months) passing ADOT inspection is one of the initial and ongoing conditions required for, and to maintain, ADOT approval.

ADOT inspections include both an equipment inspection and a procedural inspection.

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A written inspection report will be issued by ADOT to the laboratory that has been inspected. The laboratory shall provide ADOT with satisfactory responses to the noted deficiencies within 30 days of the report issuance. The responses shall provide satisfactory evidence that all significant deficiencies were corrected or that corrective action is in progress. The laboratory's inspection and responses will be considered when evaluating ADOT eligibility.

3.3.1.1 ADOT Laboratory Equipment Inspection

The equipment inspection will consist of checking dimensional, calibration, and specification conformance of all apparatus and equipment required by the test procedures contained in "ADOT's Materials Testing Manual", and in other applicable specifications. Equipment related documentation, required by AASHTO R18, is also checked during this inspection. This inspection is not a calibration service for non-ADOT laboratories. Any equipment found unacceptable shall be repaired, properly calibrated, or removed from service at the expense of the owner laboratory. Laboratory facilities will also be checked for compliance with applicable standards, such as, proper temperature and humidity control. Documentation of the calibration and verification of equipment used in field testing which is not available during the inspection will be reviewed for compliance with applicable requirements.

3.3.1.2 ADOT Procedural Inspection

The procedural inspection serves as a tool to evaluate the performance of laboratory technicians when performing tests in accordance with the "ADOT Materials Testing Manual" or other applicable specifications. ADOT, AASHTO, and American Society for Testing and Materials (ASTM) test methods referenced in the "ADOT Materials Testing Manual" will be observed. If ADOT's test methods deviate from those given in a similar AASHTO or ASTM procedure, ADOT's Materials Testing Manual will govern.

The inspection formats will generally conform to the techniques employed by AASHTO re:source and the CCRL, as appropriate. When a departure from the requirements of a test method is observed by the inspectors, they will point it out to the laboratory personnel so that immediate corrections can be made if possible. The inspectors will present a summary of their findings and identify deficiencies requiring corrective action at an informal exit review where any deficiencies discovered can be discussed openly. It is requested that the laboratory manager and supervising engineer be present at the exit review.

3.4 Qualification of Equipment

All equipment used by any technician shall be in the active inventory of an AASHTO accredited and ADOT approved laboratory. Actual calibration records for each specific inventory item shall be current and provided upon request. All equipment and apparatus shall be inspected and found acceptable. All equipment and apparatus shall be maintained in good working order.

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All equipment and apparatus shall be inspected, calibrated, and verified per the requirements of this Program, and the requirements of ADOT's "Equipment Calibration and Verification" document located in the "ADOT Material Testing Manual".

Inspection of equipment and apparatus shall be performed by either:

- An AASHTO accredited laboratory that has been approved by ADOT, or:
- An individual or company who, as a business, performs inspection and calibration of sampling and testing equipment.

Inspections and calibrations shall be performed in accordance with established ADOT, AASHTO, ASTM, and National Institute of Standards and Technology (NIST) specifications. Proper calibration equipment that is traceable to NIST standards shall be used.

3.5 Quantities of Material and Work Elements

The IQF shall continuously track and record the quantities of all materials and Work Elements incorporated into the Project. The IQF shall also continuously track and record the number of all samples and tests performed on the Project. Monthly, the IQF shall reconcile their accepted quantities with the quantities of all materials and Work Elements incorporated into the Project. Monthly, the IQF shall submit a detailed report to ADOT that, at a minimum, includes:

- The total (current month and Project total to date) number of samples and tests performed, the total (current month and Project total to date) number of required samples and tests, the total (current month and Project total to date) quantity of material incorporated into the project, the minimum sampling frequency, unit of measurement, and the sampling point, all for each individual combination of: specification section, material, type of test required, and Material Code. An example of one of these combinations is shown below:

Spec.	Mat.	Mat. Code	Type Code	Type of Test	Samp. Point	Min Samp. Freq.	Unit of Meas.	Quant. this Month	Tests Req. This Month	Tests Perf. This Month	Total Quant. to Date	Total Tests Req. to Date	Total Tests Perf. to Date
501	Bedding Material for Concrete Pipe	BM	CP	Compaction	In-Place	One per 50 Cubic Yards	Cubic Yards	#	#	#	#	#	#

- The total quantities (current month and Project total to date) of each and every Work Element incorporated into the Project. For this report, these Work Elements are individual bid items typically found on ADOT projects, and any additional, or more detailed, Project specific items.

ADOT will use the report to verify the compliance of both the IQF and ADOT testing

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frequencies. The CQMP shall define how the IQF will accurately track, record, and report the quantities of all materials and Work Elements incorporated into the Project. At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of the report listed above to ADOT, for ADOT's review and approval.

3.6 Sampling and Testing

This section provides requirements for acceptance sampling and testing.

3.6.1 Types and Uses

Sampling is either random or fixed, depending on whether the location was selected randomly (random) or if a specific location was subjectively identified (fixed). Sampling is also either independent or dependent, based on whether the location was independently selected (independent) or whether it is based on the location of another sample, e.g. a split sample (dependent). Only ADOT and IQF samples selected randomly and independently shall be used to meet the acceptance testing minimum frequency requirements of the sampling Guide Schedule. This includes both the items shown in Appendix D, as well as any Project specific sampling and testing frequency requirements. A failing IQF random independent test requires both a passing fixed test at the original failing location and an additional passing random independent test within the unit or quantity of material being accepted.

The IQF shall perform additional fixed tests when the quality of material is questionable. If these additional fixed tests fail, they shall be addressed in the same manner as a failing random independent test. Fixed tests do not count towards meeting the Guide Schedule testing frequencies.

A comparison process for performing and analyzing split samples between ADOT and IQF is required during the initial implementation of, and throughout, this Program to ensure that ADOT and IQF equipment and testing procedures are in alignment. ADOT will determine how many and which type of tests will be used during this comparison process. These test results will be analyzed by ADOT and shared with the IQF to assure laboratory and technician test results compare favorably. This process will help provide initial alignment of the ADOT and IQF laboratories and testing procedures. The IQF shall commit the resources and sample material necessary to accommodate splitting alignment activities described in the Program. When the allowable variation limits in Appendix C of this Program are exceeded, corrective actions for either or both parties will be identified and incorporated as appropriate.

Split samples may also be performed throughout the life of the Project to investigate non-validating material categories and to verify or realign testing equipment and personnel.

3.6.2 Frequencies, Labeling, and Representative Quantities

The quality of materials and construction incorporated into the Project are controlled by

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acceptance sampling, acceptance testing, and acceptance inspection activities. Acceptance test results and acceptance inspection results shall be accepted based on compliance with the specifications and the Contract Documents. The IQF shall randomly sample at prescribed frequencies, based on the sampling Guide Schedule, that meet or exceed those presented in the Appendix D. The Project's sampling Guide Schedule shall be published in the CQMP.

The IQF's sampling Guide Schedule shall apply to sampling frequencies only for acceptance sampling and testing. It shall indicate the material type to be sampled, the controlling specification(s), the frequency of sampling, the location where sampling will occur, the testing to be performed, and the acceptance criteria. The IQF's acceptance samples shall be obtained randomly. The Contractor and IQF shall use the Material Codes as shown in Appendix E. All Material Codes and material types to be used on the Project shall be included in the CQMP. The Contractor or IQF may request to modify Material Codes or material types based on specific Project needs. This request is subject to ADOT's approval. ADOT may alter the Material Codes in Appendix E at any time to accommodate the separation of materials into appropriate categories for statistical validation or verification. The IQF shall also label samples and sample tickets in accordance with the example sample ticket in Appendix E. At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of sample tickets to be used to ADOT, for ADOT's approval.

Every IQF sample is a representative sample that represents quality of a larger quantity of material or Element of Work. The test result for each individual test performed shall be applied to the larger quantity of material or Work that the individual test result represents. This applies to all sampling and testing per the Guide Schedule, as well as any sampling, testing, or activities with required frequencies, identified in the CQMP or Contract Documents.

The CQMP shall define the methodology that is used by the IQF to define the specific quantity of material or Work that each representative sample represents from the larger quantity of material or Work.

This includes, but is not limited to materials that are sampled on a time designated lot basis. The CQMP shall define the methodology to estimate the relationship between the production quantity and the time required to produce such quantity. This relationship is required for the IQF to determine the recommended number of acceptance samples. The CQMP shall also define how the sampling times are determined, and quantity of material each sample represents.

3.6.3 Notification

Every week, the Contractor shall update and provide the IQF and ADOT with an accurate rolling 3 week look ahead schedule consistent with the current complete Project schedule. This complete Project schedule is often referred to as the Project's complete critical path method schedule. The look ahead schedule shall include all offsite fabrication activities, all offsite inspection activities, and all offsite sampling and testing activates. The look ahead schedule

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shall also include all onsite fabrication activities, all onsite inspection activities, and all onsite sampling and testing activities.

Every day, the Contractor shall provide the IQF and ADOT with an accurate and complete hourly schedule, for any and all sampling and testing that will occur the following day. All sampling and testing requires at a minimum one complete business day notification. The hourly schedule shall include all offsite inspection, sampling, and testing activities. The hourly schedule shall include all onsite inspection, sampling, and testing activities.

3.7 Status of Material Quality

All material incorporated into the Project shall adhere to the Contract Documents. If material is to remain incorporated into the Project that does not adhere to the Contract Documents, Engineering Judgment shall be utilized and properly documented, or the Nonconformance Report (NCR) process shall be completed by the Contractor.

With regard to ADOT and IQF test results, there are multiple possible combinations of passing and failing results. The following describes the process that shall be followed based on the different possible combinations:

3.7.1 Both the IQF and ADOT test results are within specification limits. The material represented by the samples is considered acceptable and may be left in place.

3.7.2 The IQF test results are outside of the specification limits (No ADOT test result or ADOT test results are within the specification limits). The material may be accepted and left in place only if one of the following occurs:

3.7.2.1 The NCR process is completed by the Contractor.

3.7.2.2 The IQF test result indicates reasonable conformance with specification requirements and the IQF exercises Engineering Judgment to accept the material.

3.7.2.3 The IQF test results do not indicate reasonable conformance with specification requirements. The material shall be removed, reworked, or repaired. The failing IQF test result is replaced by two additional IQF passing test results. The first additional passing test shall be a fixed IQF test at the same location as the original failing sample, and the second sample shall be a random independent IQF test within the quantity of material that the initial failing test represented.

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

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3.7.3 The IQF test results are within the specification limits and the ADOT test results are outside of specification limits. The material may be accepted and left in place only if one of the following occurs:

3.7.3.1 The NCR process is completed by the Contractor.

3.7.3.2 The ADOT test result indicates reasonable conformance with the specification requirements and both the IQF exercises Engineering Judgment to accept the material and ADOT concurs with the acceptance of the material based on the IQF's Engineering Judgment.

3.7.3.3 ADOT test results do not indicate reasonable conformance with specification requirement in ADOT's Sole Discretion:

The material shall be removed, reworked, or repaired. The failing ADOT test result is addressed with two additional passing IQF test results. The first additional sample shall be an IQF fixed test at the same location as the original ADOT failing sample, and the second sample shall be a new IQF random sample within the quantity of material that the initial failing ADOT sample represented (the test shall not be any previous IQF test result). Any failing IQF test results during this process shall initiate the start of the process in Section 3.7.2 "The IQF test results are outside of the specification limits (No ADOT test result or ADOT test results are within the specification limits)…". ADOT may conduct an additional tests or samples at any time during this process. Any failing ADOT test result shall require two new additional IQF test results (Section 3.7.3.3 starts from the beginning for each failing result).

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.7.4 Both the IQF and ADOT test results are outside of the specification limits. The material may accepted and left in place if one of the following occurs:

3.7.4.1 The NCR process is completed by the Contractor.

3.7.4.2 The IQF and ADOT test result indicates reasonable conformance with the specification requirements and both:

The IQF exercises Engineering Judgment to accept the material (the IQF must exercise Engineering Judgment on both the IQF and ADOT results)

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and ADOT concurs with the acceptance of the material based on the IQF's Engineering Judgment.

3.7.4.3 The ADOT test result indicates reasonable conformance with the specification requirements and the IQF test results do not indicate reasonable conformance with specification requirements:

The material shall be removed, reworked, or repaired. The failing IQF test result is replaced by two additional IQF passing test results. The first additional passing test shall be a fixed IQF test at the same location as the original failing sample, and the second sample shall be a random independent IQF test within the quantity of material that the initial failing test represented.

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.7.4.4 The IQF test result indicates reasonable conformance with the specification requirements and the ADOT test results do not indicate reasonable conformance with specification requirements in ADOT's Sole Discretion:

The IQF exercises Engineering Judgment to accept the failing IQF test result material.

The material shall be removed, reworked, or repaired. The failing ADOT test result is addressed with two additional passing IQF test results. The first additional sample shall be an IQF fixed test at the same location as the original ADOT failing sample, and the second sample shall be a new IQF random sample within the quantity of material that the initial failing ADOT sample represented (the test shall not be any previous IQF test result). Any failing IQF test results during this process shall initiate the start of the process Section 3.7.2 "The IQF test results are outside of the specification limits (No ADOT test result or ADOT test results are within the specification limits)…". ADOT may conduct an additional tests or samples at any time during this process. Any failing ADOT test result shall require two new additional IQF test results (Section 3.7.4.4 starts from the beginning for each failing result).

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

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3.7.4.5 The IQF and ADOT test results do not indicate reasonable conformance with specification requirements in ADOT's Sole Discretion:

The material shall be removed, reworked, or repaired. The failing IQF test result is replaced by two additional IQF passing test results. The first additional passing test shall be a fixed IQF test at the same location as the original failing sample, and the second sample shall be a random independent IQF test within the quantity of material that the initial failing test represented.

All random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.8 Engineering Judgment

The use of Engineering Judgment is part of the Acceptance Program and the IQF needs the ability to render decisions in the field regarding the quality of Work performed. Engineering Judgment is accepting any testing result or Work that does not adhere to the Contract Documents. The CQMP shall list any specific Element / characteristic of Work or test attribute that the IQF will be allowed to exercise Engineering Judgment on when accepting test results or Work. ADOT recognizes that the IQF is a section of the Contractor's team working with the Contractor to check for, and determine, compliance with the Contract Documents. ADOT also recognizes that the IQF should be afforded the opportunity, in concert with their independent role, to render Engineering Judgment with respect to appropriate documents for inspection and testing provided that the following criteria are met:

- Engineering Judgment will only be made by the CIQM and / or ADOT. Authority for Engineering Judgment may be delegated with the approval of ADOT.
- Engineering Judgment will be made by a Professional Engineer in the State of Arizona.
- Engineering Judgment to accept material or Work failing to meet the Contract Documents will never be applied solely to promote "partnering" or to help the Contractor. The Project schedule will not be a consideration with respect to the quality delivery of the Project.
- Engineering Judgment to accept materials or Work failing to meet specification requirements will be applied only in cases that will otherwise meet the intent of the design or in cases where the rejection of material would compromise the quality of a more significant item (e.g. by rejecting a load of concrete a structural Element is subject to a cold joint).
- Engineering Judgment will only be applied to individual test results or specific Elements of Work. Patterns of failure will not be accepted and shall be considered a breakdown in QC program. Recurring use of Engineering Judgment for the same plan or specification deviation shall result in process corrections to

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the construction operations to assure material and Work is conforming Contract Documents. Engineering Judgment cannot be used to widen a specification requirement on a continuing basis.

- The individual exercising Engineering Judgment will apply good engineering practices to ensure the quality of accepted material. This may include performing additional tests, an engineering analysis, etc. and will be justified and documented in the Engineering Judgment log.
- Engineering Judgment will be technically sound and justified in the Engineering Judgment log. Engineering Judgment will only utilize localized conditions. Engineering Judgment will not be utilized to waive specifications for conditions that have Project wide implications. The acceptance of material or Work not meeting the Contract Documents in a single instance, at a specific location, will not become a Project wide decision. Each situation will be judged on the merits of its unique characteristics.
- ADOT may, at any time, remove or limit Engineering Judgment authority from any CIQM, or person delegated by the CIQM, if his/her Engineering Judgment is inappropriately exercised, as determined by ADOT.
- ADOT and FHWA have oversight agreements in place that requires specific documentation relating to Nonconforming Work that may remain in place. Any application of Engineering Judgment will be accompanied by appropriate documentation as defined in the CQMP.
- The IQF is encouraged but not required to consult with ADOT prior to making acceptance decisions based on Engineering Judgment.
- IQF personnel shall not be pressured by the Contractor to exercise Engineering Judgment. Nor shall IQF personnel be placed under duress in making their acceptance determinations.

Any of the IQF's acceptance decisions that utilize Engineering Judgment may be rejected by ADOT. ADOT may exercise Engineering Judgment at its Sole Discretion.

3.9 Referee Testing

While expected to occur very rarely, disputes over specific IQF and ADOT test results may be resolved, in a reliable, unbiased manner by referee testing and evaluation performed by ADOT's Materials Group or an independent third-party testing laboratory as appointed by ADOT's Materials Group. The decision by ADOT, or its designee, is final. Referee testing is solely an owner function. Referee testing shall only be allowed when it is specified in the Contract Documents.

The Contractor shall pay for the referee testing of IQF test results. The party whose original test results do not compare with the referee testing results will pay for the referee testing of ADOT test results.

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3.10 Additional Quality Acceptance Requirements

The CQMP shall comply with the requirements in the Contract Documents and this Program.

Monthly, and on a day of the month determined by ADOT, the IQF shall submit to ADOT a certification form. The certification form shall certify that all Elements of Work incorporated in the Project adheres to the Contract Documents. It shall also certify that the monthly Contractor payment amounts whether based on quantities or percent complete is accurate. At the beginning of the Project, and included in the CQMP, the IQF shall submit the format and detailed example of the IQF monthly certification form to ADOT, for ADOT's review and approval. The IQF monthly certification form shall be professionally signed and sealed by the CIQM. The form shall clearly certify that:

- Work incorporated into the Project adheres to the Contract Documents, unless specifically listed on the certification form.
- The IQF is compliant with certification, calibration, and accreditation requirements of the CQMP.
- Work was sampled, tested, inspected, and accepted per the approved CQMP.
- Quantities represented in Contractor's monthly payment request are accurate
- Percentages represented in Contractor's monthly payment request are accurate.

"Certificates of Compliance" and "Certificates of Analysis" are required for certain materials prior to their incorporation into the Project. Certificates shall adhere to the requirements of section 106.05 ADOT Standard Specifications and ADOT's "Series 1000 Certificates". At a minimum, all items listed in Figure 3 of "Series 1000 Certificates" and the items requiring certificates per Appendix D, shall require certificates. The Project specific sampling and testing Guide Schedule shall reflect the specific items or components, in addition to those in Appendix D, that are to be accepted based by certification. The CQMP shall define a clear and detailed process defining how the IQF will accurately track, record, and report the acceptance of materials based on certificates and how they accurately will match the certificates to all materials being accepted. Monthly, the IQF shall submit a detailed report to ADOT that, at a minimum, includes:

- The total quantities (current month and Project total to date) of items incorporated into the Project that require certificates of compliance or certificates of analysis, for each individual: Work Element, and Guide Schedule combination of specification and material.
- The total quantities (current month and Project total to date) of items

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incorporated into the Project that require certificates of compliance or certificates of analysis, for each individual: Work Element, and Guide Schedule combination of specification and material, that a certificate of compliance or certificate of analysis was received.

- Each individual certification for that month, ordered by Work Element, and Guide Schedule combination of specification and material.

At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of all items listed above to ADOT, for ADOT's review and approval.

The IQF shall ensure and monthly certify that the Project is compliant with the "Buy America" requirements of 23 CFR 635.410. The CQMP shall define a clear and detailed process defining how the IQF will accurately track, record, and report the compliance with the "Buy America" requirements. Monthly, the IQF shall submit a detailed report to ADOT that clearly demonstrates and justifies compliance with the "Buy America" requirements.

At the beginning of the Project, and included in the CQMP, the IQF shall submit the format and detailed example of the report listed above to ADOT, for ADOT's review and approval.

Unless addressed elsewhere in the Contract Documents, the IQF shall adhere to all inspection, sampling, testing, and acceptance criteria addressed in ADOT's Practice and Procedure Directives (PPD) Manual. A list of ADOT's current PPD's can be found online under "ADOT's Construction and Materials Manuals."

3.11 ADOT Owner Verification Requirements

ADOT, or its designee, will perform OV functions to verify IQF inspections, test results and conclusions.

For materials testing, verification will be achieved through comparisons between IQF test results and ADOT test results, or the observation of IQF test performances. To verify IQF test results, ADOT's testing will be programmatically performed at the levels shown in Appendix F, Owner Verification Levels of Testing Verification, subject to Project specific recommendations or changes made by ADOT. The different levels correspond to different verification requirements of this Program.

For workmanship and inspection activities, ADOT will verify that the IQF is performing the inspection procedures adequately and that the IQF is documenting the results in accordance with the CQMP. In addition to real-time evaluations, ADOT will also conduct audits to verify the Contractor's compliance with the approved CQMP.

ADOT will develop a comprehensive OVTIP for the Project. ADOT's OVTIP will include internal procedures used by ADOT to ensure that the IQF's frontline acceptance activities are performed

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in accordance with the approved CQMP and to verify the IQF's adherence to the CQMP. ADOT will complete the development of the OVTIP in parallel with approval of Contractor's CQMP.

The OVTIP will address following items:

- Methods and procedures that define the authority and responsibility for the administration of the OVTIP.
- Procedures for overseeing the inspection of the Work and procedures for overseeing the IQF's overall compliance with the CQMP and Contract Documents.
- Procedures to ensure that the education, training, and certification of personnel performing OV activities are achieved and maintained.
- Procedures to oversee the status and disposition of any identified Nonconforming Work or any item or process that does not conform to the Contract Documents.
- Measures to ensure that ADOT tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly maintained, controlled, calibrated, certified, and adjusted at specified periods to maintain accuracy within industry standards.
- A system of planned and periodic audits of Contractor's CQMP to determine adherence to and the effectiveness of the CQMP. Audit results will be documented, reviewed, and sent to the Contractor. Follow-up action, including re-audit of deficient areas following corrective action, will be taken where needed.
- A system of planned and periodic audits to determine adherence to and the effectiveness of the OVTIP. Audit results will be documented and reviewed. Follow-up action, including re-audit of deficient areas following corrective action, will be taken where needed.
- Procedures for performing periodic inspections of Work and periodic inspections the IQF inspectors to verify that the Work and IQF are in compliance with the Contract Documents. The procedure will identify a target oversight inspection frequency and methods for performing verification inspections for IQF inspectors.
- Procedures on how ADOT's material sampling and testing will be performed. This includes the process for generating random test locations, tracking material samples, processing material samples, review and approval of test records, and tracking compliance with material testing frequency.
- Procedures for reviewing IQF and ADOT test results for compliance with mutually agreed upon processes and naming conventions to ensure data integrity for accurate statistical analyses.
- Procedures for verifying that only tests performed by qualified IQF testing personnel are submitted to ADOT.
- Procedures for auditing of QC and IQF records, documentation, procedures, and

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processes to verify compliance with the Contract Documents and approved CQMP.

- Procedures for reviewing Portland cement concrete mix designs and hot-mix asphaltic concrete mix designs.
- Target frequencies for the independent sampling and testing that are to be conducted as a part of OV. The initial target frequency may include a higher frequency of testing at the beginning of the Project and may be adjusted, as appropriate, throughout the Project, based on: the observed consistency of the product, the statistical comparison between ADOT and IQF test results, and ADOT's engineering determinations.
- Procedures for ensuring that ADOT testing is performed at the frequencies stipulated in the OVTIP.
- Identification of the platform and data structure of the data management system that will be used to collect, store, and retrieve ADOT test result data.
- Identification of a strategy to coordinate test result data communication between the IQF and ADOT.
- Procedures for performing statistical analyses in compliance with procedures outlined in this Program.
- Procedures for satisfying System Basis IA obligations of this Program.
- The parameters and guidelines used to accept any statistically non-validating material.

3.12 Validation and Verification

IQF sampling, testing, and inspection results are only valid if verification is achieved by ADOT.

Prior to beginning construction, a Project specific risk analysis will be conducted and each material testing procedure expected to be performed by the IQF, and verified by ADOT, will be assigned an ADOT materials testing verification level of 1, 2, or 3. In general, test results that have a stronger correlation with material performance and Elements of construction with greater residual risk to ADOT will utilize a more vigorous verification approach. Test results that do not have a strong correlation to performance and Elements of construction with lower residual risk to ADOT will utilize a less vigorous verification approach. Appendix F lists the programmatic ADOT levels of verification associated with each test method. ADOT may change these verification levels based on specific Project needs. The IQF and Contractor shall comply with any verification levels changed from Appendix F. The IQF shall adhere to the data transfer requirements of Appendix H. Proper and efficient data transfer between the IQF and ADOT is required as part of the Program. Prior to any verification by ADOT, and included in the CQMP, data transfer formats and processes must be submitted by the IQF, and approved by ADOT prior to the start of construction activities.

3.12.1 Level 1 - Statistical Validation and Verification

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When test procedures are performed in the context of construction Elements with high ADOT residual risk, those procedures that are considered primary indicators of performance are assigned materials verification Level 1. For Level 1 procedures, the ADOT testing frequency will be approximately 10%, but not less than 5%, of the IQF's testing frequency. At a minimum, ADOT will perform three tests per quarter per analysis category with at least nine IQF test results.

For Level 1 test procedures, verification is achieved by ADOT through regular and frequent test result validation. Validation involves statistical analyses using test result comparison packages that have been prepared for specific materials during specific time frames. The F-test is used to determine if the ADOT and IQF data population variances are equal, and the t-test is used to determine if their means are equal. From the F- and t- tests, p-values ranging from 0 to 1 are calculated. Appendix F establishes the critical p-value, known as alpha (α), or "Level of Significance", for each material type. When the calculated p-value is above the alpha (α) value shown in appropriate category of Appendix F, the IQF test data has been statistically validated.

Statistical analysis will be reported utilizing only data sets from within a defined time frame. The effective ADOT testing volume for a Level 1 test procedure is intended to represent approximately ten percent (10%) of the respective IQF testing volume; however, this percentage may vary.

Where IQF test data validation is achieved, ADOT will document that the IQF test results have been verified for the given analysis category. Where ADOT test data validation is not achieved, ADOT and the IQF shall jointly investigate the source of the non-validation event.

If the joint investigation finds the quality requirements of the Project have been met, ADOT and the IQF will take the necessary steps to bring the material category into a verified status. It will be ADOT's discretion as to if the IQF test results are valid in these cases, and how they will document the verification.

If the joint investigation finds the quality requirements of the Project have not been met, ADOT and the IQF will use Engineering Judgment or the NCR process to address the quality requirements and take the necessary steps to bring the material category into a verified status.

3.12.2 Level 2 - Independent Verification

When test procedures are performed in the context of construction Elements with high ADOT residual risk, those procedures that are only considered secondary indicators of performance are assigned materials verification Level 2. Test procedures may also be assigned verification Level 2 when testing is performed in the context of construction Elements with lower residual ADOT risk. For Level 2 procedures, the ADOT testing is generally conducted at least once per quarter depending on the IQF's testing frequency and ADOT's residual risk. In some cases, low IQF test frequencies and the timing of construction operations may affect ADOT's ability to conduct Level 2 testing as planned. Depending on actual circumstances, when Level 2 testing

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cannot be conducted as planned, compensatory testing will be conducted at the next practical opportunity. At a minimum, ADOT will perform at least one test per quarter if the IQF has more than 10 tests.

For Level 2 test procedures, verification is achieved by ADOT by obtaining independent ADOT samples and comparing ADOT test results with the corresponding IQF test results. Test result verification is accomplished on a quarterly basis or as dictated by actual construction operations and schedule. If the IQF test results cannot be verified, ADOT and the IQF shall jointly investigate the root cause and bring it back into verification status.

3.12.3 Level 3 - Observation Verification

When test procedures are performed in the context of construction Elements with low ADOT residual risk, or when test procedures will be conducted very infrequently, these procedures are assigned materials verification Level 3. ADOT's OV will be performed through observation of the IQF's test performance once per Project.

For Level 3 test procedures, verification is achieved by ADOT observing the IQF performing the specific test methods. This type verification will occur once per test method, unless otherwise determined necessary by ADOT. If the test procedure cannot be verified, ADOT and the IQF shall jointly investigate the root cause and bring it back into verification status.

3.13 FHWA Reporting

ADOT will submit both quarterly reports, as well as a final certification package, to FHWA.

3.13.1 Quarterly Reports

ADOT will submit quarterly reports to FHWA to demonstrate compliance with this Program. The reporting period for specific pay items or materials is dependent on the pace of construction, the number of tests performed in each analysis category, the time period of the sampling, and the specification and quality requirements.

The FHWA quarterly report will address the following areas:

- Statistical analysis and verification results.
- Non-validation investigations.
- Split sample test results.
- Engineering Judgment log.
- Nonconformance log.
- Certifications and Buy America log.

Monthly, the IQF shall submit all data, results, investigations, results, and logs listed above to

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ADOT, on the day of the month directed by ADOT. At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of all items listed above to ADOT, for ADOT's Sole Discretion review and approval.

3.13.2 Final Certification of Material Incorporated to the Project

The IQF shall submit a final certification package to ADOT. The final certification package shall include:

- A signed and professionally sealed letter from the CIQM certifying that all sampling, testing, acceptance activities, acceptance documentation, and the Work adheres to this Program, the Contract Documents, and all required Federal Regulations (exceptions per the bullet below).

- An organized and detail report of any and all sampling, testing, acceptance activities, acceptance documentation, and Work that does not adhere to this Program, the Contract Documents, and all required Federal Regulations.

- An organized and detailed report summarizing the total quantities, required number of samples, required number of tests, number of samples taken, and number of tests performed for each combination (per the Guide Schedule) of: specification, material, and type of test(s) required; that is incorporated into the Project.

- An organized and detailed report summarizing: (1) all materials, and their corresponding quantities, incorporated into the Project that required certificates of compliance or certificates of analysis, and (2) the total quantity of each material incorporated into the Project that have documented certificates of compliance or certificates of analysis as part of the quality records.

At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of all items listed above to ADOT, for ADOT's Sole Discretion review and approval.

ADOT will submit a separate final materials certification package to FHWA that certifies ADOT's compliance with the Program. The final materials certification report will include:

- A certification letter certifying that all ADOT sampling, testing, and acceptance activities were performed in accordance with this Program.
- A summary of the total number of ADOT samples and tests.
- A summary of the statistical analysis and verification results.

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Chapter 4

Independent Assurance Program

4.1 General

23 CFR 637, Subpart B requires the implementation of an IA program. ADOT, or its designee, will implement the IA program as described in this section.

The IA program evaluates the sampling/testing personnel and testing equipment used in acceptance of materials. The CFR allows observations, split sample results, and proficiency sample results as means of evaluating testing personnel within the state's IA program. The IA program allows for the inclusion of calibration checks, split sample results, and proficiency sample results for evaluating acceptance testing equipment. The IA program does not directly determine the acceptability of materials but evaluates all personnel and equipment involved in the acceptance decision.

4.2 ADOT Independent Assurance for Sampling and Testing Personnel

The Program will utilize a "System Basis" IA which is based on evaluating and verifying satisfactory performance by the individuals performing acceptance sampling and testing, and the equipment utilized, for a twelve-month period. The IA program in this Program will be implemented as follows:

Each ADOT and IQF individual who will perform acceptance sampling and testing in the field shall be observed and evaluated on a System Basis, in which ADOT IA personnel verify that sampling and testing is being conducted properly in accordance with the appropriate test methods. Except as approved, in writing, by ADOT in its Sole Discretion, such evaluation shall occur within 30 days of initial service on the Project and every 12 months thereafter.

Each ADOT and IQF individual who will perform acceptance sampling and testing in the laboratory shall be evaluated on a System Basis, in which ADOT IA personnel verify that sampling and testing is being conducted properly in accordance with the appropriate test methods. Except as approved, in writing, by ADOT in its Sole Discretion, such evaluation shall occur within 30 days of initial service and every 12 months thereafter.

ADOT and the IQF shall track the qualification status of all their respective technicians and proactively request and schedule all evaluations. Following the end of each calendar year, ADOT will submit a report to the FHWA documenting activities of the IA "System Basis" program for the Project. The report will include the following information:

- Names and number of technicians performing acceptance sampling and testing the Project.

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- Number of such technicians evaluated by the IA program.
- Number of such technicians that had deviations, as determined by the evaluation.
- Summary of how the deviations were addressed, along with any potential systematic solutions to recurring deficiencies.
- Goals for the upcoming twelve-month period.

Test methods requiring IA sampling and testing are shown in Appendix G.

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Appendix A

Federal Regulations and Guidance:

FEDERAL-AID POLICY GUIDE
October 5, 1995, Transmittal 14

23 CFR 637B
OPI: HNG-23

SUBCHAPTER G - ENGINEERING AND TRAFFIC OPERATIONS
PART 637 - CONSTRUCTION INSPECTION AND APPROVAL

Subpart A - [Reserved]

Subpart B - Quality Assurance Procedures for Construction

Sec.
637.201 Purpose.
637.203 Definitions.
637.205 Policy.
637.207 Quality assurance program.
637.209 Laboratory and sampling and testing personnel qualifications.

Appendix A to Subpart B-Guide Letter of Certification by State Engineer

Authority: 23 U.S.C. 109, 114, and 315; 49 CFR 1.48(b).
Source: 51 FR 40417, Nov. 7, 1986, unless otherwise noted.

Subpart A-[Reserved]

Subpart B-Quality Assurance Procedures for Construction

Sec. 637.201 Purpose.

To prescribe policies, procedures, and guidelines to assure the quality of materials and construction in all Federal-aid highway projects on the National Highway System

Sec. 637.203 Definitions.

(a) Acceptance program. All factors that comprise the State highway agency's (SHA) determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection and may include results of quality control sampling and testing.

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(b) Independent assurance samples and tests. Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. Test procedures used in the acceptance program which are performed in the SHA's central laboratory would not be covered by an independent assurance program.

(c) Proficiency samples. Homogeneous samples that are distributed and tested by two or more laboratories. The test results are compared to assure that the laboratories are obtaining the same results.

(d) Qualified laboratories. Laboratories that are capable as defined by appropriate programs established by each SHA. As a minimum, the qualification program shall include provisions for checking test equipment and the laboratory shall keep records of calibration checks.

(e) Qualified sampling and testing personnel. Personnel who are capable as defined by appropriate programs established by each SHA.

(f) Quality assurance. All those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

(g) Quality control. All contractor/vendor operational techniques and activities that are performed or conducted to fulfill the contract requirements.

(h) Random sample. A sample drawn from a lot in which each increment in the lot has an equal probability of being chosen.

(I) Vendor. A supplier of project-produced material that is not the contractor.

(j) Verification sampling and testing. Sampling and testing performed to validate the quality of the product.

Sec. 637.205 Policy.

(a) Quality assurance program. Each SHA shall develop a quality assurance program which will assure that the materials and workmanship incorporated into each Federal-aid highway construction project on the NHS are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must meet the criteria in Sec. 637.207, and be approved by the FHWA.

(b) SHA capabilities. The SHA shall maintain an adequate, qualified staff to administer its quality assurance program. The State shall also maintain a central laboratory. The State's central laboratory shall meet the requirements in Sec. 637.209(a)(2).

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(c) Independent assurance program. Independent assurance samples and tests or other procedures shall be performed by qualified sampling and testing personnel employed by the SHA or its designated agent.

(d) Verification sampling and testing. The verification sampling and testing are to be performed by qualified testing personnel employed by the SHA or its designated agent, excluding the contractor and vendor.

(e) Random samples. All samples used for quality control and verification sampling and testing shall be random samples.

Sec. 637.207 Sampling and testing program.

(a) Each SHA's quality assurance program shall provide for an acceptance program and an independent assurance (IA) program consisting of the following:

(1) Acceptance program.

(I) Each SHA's acceptance program shall consist of the following:

(A) Frequency guide schedules for verification sampling and testing which will give general guidance to personnel responsible for the program and allow adaptation to specific project conditions and needs.

(B) Identification of the specific location in the construction or production operation at which verification sampling and testing is to be accomplished. Identification of the specific attributes to be inspected which reflect the quality of the finished product.

(ii) Quality control sampling and testing results may be used as part of the acceptance decision provided that:

(A) The sampling and testing has been performed by qualified laboratories and qualified sampling and testing personnel.

(B) The quality of the material has been validated by the verification testing and sampling. The verification sampling shall be performed on samples that are taken independently of the quality control samples.

(c) The quality control sampling and testing is evaluated by an IA program.

(iii) If the results from the quality control sampling and testing are used in the acceptance program, the SHA shall establish a dispute resolution system. The dispute resolution system shall address the resolution of discrepancies occurring between the verification sampling and

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testing and the quality control sampling and testing. The dispute resolution system may be administered entirely within the SHA.

(2) The IA program shall evaluate the qualified sampling and testing personnel and the testing equipment. The program shall cover sampling procedures, testing procedures, and testing equipment. Each IA program shall include a schedule of frequency for IA evaluation. The schedule may be established based on either a project basis or a system basis. The frequency can be based on either a unit of production or on a unit of time.

(I) The testing equipment shall be evaluated by using one or more of the following: Calibration checks, split samples, or proficiency samples.

(ii) Testing personnel shall be evaluated by observations and split samples or proficiency samples.

(iii) A prompt comparison and documentation shall be made of test results obtained by the tester being evaluated and the IA tester. The SHA shall develop guidelines including tolerance limits for the comparison of test results.

(iv) If the SHA uses the system approach to the IA program, the SHA shall provide an annual report to the FHWA summarizing the results of the IA program.

(3) The preparation of a materials certification, conforming in substance to Appendix A of this subpart, shall be submitted to the FHWA Division Administrator for each construction project which is subject to FHWA construction oversight activities.

(b) [Reserved]

Sec. 637.209 Laboratory and sampling and testing personnel qualifications.

(a) Laboratories.

(1) After June 29, 2000, all contractor, vendor, and SHA testing used in the acceptance decision shall be performed by qualified laboratories.

(2) After June 30, 1997, each SHA shall have its central laboratory accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(3) After June 29, 2000, any non-SHA designated laboratory which performs IA sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

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(4) After June 29, 2000, any non-SHA laboratory that is used in dispute resolution sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(b) Sampling and testing personnel. After June 29, 2000,all sampling and testing data to be used in the acceptance decision or the IA program shall be executed by qualified sampling and testing personnel.

(c) Conflict of interest. In order to avoid an appearance of a conflict of interest, any qualified non-SHA laboratory shall perform only one of the following types of testing on the same project: Verification testing, quality control testing, IA testing, or dispute resolution testing.

Appendix A to Subpart B - Guide Letter of Certification by State Engineer

Date
Project No.

This is to certify that:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications. (The following sentence should be added if the IA testing frequencies are based on project quantities. All independent assurance samples and tests are within tolerance limits of the samples and tests that are used in the acceptance program.)

Exceptions to the plans and specifications are explained on the back hereof (or on attached sheet).

Director of SHA Laboratory or other appropriate SHA Official.

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Formerly Federal-aid Policy Guide Non-Regulatory Supplement NS 23 CFR, Part 637B, July 19, 2006, Transmittal 36

See Order 1321.1C FHWA Directives Management

1. **POLICY (23 CFR 637.205).** The Division Administrator shall provide appropriate oversight to ensure that the State's quality assurance program is being implemented as approved. At a minimum the oversight should cover:

   a. Materials sampling and testing issues,

   b. Construction inspection issues covering the specific attributes which reflect the quality of the finished product, and

   c. State capabilities - maintaining an adequate, qualified staff to administer the quality assurance program and qualified laboratories.

2. **QUALITY ASSURANCE PROGRAM (23 CFR 637.207)**

   a. The State's acceptance program should provide a reasonable level of inspection to adequately assess the specific attributes which reflect the quality of the finished product. Acceptance inspection should include inspection of the component materials at the time of placement or installation, as well as the workmanship and quality of the finished product.

   b. Samples used in the acceptance decision should be taken as close as possible to where the material is incorporated into the project.

   c. The State should retain control of the verification sampling locations and timing until immediately prior to sampling.

   d. Sampling and testing frequencies may vary from State to State as the quality and uniformity of the material varies. The State may reduce its testing frequency for materials with a history of accurate, uniform test results that consistently meet specification requirements. The rate of testing should be higher on newly developed material sources, sources with questionable quality, sources with a wide range of test results, and sources with failing test results.

   e. When contractor's tests are used in the acceptance decision and the State and contractor test results do not compare, the frequency of verification testing should be increased.

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f. The State should obtain the contractor's test data as soon as it is available, no later than 24 hours after sampling is completed. The State's test results should not be given to the contractor until after the contractor results are received.

g. The State should review the contractor's source documentation as part of the State's quality assurance program.

h. Test results should not be discarded unless it is known that the sampling or testing was flawed. It may be appropriate to perform additional testing when the quality of the material is in question. However, in cases where additional tests are performed, the acceptance and pay criteria need to be adjusted to account for the additional test results.

i. If project materials are used in the Independent Assurance (IA) program, the IA samples should be split samples when possible, or in close proximity to the same location as the samples used in the acceptance decision.

j. Observation of sampling and testing procedures should be included as part of an IA system to evaluate sampling and testing personnel and ensure that test procedures are performed correctly.

k. When using the project approach for IA, the frequency should be approximately 10 percent of the frequency of the tests used in the acceptance decision.

l. When using the system approach for IA, each inspector should be covered once or twice a year.

m. The State is encouraged to develop a Qualified Products List for manufactured materials.

n. The State is encouraged to perform a risk analysis when developing an acceptance program for manufactured items. When performing a risk analysis, the State should consider the use of the product, safety, cost, and historical quality of the product.

o. The State should consider the data from the National Transportation Product Evaluation Program (NTPEP) when developing qualified product lists. See http://www.ntpep.org/.

p. The State is encouraged to report the evaluation of new products to the American Association of State Highway and Transportation Officials Product Evaluation List (APEL). See http://apel.transportation.org/.

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q. The State should consider visual inspection and/or the manufacturer's certification as a basis for accepting small quantities of non-critical material.

3. **LABORATORY AND SAMPLING AND TESTING PERSONNEL QUALIFICATION (23 CFR 637.209)**

a. All test procedures used in the acceptance decision should be in the scope of accreditation for the States central laboratory.

b. The National Cooperation for Laboratory Accreditation (NACLA) "Recognition Procedure" and the National Institute of Standards and Technology (NIST) Interagency Report 7012 (NISTIR 7012), "Technical Requirements for Construction Materials Testing", is the criteria required for the approval of comparable laboratory accreditation programs as indicated in a Notice in the Federal Register on September 22, 2004. The accreditation bodies will be evaluated against the NACLA Recognition Procedure and the Technical Requirements for Construction Materials Testing, and they must be recognized by NACLA with the Technical Requirements for Construction Materials Testing listed within its scope before the accreditation bodies will be approved by the Federal Highway Administration (FHWA). To meet the quality assurance requirements in 23 CFR 637.209(a)(2), (3), and (4), the laboratories' scope of accreditation must indicate that the laboratory was assessed according to the requirements in NISTIR 7012. The NACLA Recognition Procedure is available at http://www.nacla.net/Pdf/Evaluation%20Procedure%20RevA.pdf. The Technical Requirements for Construction Materials Testing is available at http://ts.nist.gov/ts/htdocs/210/gsig/pubs/ir7012.pdf.

c. The following should be used as guidance for reviewing and revising laboratory qualification programs for non-accredited laboratories that provide test results and information used in the acceptance decision:

1. **Personnel**

a. **Supervisors**. Supervisors of testing personnel should have a minimum of 3 years experience in testing of highway construction materials.

b. **Technicians**. Guidance for technician qualification programs is listed in paragraph 3d.

2. **Documentation**. State DOT's should develop test procedures and/or test manuals referencing standard testing procedures. These procedures should also cover handling, identification, conditioning, storage, retention and disposal of test samples.

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3. **Proficiency In Testing**. Testing personnel should be routinely evaluated by observations and split samples or proficiency samples.

4. **Frequency of Assessments**

   a. Laboratory assessments should be made on a 3- to 5-year cycle.

   b. Data from the IA program along with observations during IA tests should be used as part of the ongoing evaluation of the laboratory.

d. The following should be used as guidance for reviewing and revising a technician qualification program:

1. Formal training of personnel including all sampling and testing procedures with instructions on the importance of proper procedures and the significance of test results.

2. Hands-on training to demonstrate proficiency of all sampling and testing to be performed.

3. A period of on-the-job training with a qualified individual to assure familiarity with State DOT procedures.

4. A written examination and demonstrated proficiency of the various sampling and testing methods.

5. Requalification at 3- to 5-year intervals (data from the IA program can be used as one element of requalification).

6. A documented process for retraining or removing personnel that perform the sampling and testing procedures incorrectly.

7. The following are not appropriate criteria for achieving or maintaining qualification status: Grandfathering, the acceptance of a Professional Engineer or Engineer-in-Training certificate, or lifetime qualification.

4. **MATERIALS CERTIFICATE (23 CFR 637 APPENDIX A).** The intent of the material certification is to ensure that the quality of all materials incorporated into the project is in conformance with the plans and specifications, thus ensuring a service life equivalent to the design life. Any material represented by an acceptance test that does not meet the criteria contained in the plans and specifications is considered an exception.

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Exceptions should be investigated to determine if in fact the material is in reasonably close conformity with the plans and specifications.

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Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, and the Identification of Contractor/Department Risks

T 6120.3

August 9, 2004

Par.

1. What is the purpose of this Technical Advisory?
2. Does this Technical Advisory supersede other Federal Highway Administration (FHWA) guidance?
3. What is FHWA's policy on the use of contractor's quality control test results for acceptance?
4. Is there any existing FHWA guidance regarding 23 CFR 637B, the use of quality measures, and the identification of contractor and department risks?
5. What is the background on quality assurance and quality assurance specifications?
6. Where can I find definitions for the terms used within this Technical Advisory?
7. Do any of the terms need additional explanation?
8. What are the requirements for the use of independent samples?
9. Who is required to perform verification sampling and testing?
10. What are the validation procedures performed on independent samples?
11. What are the test method comparison procedures performed on split samples?
12. When should split samples be used?
13. Can contractor split sample test results be used in the acceptance decision?
14. What are the recommended quality measures?
15. What quality measures are not recommended?
16. What are contractor and department risks?
17. Are there any conflicts between American Association of State Highway and Transportation Officials (AASHTO) quality assurance publications and FHWA regulations?
18. Are there any reference materials on quality assurance, risks, and statistics?

1. **What is the purpose of this Technical Advisory?** This Technical Advisory provides guidance and recommendations for the use and validation of contractor's test results for acceptance, the use of quality measures, and the identification of contractor and department risks.

2. **Does this Technical Advisory supersede other Federal Highway Administration (FHWA) guidance?** Yes. This Technical Advisory supersedes previous guidance provided in the following:

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a. *Memorandum from Director, Office of Engineering, to Regional Administrators,* "INFORMATION: Quality Assurance Procedures for Construction - 23 CFR 637 - Sampling for Verification Testing," March 28, 1997.

b. *Memorandum from Chief, Highway Operations Division, to Regional Administrators, Division Administrators, Federal Lands Highway Program Administrator,* "INFORMATION: Quality Assurance Guide Specification and Implementation Manual for Quality Assurance," August 2, 1996.

3. **What is FHWA's policy on the use of contractor's quality control test results for acceptance?** The FHWA policy on the use of contractor's quality control test results for acceptance requires validation of all data not generated by the State transportation department (STD) or its designated agent if used in the acceptance decision. The requirements are codified in Title 23 Code of Federal Regulations Part 637 Subpart B (23 CFR 637B), located at http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html. (Note that the use of STD is in line with 23 CFR 637 B, as of April 1, 2003. In this Technical Advisory, all references to State Highway Agency (SHA) or "agency" have been replaced with STD or "department.")

4. **Is there any existing FHWA guidance regarding 23 CFR 637B, the use of quality measures, and the identification of contractor and department risks?** Yes. Existing FHWA guidance is provided in the following:

a. *FHWA Materials Notebook: Chapter 1 - Materials Sampling and Testing* 23 CFR 637, "23 CFR 637 ACTION: Final Rule and Questions & Answers on the Regulation," https://www.fhwa.dot.gov/pavement/materials_notebook/1sec1.htm.

b. *Publication No. FHWA-RD-02-095* "Optimal Procedures for Quality Assurance Specifications" (see paragraph 18b), http://www.tfhrc.gov/pavement/pccp/pubs/02095/.

c. *Memorandum from Chief, Highway Operations Division, to Resource Center Directors, Division Administrators,* "INFORMATION: Laboratory Qualification," October 9, 1998, https://www.fhwa.dot.gov/pavement/labqual.htm.

d. *Memorandum from Chief, Highway Operations Division, to Resource Center Directors, Division Administrators, Acting Federal Lands Highway Program Administrator,* "INFORMATION: Technician Qualification," July 17, 1998, https://www.fhwa.dot.gov/pavement/techqual.htm.

5. **What is the background on quality assurance and quality assurance specifications?**

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a. One of the fundamental concepts in quality assurance (QA) specifications is the separation of the functions of quality control (QC) and acceptance. In QA specifications, the contractor is responsible for the QC and the STD is responsible for obtaining and conducting verification tests and making the acceptance decision. Although QA is a combination of QC and acceptance, the separation of these two functions is important.

b. Due to the evolutionary nature of QA specifications, QC and acceptance functions often have been combined or intermingled. This has been a major source of confusion. The intermingling of QC and acceptance can be traced to the first statistically based specifications that were used at a time when STDs had technicians at the contractor's materials plants. The STD technicians did testing and determined when the product was acceptable. Contractors rarely did their own QC testing, and they often made changes to the process when necessary based on the STD's test results. Although QC was often recognized as a separate item from acceptance, in reality, little separation occurred.

c. With the downsizing that took place within many STDs in the 1990s, inspection and testing personnel positions were reduced significantly and many technicians were removed from the contractors' materials plants. Although STDs often took it upon themselves to control most aspects of production and construction, reductions in staff made it more important to assign QC where it rightfully belonged so the STD could focus on acceptance testing and inspection. This resulted in the contractor having to conduct the QC tests and the STD examining options for requiring more of its functions to be undertaken by the contractor. Many STDs found ways to include contractor test results in the acceptance decision, and some have questioned why the regulations prohibit the contractor from conducting acceptance testing.

d. The Federal regulations on sampling and testing of materials for construction appear in 23 CFR 637B (see paragraph 18a). These regulations were revised on June 29, 1995. This revision included clarification on the use of contractor test results in an acceptance program. The regulations most recent revision occurred in the *Federal Register* on December 10, 2002.

e. Further evolution of QA specifications has introduced the use of incentive/disincentive provisions and pay adjustment systems that utilize pay factors to adjust the amount paid to a contractor based on the level of quality of the product provided. Several different statistical quality measures were developed and used in order to determine this level of quality. Some examples of quality measures are: percent within limits, percent defective, average deviation, average absolute deviation, conformal index, and moving average. Some of these quality measures have been implemented without fully

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understanding how they apply to acceptance or whether they conform to sound statistical principles.

f. Statistical QA specifications and acceptance procedures have been implemented without fully understanding the risks involved to both the STD and the contractor. The acceptable level of STD risk and contractor risk is a subjective decision that often varies between departments. It is estimated that few departments have developed and evaluated the risk levels associated with their acceptance plans.

g. State planning and research pooled fund study SPR-2(199) "Optimal Acceptance Procedures for Statistical Construction Specifications" was conducted in order to investigate the current use of QA specifications and provide recommendations for statistically sound QA procedures and balancing of risks. The pooled fund study was administered by FHWA and the results provided in publication no. FHWA-RD-02-095, "Optimal Procedures for Quality Assurance Specifications" (see paragraph 18b). This publication provides a guide for developing new or modifying existing acceptance plans and QA specifications.

6. **Where can I find definitions for the terms used within this Technical Advisory?** The definitions for terms used in this Technical Advisory are taken from the following sources (listed in order of precedence), unless otherwise specified:

a. 23 CFR 637 (see paragraph 18a).

b. AASHTO R10 (see paragraph 18e).

c. Transportation Research Board (TRB) Circular (see paragraph 18f).

7. **Do any of the terms need additional explanation?** Some additional explanations of terms are provided below:

a. **Difference Two-Sigma Limit (D2S Limit).** The D2S method compares the contractor and department results from a single split sample. The D2S Limit indicates the maximum acceptable difference between two test results obtained on test portions of the same material (and thus, applies only to split samples), and it is provided for single and multi-laboratory situations. It represents the difference between two individual test results that has approximately a five percent chance of being exceeded if the tests are actually from the same population. The value provided by this procedure is contained in many AASHTO and American Society of Testing and Materials (ASTM) test procedures and is typically listed in the precision and bias statement as "Acceptable Range of Two Test Results" at the end of each test procedure.

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b. ***F*-test.** The *F*-test provides a method for comparing the variances (standard deviations squared, σ^2) of two sets of data by assessing the size of the ratio of the variances. The hypothesis is that the department's tests and the contractor's tests are from the same population and the variability of the two data sets are equal. The intent is to determine whether the differences in the variability of the contractor's tests and the department's tests are larger than might be expected by chance if they came from the same population. The calculated *F*-value is then compared to the critical value (F_{crit}) obtained from a table of *F*-values at a chosen level of significance (α). The *F*-test can be used to compare either an equal or unequal number of contractor vs. department sample sizes.

c. **Operating Characteristics (OC) Curves**

(1) OC curves for statistical tests. OC curves can be developed to indicate the probability of rejecting a hypothesis. This type of curve shows the relation between the probability of rejecting a hypothesis that a sample belongs to a given population with a given characteristic and the actual population value of that characteristic. OC curves can also be developed to show either the probability of not detecting a difference, or detecting a difference, versus the actual difference between the two populations being compared. There are also OC curves available to provide guidance regarding the number of tests needed to achieve a certain probability of detecting a given difference when one actually exists. OC curves that plot the probability of detecting a difference are sometimes called power curves because they plot the power of the statistical test procedure to detect a given difference.

(2) OC curves for acceptance plans. OC curves can also be a graphical representation of an acceptance plan that shows a relationship between the actual quality of a lot and either (a) the probability of its acceptance (for accept/reject acceptance plans), or (b) the probability of its acceptance at various pay levels for acceptance plans that include pay adjustment provisions.

d. **Paired *t*-test.** The paired *t*-test compares contractor and department results from an equal number of split samples. When it is desirable to compare more than one pair of split sample test results, the *t*-test for paired measurements can be used. This test uses the differences between pairs of tests and determines whether the average difference is statistically different from zero. Thus, it is the difference within pairs, not between pairs, that is being tested. The calculated *t*-value is compared to the critical value (t_{crit}) obtained from a table of *t*-values at a specified level of significance and with n-1 degrees of freedom (see *t*-test in paragraph 7e).

e. ***t*-test**

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(1) The *t*-test provides a method for comparing the means of two independent data sets and is used to assess the degree of difference in the means. The null hypothesis is that the department's tests and the contractor's tests are from the same population, and the means of the two data sets are equal. The desire is to determine whether it is reasonable to assume that the contractor's tests came from the same population as the department's tests. The *t*-test can be used to compare either an equal or unequal number of contractor vs. department sample sizes.

(2) Since the values used for the *t*-test are dependent upon whether or not the variances are assumed equal for the two data sets, it is necessary to test the variances (*F*-test) before the means (*t*-test). If it is determined that the variances are assumed to be equal ($F<F_{crit}$), then the *t*-test is conducted based on the two sample sets using a pooled estimate for the variance and pooled degrees of freedom. If the sample variances are determined to be different ($F\geq F_{crit}$), then the *t*-test is conducted using the individual sample variances, the individual sample sizes, and the effective degrees of freedom. The calculated *t*-value is compared to the critical value (t_{crit}) obtained from a table of *t*-values at a specified level of significance.

8. **What are the requirements for the use of independent samples?** The regulation 23 CFR 637B requires the use of independent samples for verification sampling and testing in the acceptance program. In order to be considered independent, each sample must contain independent information reflecting all sources of variability associated with the material, process, sampling, and testing in the test results. This does not prevent split samples from being used in the acceptance decision if the data is used properly to provide validation of independent data (see paragraph 13). Some clarification of using contractor performed sampling for verification sampling and for use in the acceptance decision is found in paragraphs 9 through 13.

9. **Who is required to perform verification sampling and testing?**

a. The regulation requires STD personnel or their representatives to perform the verification sampling and testing. The regulation also specifically indicates that verification sampling and testing cannot be performed by contractor employees. However, there are situations where labor regulations, hazardous conditions, and liability issues may dictate some contractor involvement in verification sampling. In these situations, the involvement of contractor personnel should be limited so that they are not deemed to be in control of the sampling.

(1) The STD can use the services of the contractor's personnel to assist in obtaining independent verification samples when the following requirements are adhered to:

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(a) The verification sample location or time has been randomly selected by the STD and is only given to the contractor immediately prior to sampling.

(b) The contractor's personnel are used only to provide labor to assist in physically obtaining the verification sample of the material.

(c) The STD is present to witness the taking of the verification sample.

(d) Both the STD witness and contractor labor are qualified sampling personnel.

(e) The STD witness controls the sampling process by choosing the location or timing and directing the taking of the verification sample.

(f) The STD witness immediately takes possession of the verification sample.

(2) STD verification sample independence and the intent of 23 CFR 637B are maintained when the above requirements are met. However, these situations should be the exception and not the rule. The verification sampling is expected to be performed entirely by STD personnel or their representative in the majority of situations.

b. Verification testing is required to be performed by the STD or its designated agent, excluding the contractor or vendor; therefore, verification testing cannot be based on contractor performed testing witnessed by the STD.

10. **What are the validation procedures performed on independent samples?** When comparing two data sets, such as department and contractor test results, it is important to compare both the variances and the means. The tests most often used are the *F*-test (comparison of variances) and the *t*-test (comparison of means), which are used together. A procedure that compares a single department test with 4 to 10 contractor tests is sometimes used but not recommended.

a. The *F*-test and *t*-test are the recommended methods because they have more power to detect actual differences than the method that relies on a single department test for the comparison. If either the *F*-test or the *t*-test show a significant difference ($F \geq F_{crit}$ or $t \geq t_{crit}$), it is questionable whether the data does truly come from the same population.

(1) The computational method used for the *t*-test differs depending on if the variances are found to be either equal or not equal. There is a *t*-test that corresponds with finding a difference in variances, $F \geq F_{crit}$ (see paragraph 7e). This has led to instances of incorrectly validating test results by finding no differences in the means ($t < t_{crit}$) after finding differences in the variances ($F \geq F_{crit}$). When a

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difference in the variances is identified then the test results have not been validated, even if no difference in the means has been identified.

(2) The source of the difference should be identified if it is determined that a significant difference is likely between either the variances or the means. The identification of a difference between either variances or means is simply a notice that a difference exists. Therefore, the source of the difference must still be determined.

b. The method of comparing a single department test to a number of contractor tests should not be used. Although simple, it suffers from the fact that only a single department test is used when making the comparison. Any comparison method that is based on a single test result is not effective in detecting differences between data sets. This is due to the high variability that is associated with individual values, as compared with mean values.

11. **What are the test method comparison procedures performed on split samples?**

a. The comparison of a single split sample by using the D2S limits is simple and can be done for each split sample that is obtained. However, since it is based on comparing only single data values, it is not very powerful for identifying differences when they exist. Thus, it cannot detect real differences unless the results are far apart. The appeal of the D2S method lies in its simplicity rather than its power.

b. Due to D2S method limitations, it is recommended that the paired *t*-test (see paragraph 7d) be used on the total accumulated split sample results to allow for a comparison with more discerning power. If either of these comparisons indicates a difference, then an investigation to identify the cause of the difference should be initiated.

12. **When should split samples be used?** The split sampling, testing, and comparison procedures (see paragraph 11) are primarily used as a function of an Independent Assurance (IA) program as outlined in 23 CFR 637B. The use of split samples in the IA program provides a check on testing equipment and procedures. The evaluation of split samples helps to identify where the cause of any differences may occur by isolating the testing components. This complements the QA program and ensures credibility of the testing program.

13. **Can contractor split sample test results be used in the acceptance decision?**

a. In order for contractor split sample test results to be used in the acceptance decision, the contractor's test results used in the acceptance decision must be independently validated by the STD. The validation is not required if the STD

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conducts all of the verification sampling and testing and does not wish to use the contractor's test results in the acceptance decision.

b. The contractor performs QC testing using independently obtained samples. The STD can perform verification testing using its half of the split samples when sampled as required in paragraph 9. The validation is accomplished by comparing the STD verification tests with the contractor's independently sampled QC tests (see Figure 1). The contractor's splits of the verification samples cannot be used for validation purposes because they are not independent of the STD samples. If both sets of split samples are used the only component of variability that can be compared is the testing variability. The split sample components of variability associated with materials, process, and sampling are the same, having come from the same location and sampler.

c. The contractor may or may not test their portion of the split sample. The validation procedure is the same in either case because the contractor's split samples cannot be used for validation (see Figure 1).

d. When the STD uses contractor personnel as labor to take verification samples as required in paragraph 9 and the STD then performs verification testing on these samples, the verification test results may be considered independent of the contractors test results. They may be considered independent because they have been sampled with control by the STD, independently tested, and independently compared to the contractor's independent QC test results (test results that do not include the contractor's set of split samples). Again, in order to be considered independent the two sets of samples must each contain the variability associated with the material, process, sampling, and testing.

e. If the contractor's independently sampled QC test results are validated by the STD verification test results, then the material can be accepted based on either:

(1) The total test results provided by the contractor that combine their independent QC test results and their split of the verification sample test results (see 2.1 in Figure 2),

(2) A combination of independent contractor QC test results excluding their split sample test results and the STD verification split test results (see 2.2 in Figure 2), or

(3) Only the contractor independent QC test results, excluding all split sample test results (see 2.3 in Figure 2).

f. The STD test results from their split portion of the verification samples and the contractor test results from their split portion of the of the verification samples

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cannot be combined for the acceptance decision (see 2.4 in Figure 2). If the two sets of split test results are combined, they are no longer independent and the population of the contractor's independent test results will be biased and result in an invalid comparison. In essence, a double counting of test results would occur if the two sets of split test results were combined. This is true even though the two sets of test results may have different values.

g. A scenario may exist where all samples are taken by the STD and split between the STD and contractor. In this scenario the STD only performs verification tests on a specified percentage of all the split samples they have in their possession. It is important to note, the validation must still be performed on independent sample data. Again, this is accomplished by comparing the STD verification test results with the contractor's independent test results. The contractor's independent test results cannot include the split tests that match with the STD verification tests.

(1) For example, if 11 samples were split, the contractor tests all 11 samples and the STD tests only 3 samples, the 3 STD test results would be compared against the contractor's remaining 8 test results. Independence of the two sets of data is maintained by excluding the contractor's three test results that match the STD test results.

(2) In essence, the validation shown in Figure 1 has occurred when the STD does not test all of the split samples that are in its possession. By taking possession of all the split samples, the STD does have additional material for an investigation if the contractor's results do not validate or for use in a dispute resolution system.

h. Although split samples have physically been taken, it is the method which the data from these samples is analyzed that allows independent validation and their use in the acceptance decision. The independent validation is accomplished by validation procedures performed on independent samples (see paragraph 10), not by test method comparison procedures performed on split samples (see paragraph 11).

14. **What are the recommended quality measures?** The percent within limits (PWL) or percent defective (PD) are the recommended quality measures to be used. It is necessary to measure both the center and spread when characterizing a lot of material. These quality measures use the mean and standard deviation to measure center and spread and then estimate the percentage of the lot that is within, PWL, or outside of, PD, the specification limits. Since PD and PWL can easily be converted to one another simply by subtracting from 100, they are equivalent quality measures. The preference on which of the two quality measures to use, PWL or PD, is typically based on the department's preference to highlight how much of the material meets the requirements as described with PWL, rather than how much is defective as described with PD.

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15. **What quality measures are not recommended?**

a. The average deviation from the target value should not be used as the quality measure for QA acceptance plans. This approach often encourages the contractor to manipulate its process during the production of a lot. In effect, the contractor increases process variability by making frequent adjustments to the process in order to get the average of the test results to be at or near the target value.

b. The average absolute deviation (AAD) from the target value should not be used as the quality measure for QA acceptance plans. To avoid the problem of over-adjusting the process in response to early test results, the average absolute deviation from the target has been used instead of the average deviation. By taking the absolute value of the deviation from the target, the contractor cannot benefit by any strategy other than aiming for the target value. However, the variability of the material may not be adequately measured. Very different sets of test results can give identical AAD values. Not only must it be questioned if equal pay is appropriate for these widely different conditions, the use of AAD fails to document these differences that should be used for future modifications of the specification. Specifically, the means and populations may vary considerably for different sets of test results that can give identical AAD values. These mean and variability differences are disregarded with acceptance based on AAD.

c. The conformal index (CI) should not be used as the quality measure for QA acceptance plans. The CI is very similar in practice to the AAD and has the same disadvantages of not being appropriate for a one-sided specification and potentially having the same CI value for very different test results.

d. The moving average should not be used as the quality measure for QA acceptance plans. The moving average was developed as a QC measure and not developed for use as an acceptance approach. The use of the moving average is not consistent with the use of lot-by-lot acceptance. When acceptance is based on a lot, it is assumed that the various lots are independent of one another. Since each individual test result appears in several moving average calculations, the moving averages are correlated and the results of one average are not independent of the next; therefore, it is difficult to determine when or where a lot begins or ends. In addition, it is not easy to determine pay factors on a lot-by-lot basis since the successive moving averages are correlated and individual lots are not well defined. As a result, acceptance procedures based on moving averages often result in production shut downs and plant adjustments rather than determining appropriate pay factors for specific production lots.

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16. **What are contractor and department risks?**

a. The two types of risks discussed in this section are the seller's (contractor) risk (α) and the buyer's (department) risk (β). The acceptable level of α and β risks is a subjective decision that can vary from department to department. A properly developed QA acceptance plan takes these risks into consideration in a manner that is fair to both the department and contractor. Too large a risk for either party undermines credibility.

(1) Table 1 of the AASHTO Material's Specification R 9-97(2000), "Acceptance Sampling Plans for Highway Construction" (see paragraph 18d), has suggestions for risk levels for both the seller and buyer that range from 0.001 (0.1 percent) to 0.200 (20 percent). It should be noted that large sample quantities, on the order of 10 to 20 or more, are needed to achieve some of the risk levels provided in this table. Larger sample quantities will provide this lower level of risk to both the department and contractor. The selection of the number of samples required by a department may need to be modified based on an analysis of risks.

(2) The sample size is the number of test results used to judge the quality of a lot, and therefore it is directly related to the lot size. One reason to use larger lot sizes is the potential resultant increase in sample size. This tends to provide a much lower level of risk to both the contractor and department. However, an assumption that all of the material and construction processes remain consistent throughout the lot is required. Small lot sizes may not be compatible with large sample sizes due to a large amount of required testing. Larger sample sizes can be used with large lot sizes to decrease risks of making incorrect acceptance decisions. However, the possibility of combining materials from different populations must be taken into consideration. The final decision regarding sample size per lot cannot be made until an evaluation of risks has been completed. An attempt should be made to balance the risk between the contractor and department while holding the risk to a reasonable level. This means that a large number of samples may be required. If the risks cannot be held to a reasonable level for both, the department may have to accept a disproportionate level of risk.

b. The α and β risks are very narrowly defined to occur at only two specific quality levels. The α risk is the probability of rejecting material that is exactly at the acceptable quality level (AQL), while β is the probability of accepting material that is exactly at the rejectable quality level (RQL). Therefore, they do not provide a very good indication of the risks over a wide range of possible quality levels that a contractor may operate. It is necessary to construct an OC curve that illustrates the probability of acceptance for any quality level for the acceptance plan under consideration (see Figure 3) to evaluate how the acceptance plan will actually perform in practice. Another step that is necessary

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to fully evaluate the risks for a pay adjustment acceptance plan is to plot OC curves associated with receiving various pay factors (see Figure 4).

c. The concept of α and β risks derives from statistical hypothesis testing where there is either a right or wrong decision. When α and β risks are applied to materials or construction, they are only truly appropriate for the case of a pass/fail or accept/reject decision. This may lead to considerable confusion if an attempt is made to apply them to the pay adjustment case.

(1) The evaluation of risks becomes more complicated when the acceptance system includes pay adjustment provisions. The α and β risks discussed do not fully incorporate the concept of pay adjustments. By itself, the α risk, defined as the probability that an acceptance plan will incorrectly reject acceptable quality material or construction, cannot reflect the fact that the material or construction may be accepted at any of the possible pay adjustments (full pay, increased or decreased pay). When working with a pay adjustment system, the contractor's risk may also be interpreted as the probability of acceptable material or construction being accepted at less than 100 percent pay. In order to avoid confusion in the terms when the contractor's risk is used in this manner, the risk is here called α_{100}. However, it is computed in the same manner as α at the AQL. In addition, the β risk, defined as the probability that the owner incorrectly accepts rejectable quality material or construction, cannot reflect the impact of pay adjustments on determining the department's risk. When working with a pay adjustment plan, the department's risk may also be interpreted as the probability of accepting rejectable quality material or construction at 100 percent pay or greater. In order to avoid confusion in the terms when the department's risk is used in this manner, it is here called β_{100}. There are α and β type risks (α_{PF} and β_{PF}) associated with any given level of pay adjustment or pay factor (PF) from zero through the bonus chosen by the STD. For example, at a pay factor of 0.90 (90 percent payment) the alpha and beta risks can be represented by α_{90} and β_{90}. Likewise, at a pay factor of 1.05 (bonus of 5 percent) alpha and beta can be represented by α_{105} and β_{105}.

(2) The use of α and β risks alone to evaluate pay adjustment acceptance plans is simply not sufficient. When developing a pay adjustment system the contractor's risk α_{PF} and the department's risk β_{PF} must also be considered for the entire range of risks associated with the system. If only one level of risk is evaluated alone, for example at 100 percent pay, some other risks associated with the system may be too high. Making any change to the system will change all risks involved.

d. An additional method to properly evaluate the risks when pay adjustments are added to the acceptance decision is the expected pay (EP) curve (see Figure 5).

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The EP curve has the advantage of combining all of the possible levels into a single expected or long-term average pay for each given level of quality.

e. The EP curve can also be used to ensure that a department's acceptance plan will pay 100 percent for material that is accepted at the AQL. It is generally agreed that the average pay for AQL material should be 100 percent. An average pay of 100 percent cannot be achieved unless a bonus is allowed. If the department's pay equations or tables are not properly developed, the average pay factor may be above or below 100 percent at the AQL. This would result in the contractor either being underpaid or overpaid on average. If this is the case, the department should determine if an expected pay other than 100 percent is acceptable for AQL material.

f. While the average expected pay shown with an EP curve should be used in addition to considering α and β type risks, the use of EP curves alone is also not sufficient to fully evaluate an acceptance plan. The EP alone is not a complete measure of the likelihood that any individual lot will receive a correct pay factor. The variability of the individual pay factors about the EP curve must also be considered.

g. When a price adjustment acceptance plan is used, it is essential that the department develop an EP curve and multiple OC curves for the probability of receiving various pay factors over the total range of quality levels in addition to considering all levels of α and β type risks. Both OC and EP curves must be developed and analyzed to show how an acceptance plan was designed to function. In all cases, when pay adjustments are used in the acceptance decision, the OC curves should be constructed to confirm that the acceptance procedure is working as desired and, in particular, that the average pay factor at the AQL is 100 percent. The department may also want to look at computer simulation histograms of individual pay factors to obtain a picture of how much variability is associated with the pay factor determination.

h. It is important to note that for PWL or PD acceptance plans, computer simulation is almost always used to develop α and β risks, OC and EP curves. The OCPLOT computer program that was developed as a part of FHWA Demonstration Project No. 89 (see paragraph 18j) is able to develop OC and EP curves, run simulations on the effect of the variability of the individual lot pay factors on the final pay factor determination, and create histograms. This program can be found on the Federal Highway Administration Office of Pavement Technology website at https://www.fhwa.dot.gov/pavement/qasoft.htm.

17. **Are there any conflicts between American Association of State Highway and Transportation Officials (AASHTO) quality assurance publications and FHWA regulations?**

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a. The companion reports "AASHTO Implementation Manual for Quality Assurance" (see paragraph 18h) and "AASHTO Quality Assurance Guide Specification"(see paragraph 18i) were published in February 1996 as reports of the AASHTO Highway Subcommittee on Construction. The Guide Specification is not an official AASHTO Specification and the Implementation Manual is not an official guide or voluntary standard because they have not been balloted and approved by the AASHTO Standing Committee on Highways and the AASHTO Board of Directors.

b. These reports provide uniform guidance to develop and implement quality assurance standard specifications. While these reports substantially follow 23 CFR 637B, some differences exist.

(1) One significant difference is that the reports provide for the use of either paired split (see paragraph 11) or independent (see paragraph 10) sample data comparisons for validation of contractor test results, while 23 CFR 637B allows only independent sample data for validation (see paragraph 8). The use of a paired split sample data comparison only verifies the test procedures and equipment, not the quality of the material (see paragraph 12). The use of independently obtained and tested samples assesses material, process, sampling and testing variability. Therefore, an acceptance program that uses paired split sample comparisons or witnessed tests for validation does not ensure the material quality and does not meet the requirements or intent of 23 CFR 637B.

(2) On the other hand, the use of split samples in the IA program provides a check on testing equipment and procedures. This complements the QA program and ensures the credibility of the testing program. The Implementation Manual offers the option of using either split or independent samples for IA. This does not agree with the regulation that IA testing may only be performed on split samples or proficiency samples. There is value to both split and independent samples; however, they do not provide interchangeable information.

18. **Are there any reference materials on quality assurance, risks, and statistics?** Yes. The following references apply to quality assurance, risks, and statistics.

a. "23 CFR Part 637," *Subpart B - Quality Assurance Procedures for Construction*, Federal Highway Administration, Federal Register, Washington, DC, April 2003, http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html.

b. "Optimal Procedures for Quality Assurance Specifications," *Publication No. FHWA-RD-02-095*, Federal Highway Administration, Washington, DC, April 2003, http://www.tfhrc.gov/pavement/pccp/pubs/02095/.

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c. *StatSoft, Inc., Electronic Statistics Textbook*, StatSoft, Tulsa, OK, 2003, http://www.statsoft.com/textbook/stathome.html.

d. "Acceptance Sampling Plans for Highway Construction," *AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part 1B Specifications: R 9-97 (2000)*, American Association of State Highway and Transportation Officials, 22nd Edition, 2002. (This is currently being evaluated and rewritten under the guidance of NCHRP Project 20-07, Task 164.)

e. "Definition of Terms for Specifications and Procedures," *AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part 1B Specifications: R 10-98 (2002)*, American Association of State Highway and Transportation Officials, 22nd Edition, 2002.

f. "Glossary of Highway Quality Assurance Terms," *Transportation Research Circular No. E-C037*, Transportation Research Board, Washington, DC, April 2002, http://trb.org/news/blurb_detail.asp?id=621.

g. *Introduction to Statistical Quality Control, Fourth Edition*, Douglas C. Montgomery, ISBN 0471316482, John Wiley & Sons, November 2000.

h. *AASHTO Implementation Manual for Quality Assurance*, AASHTO Construction/Materials Quality Assurance Task Force of the AASHTO Highway Subcommittee on Construction, American Association of State Highway and Transportation Officials, February, 1996.

i. *AASHTO Quality Assurance Guide Specification*, AASHTO Construction / Materials Quality Assurance Task Force of the AASHTO Highway Subcommittee on Construction, American Association of State Highway and Transportation Officials, February, 1996.

j. "Quality Assurance Software for the Personal Computer, Demonstration Project 89," *Publication No. FHWA-SA-96-026*, Federal Highway Administration, Washington, DC, May 1996, https://www.fhwa.dot.gov/pavement/qasoft.htm.

k. *Statistical Quality Control, Seventh Edition*, Eugene Grant and Richard Leavenworth, ISBN 0078443547, McGraw-Hill, January 1996.

l. *Quality Control and Industrial Statistics, Fifth Edition*, Acheson J. Duncan, ISBN 0256035350, McGraw-Hill, October 1994.

m. *Report on Limits of Use of Contractor Performed Sampling and Testing in Federal Highway Administration Programs*, Robert Bohman, et al, Federal Highway Administration, March 1993.

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n. *Materials Control and Acceptance - Quality Assurance*, NHI Course Number 134042A, Federal Highway Administration, National Highway Institute, http://www.nhi.fhwa.dot.gov.



King W. Gee
Associate Administrator for Infrastructure

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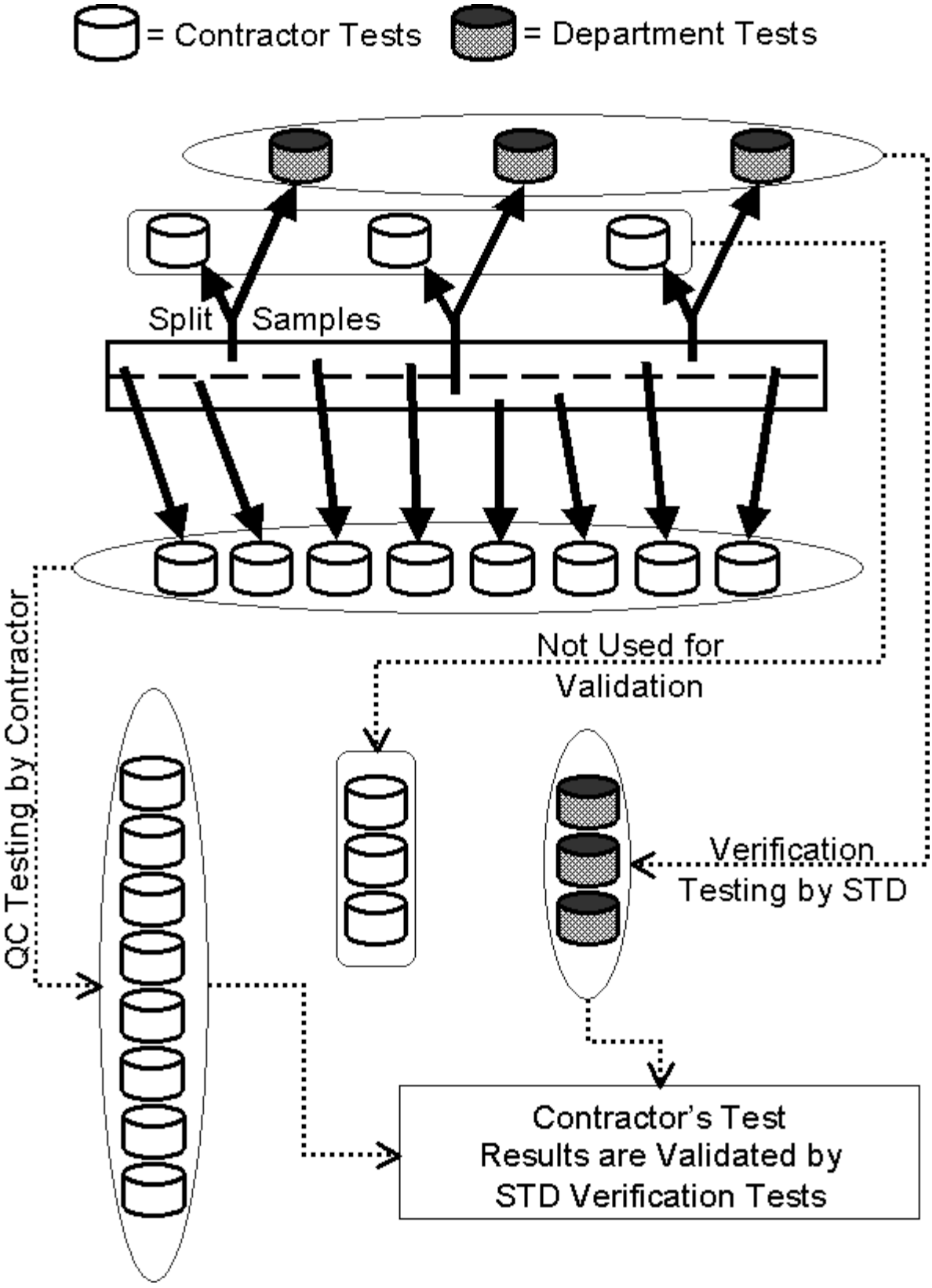


Figure 1 - Validation of Contractor's Tests

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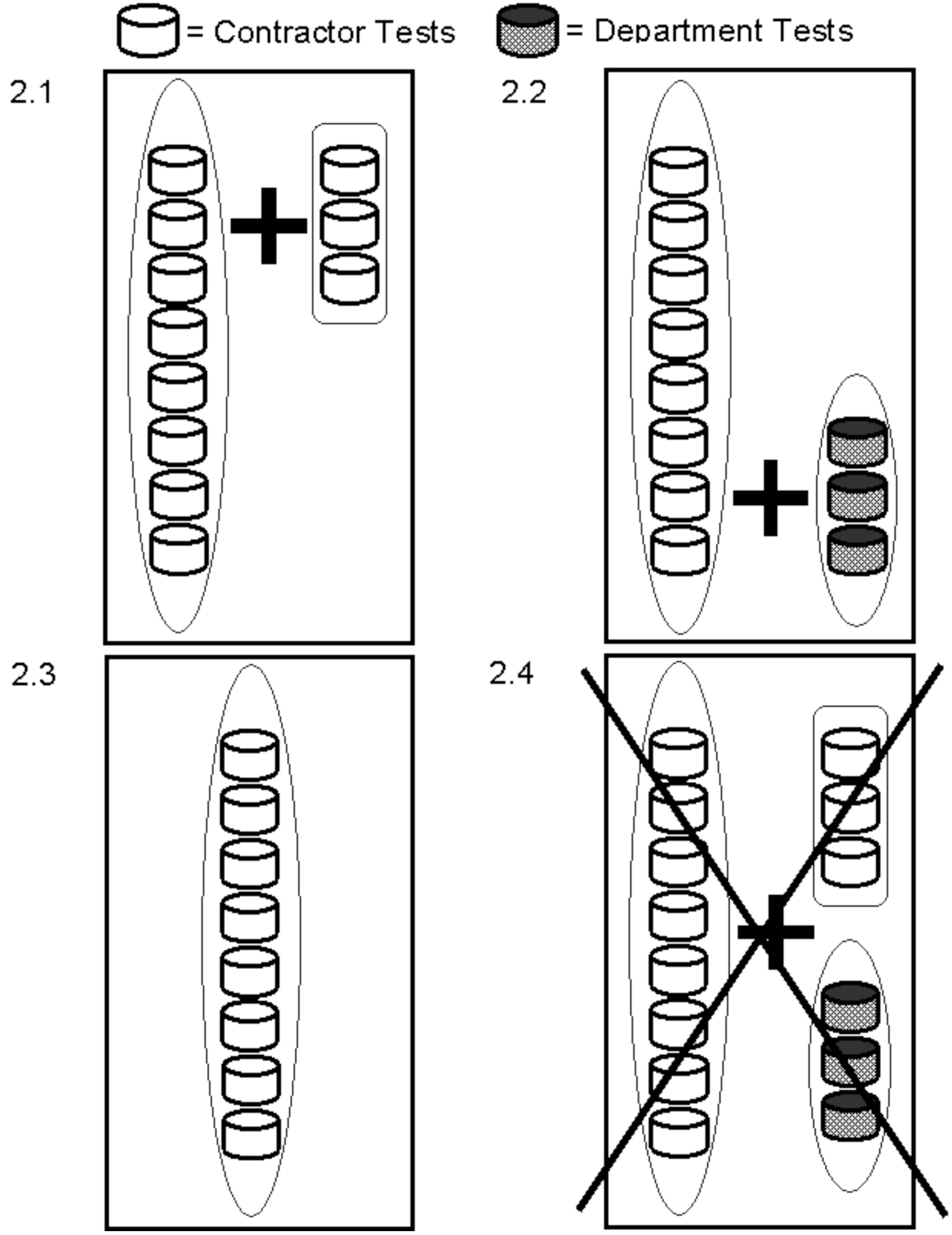


Figure 2 - Acceptance Based on Combined Test Results
(Using Sampling Plan in Figure 1)

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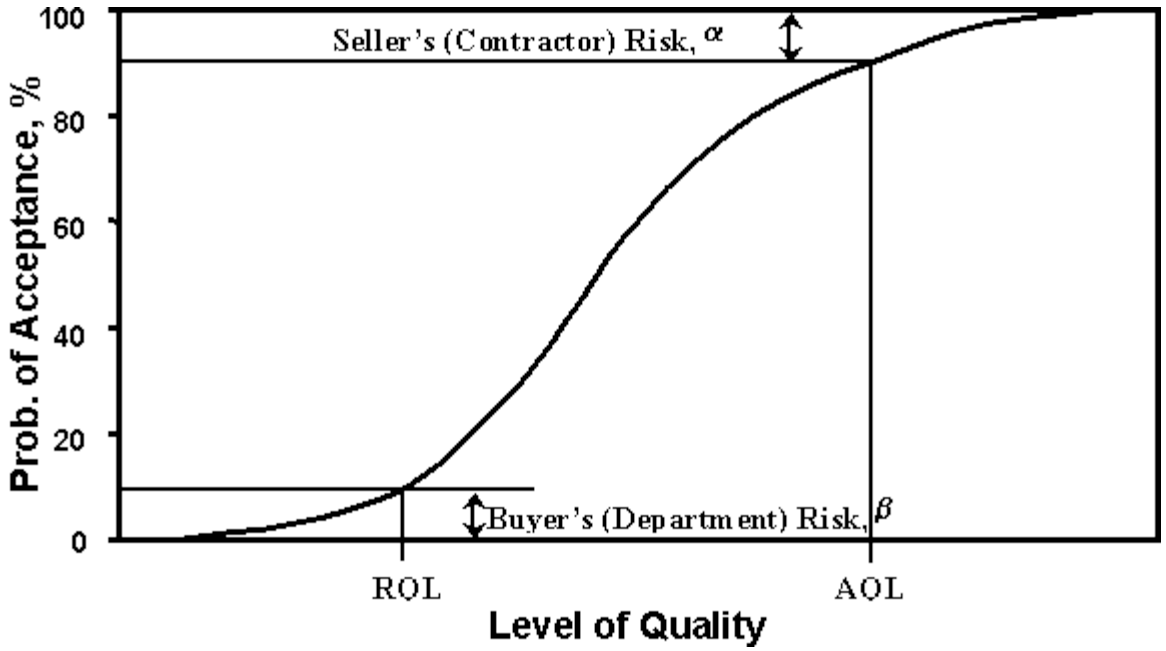


Figure 3 - Typical Operating Characteristic (OC) Curve for an Accept/Reject Acceptance

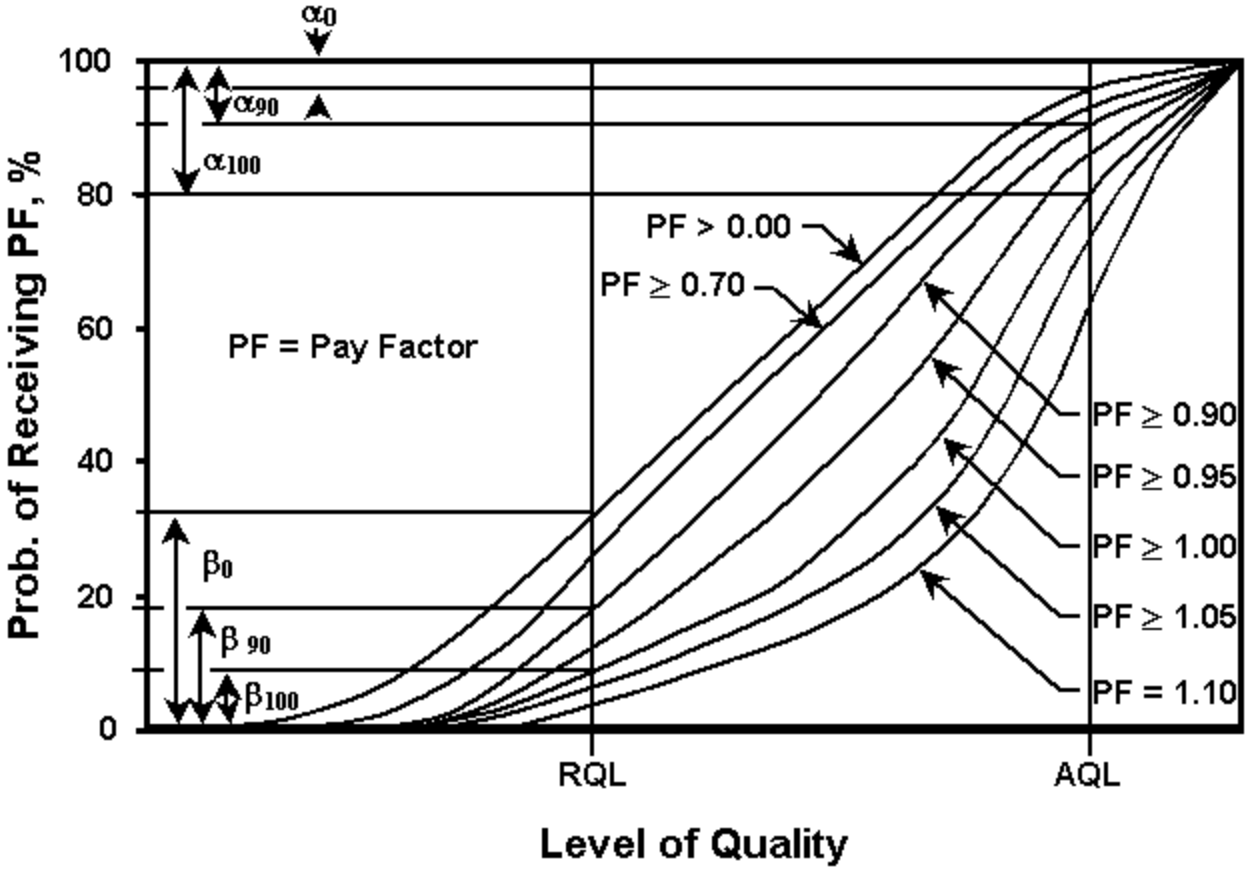


Figure 4 - Typical Operating Characteristic (OC) Curves for an Acceptance Plan with Pay Adjustments

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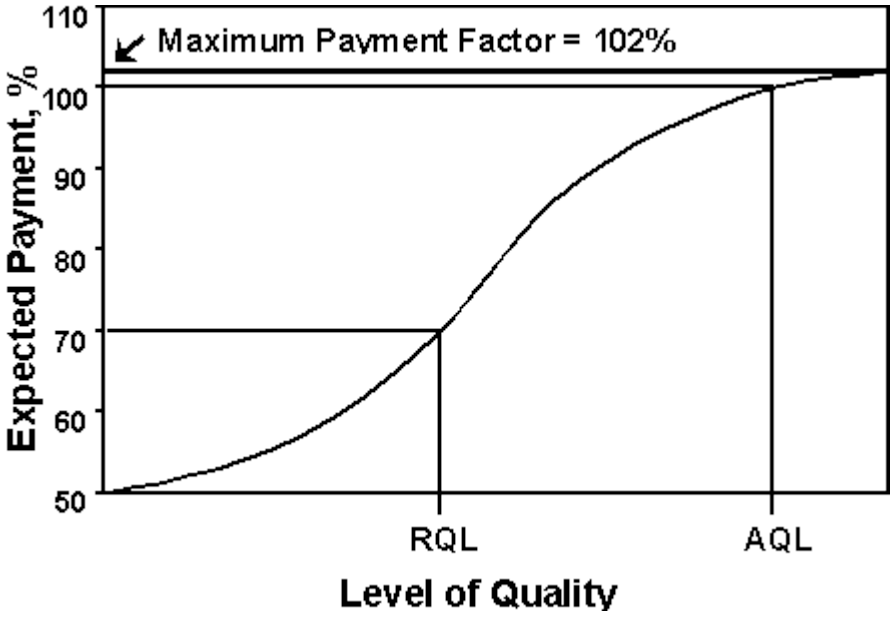


Figure 5 - Typical Expected Pay Curve

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Construction Quality Assurance for Design-Build Highway Projects

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INTRODUCTION

A majority of State transportation agencies use the design-build (DB) contracting method to deliver some transportation projects. Documented benefits of DB include faster project delivery, improved constructability, less cost growth, early cost certainty, and fewer claims.

One area of DB contracting that requires closer examination is construction quality assurance (QA). DB is believed to provide a level of project quality equal to design-bid-build (DBB), as outlined in the Federal Highway Administration's (FHWA) *Design-Build Effectiveness Study.*[(1)] However, a recent examination of State agency DB procurement packages showed that roles and responsibilities for construction quality are not clearly defined in many instances. The paper "Does Design-Build Project Delivery Affect the Future of the Public Engineer?" examined 60 DB requests for proposals (RFPs) and found 23 cases in which assignment of responsibilities for verification and acceptance could not be determined.[(2)] National Cooperative Highway Research Program (NCHRP) Synthesis 376, *Quality Assurance in Design-Build Projects*, states "With the changing quality roles found in the DB delivery method, it is imperative that quality responsibilities and the responsible parties are clearly stated in the contract documents." [(3)] However, on DB projects, there is no change in the core QA functions of contractor quality control (QC) and agency acceptance. The design-builder still has a responsibility for QC, as does the contractor with DBB projects. The agency must retain its responsibility for the acceptance function, as required by Title 23, Code of Federal Regulations, Part 637 (23 CFR 637).[(4)]

One of the attributes of the DB delivery method is the single source of responsibility for design and construction issues. When preparing the RFP and contract documents, owners must clearly define the responsibilities of the design-builder and the contracting agency. The agency performs verification tests for compliance with RFP requirements and makes progress payments under the terms of the contract. However, by doing so, the agency does not assume responsibility for any design or construction issue. The design-builder remains fully responsible for the design and the construction of the final product.

PURPOSE

The purpose of this TechBrief is to help clarify the roles, responsibilities, and activities related to construction QA on DB projects. The specific topics discussed include QA, QC, and acceptance. Related topics such as independent assurance (IA), dispute resolution, personnel qualification, laboratory qualification, and warranties are also discussed. Some RFP and contract documents for DB projects have incorrectly assigned responsibility for acceptance to the design-builder, which is not in accordance with 23 CFR 637. Additionally, because the DB

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project delivery method is often used on large, complex, fast-paced projects, it presents some unique challenges that merit discussion.

QUALITY ASSURANCE

The American Association of State Highway and Transportation Officials (AASHTO) defines *QA* as "(1) All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service; or (2) making sure the quality of a product is what it should be."(p. 14) [5]

Historically, agencies used the term QC/QA with QC referring to the contractor's role and QA to the agency's role. This term implied that QC and QA are separate functions; in fact, QA refers to the overall system for assuring project quality, with QC being one element of a comprehensive QA program. Therefore, the transportation industry has moved away from the term QC/QA and now uses QA.

Construction QA Programs

A construction QA program consists of the following core elements:

- Contractor QC.
- Agency acceptance.
- IA.
- Dispute resolution.
- Personnel qualification.
- Laboratory accreditation/qualification.

These core elements of QA apply regardless of the project delivery method. The agency's responsibility for acceptance cannot be assigned to the design-builder (or to a consultant under contract to the design-builder) but, rather, remains with the agency. Each of the six core elements of a construction QA program for DB is discussed below.

QUALITY CONTROL

FHWA's *Transportation Construction Quality Assurance Reference Manual* defines *QC* as "The system used by a contractor party to monitor, assess, and adjust their production or placement processes to ensure that the final product will meet the specified level of quality."(Section 2.3, p. 2–6) [6]

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Use of QC Test Data in Acceptance Determination

While the primary purpose of QC sampling and testing is to provide timely information for the design-builder to monitor and guide each production or placement process, QC data for critical quality characteristics may also be used in the final acceptance determination. If QC test data are to be included in the agency acceptance decision, the QC data must be validated by agency verification test results. Lot and sublot sizes, sampling and testing methods, and sampling locations should be specified for each critical quality characteristic that will be verified by the agency. This information can be included directly in the DB contract documents, or reference can be made to the agency's standard specifications or guide schedule of sampling/testing frequencies. Not all characteristics that are monitored by QC are required to be verified by the agency. Design-builders will often perform more than the minimum level of QC, including testing of material properties beyond those critical quality characteristics that will be used in the agency acceptance decision.

QC Organization

There are different approaches to QC organizational structure on DB projects. Some agencies specify that the design-builder must demonstrate, through lines of authority in the organizational chart, that QC personnel are allowed to operate independently of DB construction forces to ensure that decisions made as part of the QC process are not influenced by schedule or budget. Another approach used by some agencies (especially on large DB projects) requires the design-builder to employ an independent testing firm to conduct sampling and testing of those critical quality characteristics that will be verified by the agency as part of the acceptance decision while a separate QC team works in close coordination with the construction forces, performing sampling and testing to monitor and guide production and placement processes.

Regardless of the approach, it is important that the DB team member in charge of construction quality report to senior management of the design-builder. This will convey support for QC and minimize potential conflicts with the production staff. Senior management must realize that superior quality will not happen without the seamless interaction between the QC teams, production/placement teams, and administration. The DB contract should clearly identify requirements for the QC organization.

Use of Consultants to Perform QC

Consultant technicians and inspectors may be used to conduct QC inspection and testing on a DB project. However, responsibility for the acceptance function cannot be relinquished to the design-builder per the requirements of 23 CFR 637.207(b).[4] Use of a consultant firm hired by the design-builder for sampling, testing, and inspecting does not relieve the agency of its responsibility for verification testing.

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QC Documentation and Records

The agency should specify the minimum level of QC documentation that must be provided by the design-builder as well as the timeframe and format for providing the information. This typically includes all QC test results intended for inclusion in the agency acceptance decision. QC test results that are used strictly for process control may not need to be submitted but should be available for review by the agency as part of monitoring the design-builder's QC system.

Design-Builder Quality Management Plans

It is good practice to require the design-builder to provide a comprehensive quality management plan (QMP) that outlines the overall quality system for both design and construction of the project. The construction QC section of the QMP should describe all of the QC activities that will be conducted to assure that the completed items of work will meet the specified level of quality. If a QMP is required, the DB contract should specify the format and minimum content requirements as well as the procedure for agency review and acceptance of the QMP, including any updates and changes submitted by the design-builder following initial plan acceptance. During construction, the agency and the design-builder should monitor adherence to and effectiveness of the QMP. Any weaknesses discovered in the QC system should be corrected, including revisions to the QMP. Some agencies specify that failure by the design-builder to follow the QMP will result in actions such as suspension of work or withholding of payment.

ACCEPTANCE

FHWA-NHI-08-067 defines *acceptance* as "All factors used by the Agency (i.e., sampling, testing, and inspection) to evaluate the degree of compliance with contract requirements and to determine the corresponding value for a given product."(Section 2.3, p. 2–9) [6]

Agency Responsibility for Acceptance

According to 23 CFR 637.207(b), the agency's responsibility for acceptance does not change when using the DB delivery method. [4] While the design-builder is fully responsible for design, construction, and material selection, the agency is responsible for verifying RFP compliance and making progress payments by the acceptance of the work. As stated in FHWA-NHI-08-067, "All acceptance activities must be carried out by the agency or their designated agent (i.e., consultant under direct contract with the agency), independent of the contractor."(Section 2.3, p. 2–9) [6] This does not preclude the inclusion of design-builder QC data in the acceptance decision, provided that the QC data are validated by the agency's independently obtained verification data. It is important that the agency acceptance responsibilities be clearly defined in the DB contract documents.

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Verification Sampling and Testing

23 CFR 637 defines *verification sampling and testing* as "Sampling and testing performed to validate the quality of the product." [4]

The highway agency (or its designated agent) is responsible for conducting verification sampling and testing to provide an assessment of product quality that is completely independent of the design-builder's QC process. As required in 23 CFR 637, "The verification testing shall be performed on samples that are taken independently of the quality control samples." [4] Splits of design-builder QC samples cannot be used for verification.

Verification sampling and testing may be performed at a lower frequency than the design-builder's QC testing, particularly on DB projects where QC data are included in the acceptance determination. On some large DB projects, agencies have used frequencies of 1 verification test for every 10 or more QC tests. In order for mathematical validation procedures to be reliable, it is suggested that a minimum of 7–10 agency verification results be obtained and used to validate the design-builder's QC data.

It may be necessary to adjust the frequency of verification testing to reflect the estimated number of QC tests for each item of work. Rates of verification testing may also differ based on the risks involved. For example, verification testing may be more frequent for structural concrete than for embankment materials.

On some DB projects, it may be challenging to conduct verification testing at the specified rate due to the quantities of material being placed and the fast-paced nature of the work. In addition, because DB projects are typically bid as a single lump sum amount or using a small number of lump sum pay items, agency tracking of material quantities can be more difficult than on DBB projects that use standard unit price items. This can make it more difficult to schedule verification activities and determine random sample locations. Agencies should take this into consideration when determining staffing levels for DB projects so as to provide sufficient verification testing. The agency and design-builder must work cooperatively to find solutions to these issues because quality cannot be sacrificed due to large material quantities or fast-paced work.

Validation of QC Data

Agencies that have not included QC data in the acceptance decision on DBB projects may choose to do so on DB projects. As previously stated, if the design-builder's random QC test data are to be included in the acceptance decision, the QC data must be mathematically "validated" against the agency verification test results for each lot of material. By including validated QC data in the acceptance decision, the frequency of verification testing by the agency (or its designated agent) can be reduced.

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The DB contract documents should clearly outline the decision making process that will be used for validation of the QC data. It is important to specify the validation method (such as *F*- and *t*-tests), as well as actions that will be taken in the event that the design-builder QC test results are not validated by the agency verification results. There should be a well-defined process in place to resolve such an issue, including an investigation into the cause of the non-validation and increasing the rate of verification testing for the item. It is important to recognize that in some cases, even though the QC test data are not statistically validated, the material may be completely acceptable. In these cases, further investigation to determine the underlying cause of the non-validation is warranted. Also, it is necessary to specify the quality characteristics to which tests will be applied. Performing *F*- and *t*-tests on numerous quality characteristics for a particular material could make the analysis needlessly cumbersome. It is important that the agency identify the critical quality characteristics subject to the validation analysis for each material or work item.

Some materials, due to the small quantity being used, may not have a sufficient number of QC and verification tests to perform a statistical comparison. In these instances, use of an alternate method of acceptance may be necessary. To accept items requiring very few tests, it may be advisable to use only the agency's verification testing.

Quality Measures for Acceptance

Statistical quality measures used for acceptance, such as percent-within-limits (PWL), are well suited to DB projects, especially projects with work items having large quantities of materials. Agencies currently using PWL for work items on their DBB projects can easily incorporate it as the quality measure for the same items on DB projects. For agencies that do not use PWL, it may not be appropriate to utilize it on DB projects without first developing statistical specification limits that will provide a fair measure of quality. Statistical specification limits are typically developed by means of pilot projects completed over several years. Employing specification limits or procedures developed by another agency without proper evaluation could lead to unnecessary disputes.

The acceptable quality level (AQL) applied to each work item should be specified in the DB contract documents along with requirements for appropriate corrective action (rework or replacement) when the quality level is not met. The AQL can be set at different levels for different work items based on the risk associated with lower-quality material. Since most DB projects do not utilize unit price pay items, pay adjustments for material quality are often not applied. However, some agencies do apply pay adjustments either by including a typical unit price in the DB contract for the work item being evaluated or by requiring in the RFP that proposers submit a breakdown of work items with a unit price for each item subject to pay adjustment. When pay adjustment for quality is included in the DB contract, it is important that the agency monitor and measure material quantities. For work items not suited for PWL as the quality measure, such as items with small quantities, the agency's verification test results should be evaluated against engineering limits to determine acceptance.

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Inspection

Just as on DBB projects, visual inspection is a key part of agency acceptance on DB projects. Acceptance inspection must be performed by the agency or its designated agent, not the design-builder. "The State's acceptance program should provide a reasonable level of inspection to adequately assess the specific attributes which reflect the quality of the finished product. Acceptance inspection should include inspection of the component materials at the time of placement or installation, as well as the workmanship and quality of the finished product." (7)

INDEPENDENT ASSURANCE

23 CFR 637 defines *IA* as "Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program." (4)

The purpose of the IA system is to assure the reliability of all data used by the agency in the acceptance determination. This includes the agency's verification data and the design-builder's QC data when validated QC data are to be included in the final acceptance determination. IA is intended to confirm that the sampling and testing activities performed by the agency and the design-builder are conducted by qualified personnel using proper procedures and properly calibrated and functioning equipment. The results of IA testing should never be used to evaluate material quality.

The responsibility for IA lies with the agency. IA sampling and testing is performed by agency personnel (or by personnel of a designated agent directly contracted by the agency) that are independent of the project. IA personnel, whether employed by the agency or a designated agent, cannot perform both IA and acceptance activities. For agencies that do not routinely include QC test results in the acceptance determination, using this approach on DB projects may create new challenges for the IA system. The design-builder may not be familiar with IA requirements. The need for the design-builder QC staff to cooperate with IA personnel should be clearly stated in the DB contract. Scheduling IA activities to obtain the required level of IA evaluations is often a challenge, and keeping track of ongoing QC and verification activities and personnel on large DB projects can magnify this problem. Using the system approach to IA is an effective strategy for DB projects, since IA frequency is based on covering all active testers and equipment over a period of time, independent of the number of QC and verification tests completed on a project.

It is important that all parties involved be aware of the role that IA plays in the overall QA program and work cooperatively to assure that IA staff is kept informed of project testing schedules and personnel. Some agencies include language in the DB contract requiring the design-builder to provide the agency's project staff with updated schedules and lists of QC personnel for upcoming QC sampling and testing so that IA activities can be scheduled.

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DISPUTE RESOLUTION

If QC testing data will be included in the acceptance determination, agencies are required under 23 CFR 637 to have a dispute resolution system in place to resolve possible discrepancies between the design-builder's QC data and the agency's acceptance data. [4] While not required on projects where agency verification results will be used exclusively to determine acceptance, a dispute resolution system is highly recommended.

The dispute resolution process should be unbiased and timely. To address testing-related disputes, use of retained splits of samples used in the acceptance decision, alternate or third party laboratories, and a well-defined decision process to determine the outcome of the dispute are advisable. When retained splits are used, it is important that the dispute resolution split samples are properly labeled and that either the agency takes immediate possession of the dispute resolution split or proper sample security techniques, such as tamper-proof containers or security seals, are used.

PERSONNEL QUALIFICATION

All personnel performing sampling and testing for QC used in the acceptance decision, verification, or IA are required to be qualified, per 23 CFR 637.209. [4] Agencies participate in State, regional, or national technician qualification or certification programs to ensure that technicians and inspectors are properly qualified. The DB contract documents should specify the minimum qualifications for DB personnel performing QC sampling, testing, and inspection. Minimum qualifications for the design-builder's quality management personnel should also be clearly stated to ensure they have a thorough understanding of QA principles and experience working under QA specifications.

LABORATORY QUALIFICATION

Any laboratory used by the agency (or its designated agent) to perform verification testing and all design-builder laboratories that perform QC testing included in the acceptance decision must be qualified, as outlined in 23 CFR 637.209.[4] Laboratories that conduct QC testing only for process control are not covered by the regulation, but some agencies require these laboratories to meet a minimum standard such as approval by the agency or a certification organization. Laboratories operated by a designated agent of the agency that are used for IA or dispute resolution must be accredited by AASHTO, through a comparable program approved by FHWA, or by an accreditation body approved by the National Cooperation for Laboratory Accreditation.[8]

NON-CONFORMING MATERIALS AND WORKMANSHIP

The DB contract should describe the process for documentation and disposition of non-conforming work. Whether discovered by the design-builder or the agency, materials or

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workmanship that do not meet the specified level of quality should be properly documented, including the nature of the non-conformance, location, extent, and disposition (e.g., removed and replaced, reworked, accepted based on engineering judgment, etc.). The authority to approve the final disposition of non-conforming materials or workmanship cannot be assigned to the design-builder. The agency's role in approving the disposition of non-conforming work should be clearly identified in the contract.

WARRANTIES

Some DB contracts include warranty provisions for some items of work. Contract language should specify the warranty period and the enforcement process, including a detailed description of the measures that will be used to determine warranty compliance. These measures are typically maximum levels of various distress types that, when exceeded during the warranty period, require correction by the design-builder. Some warranty provisions also include specific corrective action for each distress type. The inspection procedure for determining warranty compliance should be clearly outlined and include provisions for notification so that a design-builder representative can observe the warranty inspections. A process for dispute of warranty inspection findings should also be included. Use of warranty provisions does not remove the need for an effective design-builder QC system; on projects where the warranty does not provide coverage for the anticipated life of the warranted product, some level of agency acceptance is still required. The requirements for warranties on DB projects are covered under 23 CFR 635.413.[9]

SUMMARY

The DB project delivery system offers several documented benefits over the traditional DBB method on certain projects. While DB offers the design-builder more control over design, materials, and construction methods than DBB, the agency still has an important role in assuring quality. As agencies develop DB procurement documents, it is important that roles and responsibilities for design-builder QC and agency acceptance be clearly defined. The responsibility for acceptance by the agency (or their designated agent) is applicable regardless of the project delivery method used.

DB is often used on large, fast-paced projects, which can create challenges for conducting QA activities. Coordination and communication between the design-builder and the agency is essential for effective quality management. By working together within a well-defined QA program, the agency and design-builder can meet the goal of delivering a high quality project to the travelling public.

FURTHER INFORMATION

The following resources provide further information on this topic:

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- National Highway Institute Course 134064, "Transportation Construction Quality Assurance".

- Office of Pavement Technology. (2012). *Independent Assurance Programs*, TechBrief, Publication No. FHWA-HIF-12-001, Federal Highway Administration, Washington, DC.

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3. Gransberg, D., Datin, J., and Molenaar, K. (2008). *NCHRP Synthesis 376: Quality Assurance in Design-Build Projects*, Transportation Research Board, Washington, DC.

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5. American Association of State Highway and Transportation Officials. (2006). *Standard Recommended Practice for Definition of Terms Related to Quality and Statistics As Used in Highway Construction*, Washington, DC.

6. Federal Highway Administration. (2008). *Transportation Construction Quality Assurance Reference Manual*, Report No. FHWA-NHI-08-067, Arlington, VA.

7. Federal Highway Administration. (2006). "Non-Regulatory Supplement for 23 CFR Part 637, Subpart B." Accessed online: March 20, 2012. (https://www.fhwa.dot.gov/pavement/0637bsup.cfm)

8. Federal Highway Administration. (2011). "Non-Regulatory Guidance on Approval of Comparable Accreditation Bodies." Accessed online: March 20, 2012. (https://www.fhwa.dot.gov/pavement/materials/111007.cfm)

9. *Construction and Maintenance*, Code of Federal Regulations, Title 23, Part 635, U.S. Government Printing Office, Washington, DC.

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the FHWA Quality Assurance Team: Michael Rafalowski (Office of Pavement Technology) at michael.rafalowski@dot.gov and Dennis Dvorak (Pavement and Materials Technical Service Team) at dennis.dvorak@dot.gov.

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Appendix B

Abbreviations and Definitions

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADOT	Arizona Department of Transportation
ASTM	American Society for Testing and Materials
ATTI	Arizona Technical Testing Institute
CCRL	Cement and Concrete Reference Laboratory
CFR	Code of Federal Regulations
CIQM	Construction Independent Quality Manager
CQMP	Construction Quality Management Plan
FHWA	Federal Highway Administration
FMS	Freeway Management System
IA	Independent Assurance
IMSA	International Municipal Signal Association
IQF	Independent Quality Firm
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
OV	Owner Verification
OVTIP	Owner Verification Testing and Inspection Plan
PCI	Precast Concrete Institute
PPD	Practice and Procedure Directive
QA	Quality Acceptance
QAP	Quality Assurance Program
QC	Quality Control

Acceptance Program means all factors that comprise ADOT's determination of the quality of the Work as specified in the Contract Documents. These factors include QA and OV sampling, testing, and inspection.

ADOT means the Arizona Department of Transportation, a public agency as constituted under the laws of the State of Arizona.

ADOT Standard Specifications means the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction, adopted by the Arizona State Transportation Board, including all revisions thereto applicable on the setting date.

Contract Documents means contract between ADOT and Contractor, including all exhibits attached hereto, as such contract or any such exhibits may be amended, supplemented, restated or otherwise modified, from time to time, and the executed originals of exhibits that are contracts.

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Contractor means the individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, contracting with ADOT for performance of the Work.

Construction Independent Quality Manager means the individual appointed by the IQF who is responsible for management of construction Quality Acceptance functions, as more particularly described the Program and the Contract Documents.

Construction Quality Management Plan means the plan that establishes QC and QA procedures for the Work as more particularly described in the Contract Documents.

Element means (a) a discrete portion of the Project (e.g., a sign) or (b) a discrete condition to be inspected and measured as set forth in the Contract Documents.

Engineering Judgment means accepting any testing result or Work that does not adhere to the Contract Documents.

Guide Schedule means the Project specific sampling and testing guide schedule from the CQMP. This Project specific guide schedule is the required acceptance sampling and testing parameters as defined in this Program and the Contract Documents. The minimum sampling guide schedule is defined in Appendix D of this Program.

Independent Assurance means activities that are an unbiased and independent evaluation of all the sampling and testing (or inspection) procedures used in the Acceptance Program. The results of IA testing or inspection are not to be used as a basis of acceptance.

Independent Quality Firm means the independent firm identified in the Proposal (or such other firm approved by ADOT in ADOT's sole discretion) responsible for performing independent quality assurance material testing, inspection, and audits of the Construction Work and the Construction Quality Management Plan.

Material Code means each combination of material code and type code listed in Appendix E

Nonconformance Report is a defined resolution process for addressing any and all Nonconforming Work, as well as any meaning set forth in the Contract Documents.

Nonconforming Work means Work that does not conform to the requirements of the Contract Documents, any governmental approvals, any applicable law, or the released-for-construction drawings.

Owner Verification means inspection, sampling and testing performed by ADOT or ADOT's representatives to verify that the Project is constructed and accepted in compliance with the Contract Documents.

Owner Verification Firm means the firm hired by ADOT to perform OV.

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Owner Verification Testing and Inspection Plan means project specific planned processes for performing OV per this Program and the Contract Documents.

Professional Engineer means a person who has been granted registration in one or more branches of engineering by the Arizona State Board of Technical Registration, and is authorized to practice professionally in the State of Arizona. If a branch of engineering is included in the title, such as Professional Civil Engineer, registration in that branch shall be required.

Project means facilities and all related structures, improvements and system to be developed, design, constructed, operated and maintained, or any of the foregoing, pursuant to the terms of the Contract Documents.

Program means the ADOT Quality Assurance Program - Projects Utilizing Contractor Performed Acceptance.

Quality Acceptance means all planned and systematic processes and actions performed by the IQF, as defined in the Contract Documents, for their portion of the Acceptance Program.

Quality Assurance Program means the FHWA required quality assurance program.

Quality Control means processes undertaken by the Contractor to produce Work compliant with the Contract Documents. Quality Control efforts are not part of the Acceptance Program.

Sole Discretion has the same meaning as set forth in the Contract Documents. If there is not a definition listed elsewhere in the Contract Documents, Sole Discretion means the right and power to decide a matter, which right may be exercised arbitrarily at any time and from time to time.

Work means all of the work required under the Contract Documents, including all administrative, design, engineering, right of way acquisition, support services, utility adjustment Work to be furnished or provided by the Contractor, procurement, professional, manufacturing, supply, installation, construction, supervision, management, testing, verification, labor, materials, equipment, maintenance, documentation, and other duties and services to be furnished and provided by the Contractor as required by the Contract Documents, including all efforts necessary or appropriate to achieve final acceptance, except for those efforts that the Contract Documents expressly specify will be performed by persons other than the Contractor.

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Appendix C

Split Sample Tolerances

INDEPENDENT ASSURANCE AND CORRELATION TESTING ALLOWABLE VARIATIONS (±)
(See Notes 1 and 2 below.)

PORTLAND CEMENT CONCRETE	
TEST	SAMPLE RESULT vs. SPLIT RESULT (See Note 3 below.)
Coarse Aggregate Gradation:	
+1"	4
1"	4
3/4"	4
1/2"	4
3/8"	4
1/4"	4
No. 4	4
No. 8	4
Fine Aggregate Gradation:	
No. 4	4
No. 16	3
No. 50	3
No. 100	3
No. 200	1.5
28-Day Compressive Strength: (Class P, S, and B) (See Note 4 below.)	15% of the mix design strength

BITUMINOUS MIXTURES	
TEST	SAMPLE RESULT vs. SPLIT RESULT (See Note 3 below.)
Mineral Aggregate Gradation:	
+3/4"	4
3/4"	4
1/2"	4
3/8"	4
No. 4	4
No. 8	4
No. 30	2
No. 40	2
No. 200	1.0
Percent Asphalt	0.4
Bulk Density, pounds/cu. ft.	2.0
Rice Density, pounds/cu. ft.	2.0
Voids, percent	1.5
Marshall Stability, pounds	1200

SOILS AND AGGREGATES	
TEST	SAMPLE RESULT vs. SPLIT RESULT (See Note 3 below.)
Gradation, except for Portland Cement Concrete and Bituminous Mixtures:	
+1"	4
1"	4
3/4"	4
1/2"	4
3/8"	4
1/4"	4
No. 4	4
No. 8	4
No. 16	4
No. 40	3
No. 200	1.5
Sand Equivalent	6
Flakiness Index	3
Uncompacted Void Content	1.0
pH	0.4
Optimum Moisture, percent	2.0
Proctor Density, pounds/cu. ft.	4.0
Fractured Coarse Aggregate Particles (See Note 5 below.)	15% of the mean of the results
Plasticity Index: (See Note 5 below.)	
Liquid Limit (LL)	13% of the mean of the results
Plastic Limit (PL)	18% of the mean of the results

Note 1: Use applicable test characteristics specified for material being tested.
Note 2: Regional Materials Engineer to determine allowable variations for test characteristics not shown.
Note 3: Allowable variations apply for both independent assurance testing and correlation testing comparisons.
Note 4: Allowable variations based on a percentage of the mix design strength shall be rounded if necessary to the nearest whole number.
Note 5: Allowable variations based on a percentage of the mean of the results shall be rounded if necessary to the nearest whole number.

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Appendix D

Independent Quality Firm Minimum Sampling Guide Schedule

The minimum acceptance sampling and testing requirements are listed in the tables contained in this appendix.

Index of Materials Listed in Tables 1 through 8

Table 1	Soils
Table 2	Aggregates
Table 3	Bituminous Materials
Table 4	Portland Cement Concrete
Table 5	Materials Used With Portland Cement Concrete
Table 6	Stabilized Soils and Bases
Table 7	Bituminous Mixtures
Table 8	Miscellaneous Materials

Some tables are larger than a single page.

Within these tables, some rows and / or columns extend onto the following page. If an individual row or column is blank, see the corresponding row or column directly above, on the previous page.

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INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Admixtures for Portland Cement Concrete
Aggregate for Arrestor Bed
Aggregate for Cement Stabilized Alluvium
Aggregate for Cement Treated Base
Aggregate for Lean Concrete Base
Aggregate for Soil-Cement Bank Protection
Aggregate Base
Aggregate Subbase
Asphalt Cement (PG XX-XX)
Asphalt Cement (PG XX-XX) for Asphalt-Rubber
Asphaltic Concrete (Asphalt-Rubber) [AR-AC]
Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]
Asphaltic Concrete - End Product
Asphaltic Concrete (End Product) SHRP Volumetric Mix
Asphaltic Concrete Friction Course (ACFC)
Asphaltic Concrete Friction Course (Asphalt-Rubber) [AR-ACFC]
Asphaltic Concrete Friction Course (ACFC) - Miscellaneous
Asphaltic Concrete - Miscellaneous Paving
Asphaltic Concrete (Miscellaneous Structural)
Asphaltic Concrete (Miscellaneous Structural - Special Mix)
Asphalt-Rubber (CRA)
Bank Protection Fabric
Barbed Wire
Barbless Wire
Bearing Pads
Bedding Material for Pipe
Bedding Material for Polyvinyl Chloride (PVC) Irrigation Pipe
Bituminous Treated Base
Blotter Material
Borrow
Brick for Manholes
Cement Stabilized Alluvium
Cement Treated Base
Cement Treated Subgrade
Chain Link Fabric
Cinder Block
Coarse Aggregate for Portland Cement Concrete (PCC)
Cover Material
Crash Barrel Sand
Crumb Rubber for Asphalt-Rubber
Curing Compound
Decomposed Granite
Dual Component Pavement Markings
Embankment

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INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Emulsified Asphalt
Emulsified Asphalt Special Type
Emulsified Asphalt for Cold Recycled Asphaltic Concrete
Emulsified Recycling Agent (ERA)
Fence Hardware, Miscellaneous
Fence Post and Rails
Fence Stays
Filter Material for Perforated Pipe
Fine Aggregate for Portland Cement Concrete (PCC)
Fly Ash and Natural Pozzolan
Geocomposite Edge Drain System
Geocomposite Wall Drain System
Geogrid
Geomembrane
Geosynthetics
Glass Beads
Granite Mulch
Guardrail Elements
Guardrail Fasteners
Guardrail Posts and Blocks
High Strength Bolts, Nuts, Washers, or Anchor Bolts
Hydrated Lime (for use as mineral admixture in asphaltic concrete mixes)
Hydraulic Cement
Hydraulic Cement (for use in soil stabilization, mortar, and grout)
Joint Materials
Lean Concrete Base
Lime (for use in soil stabilization, mortar, and grout)
Lime Treated Subgrade
Liquid Asphalt [Cutback Asphalt - (Medium Curing Type)]
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) [AR-AC]
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) – End Product [AR-AC]
Mineral Aggregate for Asphaltic Concrete - End Product [without reclaimed asphaltic pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete – End Product [with reclaimed asphaltic pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix [without reclaimed asphalt pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix [without reclaimed asphalt pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC)
Mineral Aggregate for Asphaltic Concrete Friction Course (Asphalt-Rubber) [AR-ACFC]
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC) - Miscellaneous
Mineral Aggregate for Asphaltic Concrete - Miscellaneous Paving
Mineral Aggregate for Asphaltic Concrete (Miscellaneous Structural)
Mineral Aggregate for Asphaltic Concrete (Miscellaneous Structural – Special Mix)
Mineral Aggregate for Micro-Surfacing

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INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Natural Ground
Paint
Pavement Fabric
Paving Brick
Permanent Pavement Markings (Painted)
Pipe Backfill
Pipe, Corrugated Metal (CMP) [Coated or Non-coated]
Pipe, Non-Reinforced Cast-in-Place Concrete
Pipe, Polyvinyl Chloride (PVC) for Electrical Conduit
Pipe, Polyvinyl Chloride (PVC) for Water
Pipe, Precast Reinforced or Non-Reinforced Concrete
Pipe, Vitrified Clay
Plating Material for Pipe Ends
Portland Cement and Blended Hydraulic Cement (for use as mineral admixture in asphaltic concrete mixes)
Portland Cement Concrete (PCC) (Class P)
Portland Cement Concrete (PCC) (Class S) (with a compressive strength requirement less than 4,000 psi)
Portland Cement Concrete (PCC) (Class S) (with a compressive strength requirement equal to or greater than 4,000 psi)
Portland Cement Concrete (PCC) (Class B)
Portland Cement Structural Concrete for Minor Precast Structures
Post Clips and Hog Rings
Post-Tensioning Steel
Preformed Plastic Pavement Marking
Prestressed Concrete
Prestressing Steel
Raised Pavement Markers
Recycling Agent
Reinforcement Bars
Retroreflective Sheeting
Rock
Shotcrete
Sign Panel Silk-Screened Characters
Silica Fume
Slump Block
Soil for Shoulder Build-up
Soil-Cement Bank Protection
Separation Geotextile Fabric
Structure Backfill
Subgrade
T-Post
Thermoplastic Pavement Markings
Tie Wire and Tension Wire
Top Soil
Trench Backfill

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INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Utility Concrete
Water
Welded Wire Fabric (Smooth)
Welded Wire Fabric (Deformed)
Wire Rope
Woven Wire Fabric

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TABLE 1
ACCEPTANCE SAMPLING GUIDE FOR SOILS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203	Borrow (within 3 ft. of finished subgrade elevation)	Gradation [1] PI [1]	In-Place	One per 1500 ft.
203	Embankment	Proctor Density Optimum Moisture	In-Place	One per soil type, and as needed.
		Compaction	In-Place	One per 1500 ft. per lift.
	Embankment for Metal Pile Location only	pH Resistivity	In-Place or Source	One per source.
203	Natural Ground for Embankment 5 ft. or less in height	Proctor Density Optimum Moisture	In-Place	One per soil type, and as needed.
		Compaction	In-Place	One per 1500 ft.

[1] Independent Assurance Sampling and Testing required.

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TABLE 1 (continued)
ACCEPTANCE SAMPLING GUIDE FOR SOILS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203	Subgrade	Proctor Density Optimum Moisture	Roadway	One per soil type, and as needed.
		Compaction	Roadway	One per 1500 ft.
		Gradation [1]	Roadway	One per 1500 ft. or change in material.
		PI [1]		
203	Soil for Shoulder Build-up	Gradation	In-Place or Source	One per soil type.
		PI		
		pH		
		Soluble Salts		
		Compaction	In-Place	One per 1500 ft. or as directed by the Engineer.
501	Trench Backfill	Proctor Density Optimum Moisture	In-Place	One per soil type, and as needed.
		Compaction	In-Place	One per 100 CY.

[1] Independent Assurance Sampling and Testing required.

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TABLE 1 (continued)
ACCEPTANCE SAMPLING GUIDE FOR SOILS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
803	Granite Mulch or Decomposed Granite	Gradation	In-Place or Source	One per 10,000 CY.
804	Top Soil	Gradation [(1)]	In-place	Written soil analysis per source and six samples per lot [a lot is considered approximately 20,000 CY per source].
		PI [(1)]		
		pH [(1)]		
		Soluble Salts		
		Calcium Carbonate		
		Exchange-able Sodium in percent and parts per million		

[(1)] Independent Assurance Sampling and Testing required.

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TABLE 2
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203 501 (When Contractor Quality Control **is not** a bid item.)	Structure Backfill or Pipe Backfill	Proctor Density Optimum Moisture	Stockpile	One per source, and as needed.
		Compaction	In-Place	One per 75 CY.
		Resistivity(1)	Source or Stockpile	One per source.
		pH(1)		
		Gradation (1)	On Job Site	One per 500 CY per source.
		PI (1)		
203 501 (When Contractor Quality Control **is** a bid item.)	Structure Backfill or Pipe Backfill	Proctor Density Optimum Moisture	Stockpile	One per source, and as needed.
		Compaction	In-Place	One per 100 CY.
		Resistivity(1)	Source or Stockpile	One per source.
		pH(1)		
		Gradation (1)	On Job Site	One per 1500 CY per source.
		PI (1)		

(1) Independent Assurance Sampling and Testing required.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **<u>is not</u>** a bid item.)	Aggregate Base Class 1, Class 2, and Class 3	Abrasion [2]	Source	One per source.
		Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
		Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **is** a bid item.)	Aggregate Base Class 1, Class 2, and Class 3	Abrasion [2]	Source	One per source.
		Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1500 ft.
		Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **is not** a bid item.)	Aggregate Subbase Class 4, Class 5, and Class 6	Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
	Class 4	Fractured Coarse Aggregate Particles (1)	Stockpile	One per 10,000 tons.
		Gradation (1)	Windrow	One per 2000 tons, minimum one per shift.
		PI (1)		
		Abrasion (2)	Source	One per source.
	Class 5 and Class 6	Gradation (1)	Windrow	One per 2000 tons, minimum one per shift.
		PI (1)		

(1) Independent Assurance Sampling and Testing required.

(2) Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **is** a bid item.)	Aggregate Subbase Class 4, Class 5, and Class 6	Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1500 ft.
	Class 4	Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		
		Abrasion [2]	Source	One per source.
	Class 5 and Class 6	Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
304 305	Aggregate for Cement Treated Base or Lean Concrete Base	Gradation [1]	Stockpile	One per 2000 tons, minimum one per shift.
		Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Abrasion [2]	Source	One per source.
	for Cement Treated Base	PI [1]	Stockpile	One per 2000 tons, minimum one per shift.
	for Lean Concrete Base	Sand Equivalent [1]	Stockpile	One every other day of Lean Concrete Base production.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
404	Cover Material	Abrasion [2]	Source or Stockpile	One per source.
		Bulk O.D. Specific Gravity	Stockpile	One per source.
		Percent Carbonates		
		Dry Unit Weight		
		Fractured Coarse Aggregate Particles	Stockpile	One per 600 tons.
		Flakiness Index		
		Gradation [1]	Final Stockpile	One per 300 tons.
		Moisture Content	Trucks at Scale	One per 300 tons.
404 412 413 415	Blotter Material	Gradation [1]	Final Stockpile	One per stockpile.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Mineral Aggregate for Micro-Surfacing	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates	Stockpile	One per source.
		Gradation [1]	Final Stockpile	One prior to start of Micro-Surfacing production, and one per 300 tons
		Sand Equivalent	Stockpile	One prior to start of Micro-Surfacing production, and one per 600 tons
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content		
		Moisture Content	Trucks at Scale	One per 300 tons.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
407	Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates		
		Specific Gravity		
		Gradation	Cold Feed	One prior to the start of ACFC production.
		Sand Equivalent [1]	Cold Feed or Stockpile	One prior to the start of ACFC production and one per each two days of ACFC production, minimum of two per project.
		Flakiness Index [1]		
		Fractured Coarse Aggregate Particles [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation [1]	Cold Feed or Hot Bins	One per 500 tons of ACFC production, minimum of one per shift.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
409	Mineral Aggregate For Asphaltic Concrete (Miscellaneous Structural) [For Special Mix, see below.]	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One per source.
		Fractured Coarse Aggregate Particles		
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of asphaltic concrete production.
		Gradation	Cold Feed or Hot Bins	At discretion of the Engineer.
409	Mineral Aggregate for Asphaltic Concrete (Miscellaneous Structural – Special Mix)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent [1]	Stockpile	One per source.
		Uncompacted Void Content [1]	Stockpile	One prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles [1]	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of asphaltic concrete production.
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (Miscellaneous Structural - Special Mix) on Page 45.)	

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
411	Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC) - Miscellaneous	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates		
		Sand Equivalent	Stockpile	One per source.
		Flakiness Index		
		Fractured Coarse Aggregate Particles		
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of ACFC production.
		Gradation	Cold Feed or Hot Bins	At the discretion of the Engineer.
413	Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) [AR-AC]	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Specific Gravity	Stockpile	One per source.
		Gradation	Cold Feed	One prior to the start of AR-AC production.
		Sand Equivalent [1]	Cold Feed or Stockpile	One prior to the start of AR-AC production and one per each two days of AR-AC production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of AR-AC production.
		Gradation [1]	Cold Feed or Hot Bins	One per 500 tons of AR-AC production, minimum of one per shift.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
414	Mineral Aggregate for Asphaltic Concrete Friction Course (Asphalt-Rubber) [AR-ACFC]	Abrasion [2]	Source or Stockpile	One per source.
		Specific Gravity	Stockpile	One per source.
		Percent Carbonates		
		Gradation	Cold Feed	One prior to the start of AR-ACFC production.
		Sand Equivalent [1]	Cold Feed or Stockpile	One prior to the start of AR-ACFC production and one per each two days of AR-ACFC production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Flakiness Index [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation [1]	Cold Feed or Hot Bins	One per 500 tons of AR-ACFC production, minimum of one per shift.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
415	Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One at least five working days prior to start of AR-AC production.
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content		
		Ignition Furnace Calibration		
		Sand Equivalent [1]	Cold Feed or Stockpile	One per each two days of AR-AC production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Uncompacted Void Content [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (Asphalt-Rubber) - End Product on Page 46.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
416	Mineral Aggregate for Asphaltic Concrete - End Product **[without reclaimed asphalt pavement (RAP)]** (See Page 18 for mixes with RAP.)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content **(Special Mix only)**		
		Ignition Furnace Calibration		
		Sand Equivalent [1]	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Uncompacted Void Content [1] **(Special Mix only)**		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete - End Product on Page 47.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
416	Mineral Aggregate for Asphaltic Concrete - End Product **[with reclaimed asphalt pavement (RAP)]** See PPD [3]. (See Page 17 for mixes without RAP.)	Abrasion [2] (Virgin Agg. and RAP Agg. separately)	Source or Stockpile	One per source.
		Percent Carbonates (if required) (Composite of Virgin Agg. and RAP Agg.)		
		Sand Equivalent (Virgin Agg. only)	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles (Composite of Virgin Agg. and RAP Agg.)		
		Uncompacted Void Content **(Special Mix only)** (Virgin Agg. only)		
		Ignition Furnace Calibration (Virgin Agg., RAP Agg., and RAP material)		
		Gradation, Binder Content [1], and Moisture Content of RAP material	Individual stockpiles (belt cut may be used for single stockpile)	One per each lot of asphaltic concrete production.
		Sand Equivalent [1] (Virgin Agg. only)	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.

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		Fractured Coarse Aggregate Particles [1] (Composite of Virgin Agg. and RAP Agg. obtained from Arizona Test Method 428)		
		Uncompacted Void Content [1] **(Special Mix only)** (Virgin Agg. only)		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete - End Product on Page 47.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
417	Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix **[without reclaimed asphalt pavement (RAP)]** (See Page 20 for mixes with RAP.)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content		
		Ignition Furnace Calibration		
		Sand Equivalent [1]	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Uncompacted Void Content [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (End Product) SHRP Volumetric Mix on Page 48.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
417	Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix **[with reclaimed asphalt pavement (RAP)]** See PPD [3]. (See Page 19 for mixes without RAP.)	Abrasion [2] (Virgin Agg. and RAP Agg. separately)	Source or Stockpile	One per source.
		Percent Carbonates (if required) (Composite of Virgin Agg. and RAP Agg.)		
		Sand Equivalent (Virgin Agg. only)	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles (Composite of Virgin Agg. and RAP Agg.)		
		Uncompacted Void Content (Virgin Agg. only)		
		Ignition Furnace Calibration (Virgin Agg., RAP Agg., and RAP material)		
		Gradation, Binder Content [1], and Moisture Content of RAP material	Individual stockpiles (belt cut may be used for single stockpile)	One per each lot of asphaltic concrete production.
		Sand Equivalent [1] (Virgin Agg. only)	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.

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		Fractured Coarse Aggregate Particles [1] (Composite of Virgin Agg. and RAP Agg. obtained from Arizona Test Method 428)		
		Uncompacted Void Content [1] (Virgin Agg. only)		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (End Product) SHRP Volumetric Mix on Page 48.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Mineral Aggregate for Asphaltic Concrete - Miscellaneous Paving	Abrasion [2]	Source or Stockpile	One per source.
		Sand Equivalent	Stockpile	One per source.
		Gradation	Cold Feed or Hot Bins	At discretion of the Engineer.
501	Bedding Material for Pipe	Gradation [1]	Source or Stockpile	One per 300 CY per source.
		PI [1]		
		pH [1]		One per source.
		Resistivity [1]		
		Proctor Density	Source or Stockpile	One per source, and as needed.
		Optimum Moisture		
		Compaction	In-Place	One every 50 CY.
501	Filter Material for Perforated Pipe	Gradation [1]	Source or Stockpile	One per 300 CY per source.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
501	Plating Material for Pipe Ends	Gradation	Source or Stockpile	One per source, and as needed.
		PI		
		Proctor Density		
		Optimum Moisture		
		Compaction	In-Place	One every 50 CY.
702	Crash Barrel Sand	Gradation	Plant or Site	One per each attenuator system location.
		Dry Unit Weight per cubic foot		
		Moisture Content		
	Sand and Rock Salt Mixture (when Sand Barrel Crash Cushions are installed at elevations above 3,000 feet)	Percent Rock Salt		
808	Bedding Material for Polyvinyl Chloride (PVC) Irrigation Pipe	Gradation	Source or Stockpile	One per source.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
913	Rock for Wire Tied Riprap, Gabions, Riprap (Slope Mattress), and Rail Bank Protection	Specific Gravity	Source	One per source.
		Gradation (visual)	Project	One per 1/2 shift.
	Rock for Grouted Riprap and Dumped Riprap	Specific Gravity	Source	One per source.
		Gradation	Project	One per 1/2 shift.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Fine Aggregate for Portland Cement Concrete (PCC) Classes P, S, and B	Gradation [1]	Batch Plant Conveyer Belt or Stockpile	Once per week of production.
		Sand Equivalent [1]		
		Soundness [when used in concrete over 4500 ft. elevation]	Stockpile	One per source. For evaluation of concrete aggregate sources, see PPD [3].
		Organic Impurities		
		Mortar Strength		
		Deleterious Substances [Clay Lumps and Friable Particles; Lightweight Particles]	Stockpile	At the discretion of Materials Group. For evaluation of concrete aggregate sources, see PPD [3].

[1] Independent Assurance Sampling and Testing required.

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Coarse Aggregate for Portland Cement Concrete (PCC) Classes P, S, and B	Gradation [1]	Batch Plant Conveyer Belt or Stockpile	Once per week of production.
		Soundness [when used in concrete over 4500 ft. elevation]	Stockpile	One per source. For evaluation of concrete aggregate sources, see PPD [3].
		Abrasion [2]		
		Deleterious Substances [Clay Lumps and Friable Particles; Lightweight Particles; Material Passing No. 200 Sieve]	Stockpile	With the exception of "Material Passing No. 200 Sieve", at the discretion of Materials Group. For evaluation of concrete aggregate sources, see PPD [3].
		Fractured Coarse Aggregate Particles	Stockpile	One per source.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Aggregate for Arrestor Bed	Abrasion [2] Specific Gravity	Screen Belt or Stockpile	One per source.
		Gradation [1] Fractured Coarse Aggregate Particles [1] Flakiness Index [1]	Screen Belt or Stockpile	One per shift.
Refer to Special Provisions	Aggregate for Soil-Cement Bank Protection or Cement Stabilized Alluvium	Gradation [1] PI [1]	Source or Stockpile	One per 2000 tons, minimum of one per day.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

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TABLE 3
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	Recycling Agent RA-1 RA-5 RA-25 RA-75	Per Specifications	Circulation Line Recom-mended [4]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per 1/2 shift.
1005 404	Liquid Asphalt [Cutback Asphalt - (Medium Curing Type)] MC-70 MC-250 MC-800 MC-3000 for Prime Coat	Per Specifications	Distributor Recom-mended [4]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per delivery unit.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	Emulsified Asphalt RS-1 CRS-1 RS-2 CRS-2 SS-1 CSS-1 CRS-2P	Per Specifications	Supplier (For pre-approval of material.)	See PPD [3].
		Residue	Distibutor Recom-mended [4]	See PPD [3].
				For preapproved emulsions, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
404	for Chip Seal Coat, Tack Coat, and Fog Coat			For emulsions not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005 404	Emulsified Asphalt Special Type (Diluted SS-1 or CSS-1) for Tack Coat and Fog Coat	Residue	Distributor Recom-mended [4]	See PPD [3]. For preapproved undiluted emulsions, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit. For undiluted emulsions not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	Asphalt Cement (PG XX-XX)	Per Specifications		
404	for Tack Coat			Certificate of Compliance required.
416 417	for Asphaltic Concrete		Supplier or Project	A two gallon sample (two full one-gallon metal cans) at least five days prior to start of asphaltic concrete production (for calibration of ignition furnace).
			Circulation Line Recom-mended [4]	
404	for Chip Seal Binder Coat		Distributor Recom-mended[4]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per 1/2 shift.
407 409 411 416 417	for Asphaltic Concrete, or ACFC		Circulation Line Recom-mended [4]	

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005		Per Specifications	Supplier (For pre-approval of material)	See PPD [3].
	Emulsified Recycling Agent (ERA) ERA-1 ERA-5 ERA-25 ERA-75	Residue	Distributor Recom-mended [4]	See PPD [3]. For preapproved ERA, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit. For ERA not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
404	ERA (Diluted) for Fog Coat	Residue	Distributor Recom-mended [4]	See PPD [3]. For preapproved undiluted ERA, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit. For undiluted ERA not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005 1009 410	Asphalt Cement (PG XX-XX) for Asphalt - Rubber (Sprayed Applications)	Per Specifications	Delivery Unit or Terminal (if blended at terminal)	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) for each shipment - not less than one set of duplicate samples for each 40 tons.
1005 1009 413 414 415	Asphalt Cement (PG XX-XX) for Asphalt - Rubber for AR-AC or AR-ACFC	Per Specifications	Delivery Unit or Terminal (if blended at terminal) [(4)]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per 1/2 shift.
1009	Crumb Rubber for Asphalt - Rubber Type A or Type B	Gradation	Project (or Terminal (if blended at terminal)	Certificate of Compliance required and one sample [approximately 1500 grams (one gallon) per Arizona Test Method 714] per lot per type.
1009 410	Asphalt - Rubber [CRA [(5)]] Type 1, Type 2, or Type 3 (Sprayed Applications)	Per Special Provisions.	Distributor Recom-mended [(4)]	Certificate of Compliance required and a one gallon sample in a metal can per delivery unit.

[(4)] Point of sampling specified by Engineer.

[(5)] CRA = Crumb Rubber Asphalt

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1009 413 414 415	Asphalt - Rubber [CRA [5]] Type 1, Type 2, or Type 3 For AR-AC or AR-ACFC			Certificate of Compliance required.
		Penetration	Circulation Line Recom-mended [4]	Duplicate samples (each one gallon in a metal can) per 1/2 shift.
		Softening Point		
		Resilience		
		Rotational Viscosity		
		Rotational Viscosity (at plant)		One sample (one gallon in a metal can) per batch.
415	for AR-AC		Supplier or Project	A two gallon sample (two full one-gallon metal cans) at least five days prior to start of asphaltic concrete production (for calibration of ignition furnace).
			Circulation Line Recom-mended [4]	

[4] Point of sampling specified by Engineer.

[5] CRA = Crumb Rubber Asphalt

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Emulsified Asphalt for Cold Recycled Asphaltic Concrete HFE-150P HFE-300P	Per Special Provisions.	Supplier (for pre-approval of material.)	See PPD [3].
		Residue	Distibutor Recom-mended [4]	See PPD [3].
				For preapproved emulsions, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
				For emulsions not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

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TABLE 4
ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
402	Dowel Bar	Epoxy Coating		Certificate of Compliace required for each shipment from the coating manufacturer. Certificate of Anaysis required for each shipment from the coating applicator.
401 1006	Portland Cement Concrete (PCC) Class P	Compressive Strength [1]	Immediately before going into paver or forms, or as otherwise directed by the Engineer.	Five samples per lot.
		Slump		(For compressive strength, one set of three cylinders per sample.)
		Air Content (when Required)		
		Temperature		
		Thickness	Roadway	10 cores per lot.
1006	Portland Cement Concrete (PCC) Class S **(with a compressive strength requirement less than 4,000 psi)**	Compressive Strength [1]	At Discharge [6]	One sample for each 100 CY, or fraction thereof, of continuously placed concrete per day from each batch plant. For daily placements of 10 CY or less, at the discretion of the Engineer.
		Slump		
		Temperature		(For compressive strength, one set of two cylinders per sample.)
		Air Content (when Required)	At Discharge [6]	Sample for air content every 50 CY when elevation is above 3000 ft. For daily placements of 10 CY or less, at the discretion of the Engineer.

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[1] Independent Assurance Sampling and Testing required.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

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TABLE 4 (continued)
ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Portland Cement Concrete (PCC) Class S **(with a compressive strength requirement equal to or greater than 4,000 psi)**	Compressive Strength [1]	At Discharge [6]	One sample for each 50 CY, or fraction thereof, of continuously placed concrete per day from each batch plant. For daily placements of 10 CY or less, at the discretion of the Engineer.
		Slump		
		Temperature		(For compressive strength, one set of three cylinders per sample.)
		Air Content (when Required)	At Discharge [6]	Sample for air content every 50 CY when elevation is above 3000 ft. For daily placements of 10 CY or less, at the discretion of the Engineer.

[1] Independent Assurance Sampling and Testing required.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

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TABLE 4 (continued)
ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Portland Cement Concrete (PCC) Class B	Compressive Strength [1]	At Discharge [6]	One sample for each 100 CY of concrete placed from each batch plant For daily placements of 10 CY or less, at the discretion of the Engineer.
		Slump		
		Temperature		(For compressive strength, one set of two cylinders per sample.)
		Air Content (when Required)	At Discharge [6]	Sample for air content every 50 CY when elevation is above 3000 ft. For daily placements of 10 CY or less, at the discretion of the Engineer.

[1] Independent Assurance Sampling and Testing required.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

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TABLE 4 (continued)
ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
601 1006	Portland Cement Structural Concrete for Minor Precast Structures (Manholes, Cattle Guards, Utility Vaults, Catch Basins, Flared Ends, etc.)	Rebound Hammer	At Fabrication Yard	One set of readings per precast unit.
601 1006	Prestressed Concrete	Compressive Strength	At Discharge (6)	One sample per member or for each day's production. (For compressive strength, a minimum of two sets of 3 cylinders for detensioning, and one set of 3 cylinders for 28-day breaks.)
		Slump		
		Temperature		
912	Shotcrete	Compressive Strength	Test Panels	Three cores from a test panel every 100 CY or fraction thereof, per day.
		Slump	At Mixer Discharge	One per 50 CY or fraction thereof, per day.
		Air Content (For Shotcrete placed at an elevation of 3,000 feet or above)	For wet-mix process, just prior to pumping	
			For dry-mix process, from in-place material	
922 1006	Utility Concrete	None		

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(6) Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

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TABLE 5
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH
PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
402	Dowel Bar	Epoxy Coating		Certificate of Compliace required for each shipment from the coating manufacturer. Certificate of Anaysis required for each shipment from the coating applicator.
602 1003	Prestressing Steel (Spiral, Bars, Strand Wire, or Wire)	Tensile Strength	Project or Fabrication Plant	Certificate of Compliance required and one 6 ft. piece from each bar size, heat, reel, or coil.
602 1003	Post-Tensioning Steel	Tensile Strength	Project	Certificate of Compliance required and one 6 ft. piece from each bar size, heat, reel, or coil.
605 1003	Reinforcement Bars (Epoxy Coated or Uncoated)	Yield Strength, Tensile Strength, Bend Test, Elongation, Weight/Foot, and Coating Thickness (if applicable)		
	Phoenix and Tucson Sources		Fabrication Plant or Supplier's Yard	Certificate of Compliance required and samples as per PPD [3].
			Project	Certificate of Compliance required and one 7 ft. bar per shipment. See PPD [3].
	Other sources		Project	Certificate of Compliance required and samples as per PPD [3].
1003	Welded Wire Fabric (Smooth)	Tensile Strength, Diameter, Spelter, Weld Shear, Reduction in Area	Supplier's Yard or Project	Certificate of Compliance required and one 2 ft. x 2 ft. sample per 25 rolls.

[3] ADOT Materials Practice and Procedure Directive.

TABLE 5 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH
PORTLAND CEMENT CONCRETE

DocuSign Envelope ID: C45ADE1E-5571-4362-BABC-433DB5325734

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1003	Welded Wire Fabric (Deformed)	Tensile Strength, Weld Shear, Weight/Foot	Supplier's Yard or Project	Certificate of Compliance required and one 4 ft. x 4 ft. sample per 25 sheets.
1006	Admixtures			Certificate of Compliance required and must be on the Department's Approved Products List. See Subsection 1006-2.04.
1006	Curing Compound		Project	For material previously approved,Certificate of Analysis only. See Subsection 1006-6.01. For material not previously approved, Certificate of Compliance and a 1/2 gallon sample per lot. See Subsection 1006-6.01.
1006	Fly Ash and Natural Pozzolan			Material supplied from an Approved Material Source. See Subsection 1006-2.01.
1006	Silica Fume			Certificate of Compliance required with each lot. See See Subsection 1006-2.01.

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TABLE 5 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH
PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Water	Soluble Salts pH	Source	One sample (1 pint in glass container) per source [7].
1006	Hydraulic Cement (All Types)			Material supplied from an Approved Material Source. See Subsection 1006-2.01.
1011	Joint Materials	Per Specifications		Silicone joint sealant must be on the Department's Approved Product List. In addition, a Certificate of Analysis shall accompany each lot or batch of sealant. For joint materials other than silicone joint sealant, only a Certificate of Compliance is required.

[7] No sample is necessary if water is potable and comes from a proven source.

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TABLE 5 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH
PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1013 604	Bearing Pads (Preformed Fabric)	Thickness --- Compression Load	Project/ Contractor's Yard	Certificate of Analysis required and two sample pads from every 100, or fraction thereof, with a minimum of one sample pad from each lot for each type of pad. (Tested by ADOT.)
1013 604	Bearing Pads (Plain and Fabric Reinforced Elastomeric)	Per Specification Subsection 1013-2	Project/ Contractor's Yard	Certificate of Analysis required and two sample pads from every 100, or fraction thereof, with a minimum of one sample pad from each lot for each type of pad. (Not tested by ADOT) [Tested by Engineer approved testing laboratory. See Subsection 1013-3.01.]
1013 604	Bearing Pads (Steel Reinforced Elastomeric)	Per Specification Subsection 1013-2	Project/ Contractor's Yard	Certificate of Analysis required and two sample pads from every 100, or fraction thereof, with a minimum of one sample pad from each lot for each type of pad.(Not tested by ADOT) [Tested by Engineer approved testing laboratory. See Subsection 1013-3.01.]

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TABLE 6
ACCEPTANCE SAMPLING GUIDE FOR STABILIZED SOILS AND BASES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
301	Lime Treated Subgrade	Proctor Density	Roadway	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
302	Cement Treated Subgrade	Proctor Density	Roadway	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
304	Cement Treated Base	Proctor Density	Roadway	At start of production then one per week, and as needed.
		Optimum Moisture		
		Compaction	Roadway or Point of Placement	One per lift per 1000 ft.
		Compressive Strength [(1)]		Three random samples per shift. (Three specimens from each sample.)

[(1)] Independent Assurance Sampling and Testing required.

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TABLE 6 (continued)
ACCEPTANCE SAMPLING GUIDE FOR STABILIZED SOILS AND BASES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
305	Lean Concrete Base	Compressive Strength [1]	At Discharge	Four random samples per 4000 SY, minimum four samples per shift.
		Slump		
		Air Content (when required)		
		Thickness	Roadway	Per Specifications.
Refer to Special Provisions	Bituminous Treated Base	See Special Provisions	Roadway	At the discretion of the Engineer.
Refer to Special Provisions	Cement Stabilized Alluvium	Compressive Strength [1]	Roadway or Point of Placement	One set of three per 1500 CY, minimum one set of three per 1/2 shift.
Refer to Special Provisions	Soil-Cement Bank Protection	Compressive Strength [1]	Roadway or Point of Placement	One set of three per 1500 CY, minimum one set of three per 1/2 shift.

[1] Independent Assurance Sampling and Testing required.

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TABLE 7
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
407	Asphaltic Concrete Friction Course (ACFC)	% Asphalt (1) Moisture Content (1)	Trucks at Mixing Plant	4 per shift.
409	Asphaltic Concrete (Miscellaneous Structural) [For Special Mix, see below]	% Asphalt Moisture Content Rice Marshall Density	Roadway	At the discretion of the Engineer.
409	Asphaltic Concrete (Miscellaneous Structural - Special Mix)	% Asphalt (1) Moisture Content (1) Rice (1) Marshall Density (1) Gradation (1)	Roadway	One sample per 500 tons.
411	Asphaltic Concrete Friction Course (ACFC) - Miscellaneous	% Asphalt Moisture Content	Trucks at Mixing Plant	At the discretion of the Engineer.
413	Asphaltic Concrete (Asphalt – Rubber) [AR-AC]	% Asphalt-Rubber (1) Moisture Content (1)	Roadway	4 per shift.

(1) Independent Assurance Sampling and Testing required.

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TABLE 7 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
414	Asphaltic Concrete Friction Course (Asphalt – Rubber) [AR-ACFC]	% Asphalt-Rubber (1) Moisture Content (1)	Trucks at Mixing Plant	4 per shift.
415	Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]	% Asphalt-Rubber (1) Moisture Content (1) Gradation (1) Marshall Density (1) Rice (1)	Roadway	4 per lot.
		Compaction	Roadway	20 cores per lot (10 locations/2 cores per location).

(1) Independent Assurance Sampling and Testing required.

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TABLE 7 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
416	Asphaltic Concrete - End Product [For mixes containing reclaimed asphalt pavement (RAP), see PPD [3].]	% Asphalt [1]	Roadway	4 per lot.
		Moisture Content [1]		
		Gradation [1]		
		Marshall [1] [Density, Stability, and Flow]		
		Rice [1]		
		Compaction, unless otherwise specified. (Courses > 1½ inch in nominal thickness)	Roadway	20 cores per lot (10 locations/2 cores per location).

[1] Independent Assurance Sampling and Testing required.

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 7 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
417	Asphaltic Concrete (End Product) SHRP Volumetric Mix [For mixes containing reclaimed asphalt pavement (RAP), see PPD [3].]	% Asphalt [1]	Roadway	4 per lot.
		Moisture Content [1]		
		Gradation [1]		
		Gyratory Density [1]		
		Rice [1]		
		Compaction (Courses > 1½ inch in nominal thickness)	Roadway	20 cores per lot (10 locations/2 cores per location).
Refer to Special Provisions	Asphaltic Concrete - Miscellaneous Paving			Tested at the discretion of the Engineer.

[1] Independent Assurance Sampling and Testing required.

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 8
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
301 503 913 1010	Lime (for use in soil stabilization, mortar, and grout)	Chemical and Physical		See PPD [3].
407 409 411 413 414 415 416 417	Hydrated Lime (for use as mineral admixture in asphaltic concrete mixes)			Material supplied from an Approved Material Source. See PPD [3].
302 304 501 503 505 601 602 912 913 1010	Hydraulic Cement (for use in soil stabilization, mortar, and grout)	Chemical and Physical		See PPD [3].
407 409 411 413 414 415 416 417	Portland Cement and Blended Hydraulic Cement (for use as mineral admixture in asphaltic concrete mixes)			Material supplied from an Approved Material Source. See PPD [3].

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
501	Corrugated Metal Pipe (CMP) [Coated or Non-coated]			Certificate of Compliance required.
501 1006	Non-Reinforced, Cast-in-Place Concrete Pipe	Compressive Strength Slump Air Content (when required) Temperature	At Discharge [6]	Per Specifications.
		Wall Thickness	Site	
501 1010	Precast Reinforced or Non-Reinforced Concrete Pipe	Compression (D-Load) Wall Thickness	Supplier's Yard	Certificate of Compliance required and one sample for each 100 sections per size per type.
Refer to Special Provisions	Vitrified Clay Pipe	Compression	Project	One sample for each 100 sections per size per type.
505	Brick for Manholes	Compression	Project	One sample (6 bricks of like kind and size) per project.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Paving Brick	Compression --- Absorption	Project	One sample (6 paving bricks of like kind and size) per project.
Refer to Special Provisions	Cinder Block	Compression --- Absorption	Project	One sample (6 cinder blocks of like kind and size) per project.
Refer to Special Provisions	Slump Block	Compression --- Absorption	Project	One sample (6 slump blocks of like kind and size) per project.
601	Vertical Restrainer	Tensile	Project	1 test loop/40 assembly per type 1 , and Certificate of Analysis required.
604 731 1004 1012	High Strength Bolts, Nuts, Washers, or Anchor Bolts	Rockwell Hardness --- Wedge Tensile Strength	Project	Certificate of Analysis required and three samples per lot, or 0.1% of lots in excess of 3000, for each bolt diameter, including nuts and washers.
608 1007	Retroreflective Sheeting	Per Specifications		Certificate of Compliance required and also must be on the Department's Approved Products List
608	Sign Panel Silk-Screened Characters			Certificate of Compliance required.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
704 708 709	Glass Beads	Roundness Gradation Refractive Index Moisture Resistance Heavy Metal Concentration (if required)	Supplier's Yard (Recom-mended) or Project	See PPD [3]. = = = = = = = = = = = = = = = = = = = For other than Dual Component Pavement Markings: - Certificate of Compliance required*, and if preapproved, a copy of the Central Lab test results. - If not preapproved by Central Lab, Certificate of Compliance required*, and a gallon sample when material is supplied in a "super sack." - *If required, a Certificate of Analysis must also be submitted (certifying that the Heavy Metal Concentration meets the specifications). = = = = = = = = = = = = = = = = = = = For Dual Component Pavement Markings: - Certificate of Analysis required**, and if preapproved, a copy of the Central Lab test results. - If not preapproved by Central Lab, Certificate of Analysis required**, and a gallon sample when material is supplied in a "super sack. - **The Certificate of Analysis shall also include a Material Safety Data Sheet (MSDS).

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
704	Thermoplastic Pavement Markings	Per Specifications	Manufac-turer	For precertification, the manufacturer shall prepare a metal can powder sample per specifications.
			Project	Certificate of Compliance and a copy of the Central Materials Chemistry Lab test results are required. Also must be on the Department's Approved Products List.
				In-place field verification checks for thickness or sampling for composite testing will be made at the discretion of the Engineer . Material shall be sampled utilizing a 4 inch x 12 inch galvanized sheet metal plate without additional application of glass beads.
705	Preformed Plastic Pavement Marking			Certificate of Compliance required*, and also must be on the Department's Approved Products List. *A Certificate of Analysis is also required (certifying that the Heavy Metal Concentration of the glass beads meets the specifications).

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
706	Raised Pavement Markers	Per Specifications	Project	Certificate of Compliance required for markers and adhesive.
				Adhesive must be on the Department's Approved Products List.
				For non-reflective pavement markers, one sample (one marker) per lot per type.
				For reflective pavement markers, one sample (three markers) per lot per type.
708	Permanent Pavement Markings (Painted)	Per Specifications	Supplier, Contractor, or Manufac-turer	For precertification: The Supplier, Contractor, or Manufacturer shall prepare a one-gallon powder sample per specifications.
			Project	Certificate of Compliance and a copy of the Central Materials Chemistry Lab test results are required.
				Check-samples of finished paint while being applied, at intervals determined by the Engineer.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
709	Dual Component Pavement Markings	Per Specifications	Project	Certificate of Analysis required and must be on the Department's Approved Projects List. Random spot checks for thickness.
732	Polyvinyl Chloride (PVC) Pipe for Electrical Conduit	Resistance to Crushing	Project	One sample per 5000 ft.
808	Polyvinyl Chloride (PVC) Pipe for Water	Wall Thickness Burst Pressure Diameter	Project	One sample per 10,000 ft.
902	Chain Link Fabric			Certificate of Compliance required.
902	Fence Post and Rails			Certificate of Compliance required.
902 903	Miscellaneous Fence Hardware			Certificate of Compliance required.
902 903	Post Clips, Hog Rings, Tie Wire, or Tension Wire			Certificate of Compliance required.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
903	Barbed Wire or Barbless Wire	Tensile Strength Spelter Diameter	Supplier's Yard or Project	Certificate of Compliance[8] required and one 4 ft. sample per 50 rolls.
903	Fence Stays			Certificate of Compliance required.
903	T-Post	Weight/Foot Length	Supplier's Yard or Project	Certificate of Compliance[8] required and one post per 500 posts, or fraction thereof, per lot.
903	Woven Wire Fabric	Spelter Diameter Tensile Strength	Supplier's Yard or Project	Certificate of Compliance[8] required and one sample [3 feet long, the full height (width) of the fabric] per 50 rolls.
904 913	Wire Rope			Certificate of Compliance required.

[8] Certifying that manufacturing processes and application of coating occurred in the United States. (This certification required for Federal-Aid projects only. See Special Provisions for exception based on quantity being used.)

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1002	Paint	Per Specifications	Project	Paint for use on structural steel and other metallic surfaces: - Certificate of Compliance is required and the system must be on the Department's Approved Products List. = = = = = = = = = = = = = = = = = =
			= = = = = = = =	Paint for use on concrete or masonry surfaces: -
			Supplier or Contractor	A sample (one quart in a metal can) of the material from each batch must be submitted to Central Lab for testing prior to use. -
			Project	Certificate of Compliance and a copy of the Central Materials Chemistry Lab test results are required. Also must be on the Department's Approved Products List. = = = = = = = = = = = = = = = = = =
			= = = = = = = =	Paint for use on other than structural steel and other metallic surfaces, concrete surfaces, or masonry surfaces: -
			Project	Certificate of Compliance is required and one sample (one quart in a metal can) per batch submitted to Central Lab for testing.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1012	Guardrail Elements			Certificate of Compliance required.
1012	Guardrail Fasteners	Rockwell Hardness Tensile Strength	Project	For other than High Strength Anchor Bolts, Certificate of Compliance required and three samples per lot, or 0.1% of lots in excess of 3000, for each bolt diameter, including nuts and washers. For High Strength Anchor Bolts, see Page 51.
1012	Guardrail Posts and Blocks	None		Certificate of Compliance required. For timber guardrail posts and blocks, see PPD [3].

[3] ADOT Materials Practice and Procedure Directive.

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1014	Geosynthetics		Supplier and Project	If material has been preapproved, Certificate of Compliance required and one sample for every 10 rolls per lot. (Minimum of one sample per lot.) Samples shall not be taken within 5 feet from either end of the roll, and shall be at least 6 feet long by the full width of the roll.
			Project	If material has not been preapproved, Certificate of Analysis required and one sample for every 10 rolls per lot. (Minimum of one sample per lot.) Samples shall not be taken within 5 feet from either end of the roll, and shall be at least 6 feet long by the full width of the roll.
NOTE: Information on Geosynthetics continued on next page.				

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TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
NOTE: Information on Geosynthetics continued from previous page.				
1014 412	Pavement Fabric	Per Specification Subsection 1014-2		
1014 306	Geogrid	Per Specification Subsection 1014-3		
1014 208	Separation Geotextile Fabric	Per Specification Subsection 1014-4		
1014 913	Bank Protection Fabric	Per Specification Subsection 1014-5		
1014 203	Geocomposite Wall Drain System	Per Specification Subsection 1014-6		
1014 307	Geocomposite Edge Drain System	Per Specification Subsection 1014-7		
208	Geomembrane	See Special Provisions.		

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Appendix E

Example Material Identification Codes

Material codes and type codes are used to identify what a material is used for. Each code combination in each line below makes up an individual Material Code allowed to be used on the Project. For example, the Material Code for Aggregate Base Class 2 is: AB-2. The Material Code for Decomposed Granite is: DG.

Soils, Aggregates, Stabilized Soils and Bases

The source of the material (supplier or segment) should also be document.

Portland Cement Concrete

Portland cement concrete mixes should be identified by mix design and plant number.

Hot-Mix Asphalt Concrete

Hot-mix asphalt cement concrete mixes should be identified by mix design and plant number.

Material Code Combinations			
Material	Code	Type	Code
Admix	AD		
Aggregate	AG	Bituminous Treated Base	BB
Aggregate	AG	Cement Treated Base	CB
Aggregate	AG	Cement Treated Subgrade	CS
Aggregate	AG	Lean Concrete Base	LC
Aggregate	AG	Lime Treated Subgrade	LS
Aggregate	AG	Road Mix	RM
Aggregate	AG	Soil Cement	SC
Aggregate Base	AB	Class 1	1
Aggregate Base	AB	Class 2	2
Aggregate Base	AB	Class 3	3
Aggregate Subbase	AS	Class 4	4
Aggregate Subbase	AS	Class 5	5
Aggregate Subbase	AS	Class 6	6
Arrestor Bed Aggregate	AA		
Asphaltic Concrete	AC	1/2" Asphaltic Concrete	12
Asphaltic Concrete	AC	1/2" Fine Band 417 AC	12F
Asphaltic Concrete	AC	1/2" Coarse Band 417 AC	12K
Asphaltic Concrete	AC	3/4" Asphaltic Concrete	34

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Material Code Combinations			
Material	Code	Type	Code
Asphaltic Concrete	AC	3/4" Fine Band 417 AC	34F
Asphaltic Concrete	AC	3/4" Coarse Band 417 AC	34K
Asphaltic Concrete	AC	Asphaltic Concrete Friction Course (ACFC)	FC
Asphaltic Concrete	AC	Asphalt-Rubber Asphaltic Concrete (AR-AC)	RD
Asphaltic Concrete	AC	Asphalt-Rubber Asphaltic Concrete Friction Course (AR-ACFC)	RF
Asphaltic Concrete	AC	Base Mix	BM
Asphaltic Concrete	AC	Bituminous Treated Base	BB
Asphaltic Concrete	AC	AZ409 Miscellaneous Structural	409MI
Asphaltic Concrete	AC	AZ409 Miscellaneous Structural (Special Mix)	409SP
Asphaltic Concrete	AC	Other	OT
Asphaltic Concrete	AC	Recycled Asphaltic Concrete	RC
Asphaltic Concrete	AC	Road Mix	RM
Asphaltic Concrete Friction Course (ACFC)	FC		
Asphalt-Rubber Asphaltic Concrete (AR-AC)	RD		
Asphalt-Rubber Asphaltic Concrete Friction Course (AR-ACFC)	RF		
Backfill	BF	Aluminum Pipe	AP
Backfill	BF	Concrete Pipe	CP
Backfill	BF	Metal Pipe	MP
Backfill	BF	Plastic Pipe	PP
Backfill	BF	Slurry	SL
Backfill	BF	Special	SP
Backfill	BF	Trench	TR
Bedding Material	BM	Concrete Pipe	CP
Bedding Material	BM	Corrugated Metal Pipe	MP
Bedding Material	BM	PVC Pipe	PV
Bedding Material	BM	Slurry	SL
Blotter Material	BL		
Borrow	BW		
Cement Stabilized Alluvium	CS		
Coarse Aggregate	CA	Size 1	1

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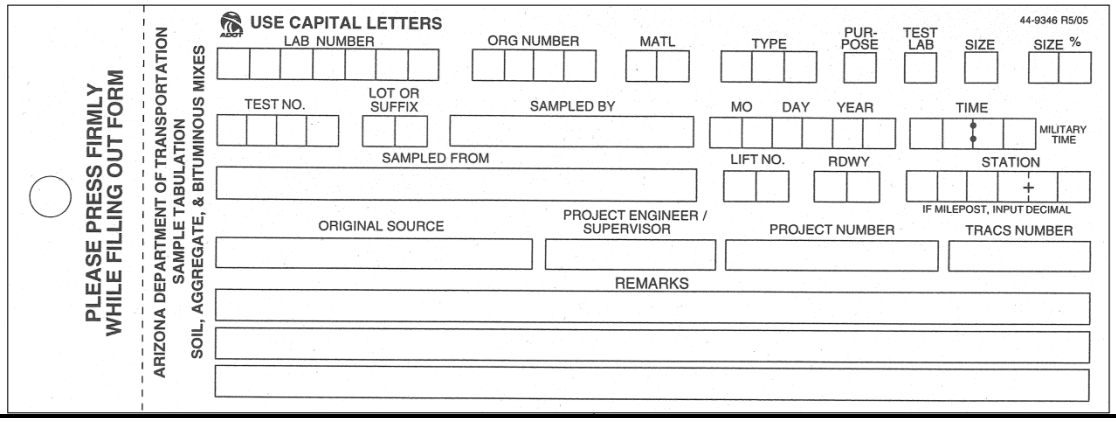
Material Code Combinations			
Material	Code	Type	Code
Coarse Aggregate	CA	Size 2	2
Coarse Aggregate	CA	Size 3	3
Coarse Aggregate	CA	Size 4	4
Coarse Aggregate	CA	Size 5	5
Coarse Aggregate	CA	Size 6	6
Coarse Aggregate	CA	Size 7	7
Coarse Aggregate	CA	Size 8	8
Coarse Aggregate	CA	Size 9	9
Coarse Aggregate	CA	Size 10	10
Coarse Aggregate	CA	Size 24	24
Coarse Aggregate	CA	Size 56	56
Coarse Aggregate	CA	Size 57	57
Coarse Aggregate	CA	Size 67	67
Coarse Aggregate	CA	Size 68	68
Coarse Aggregate	CA	Size 78	78
Coarse Aggregate	CA	Size 89	89
Coarse Aggregate	CA	Size 357	357
Coarse Aggregate	CA	Size 467	467
Coarse Aggregate	CA	Composite Samples	NA
Cover Material	CM		
Crash Barrel Sand	CB		
Decomposed Granite	DG		
Embankment	EM		
Embankment	EM	Requiring 95% Compaction	95
Embankment	EM	Requiring 100% Compaction	100
Entrained Air (Air Content)	ET		
Filter Material	FM		
Fine Aggregate	FA		
Fly Ash	FF		
Granite Mulch	GM		
Granulated (Crumb) Rubber	GR		
Grout	GT		
Maintenance	MT		
Membrane Seal	MS		
Mineral Aggregate	MA		
Mineral Aggregate	MA	½” Asphaltic Concrete	12
Mineral Aggregate	MA	½” Fine Band 417 AC	12F
Mineral Aggregate	MA	½” Coarse Band 417 AC	12K
Mineral Aggregate	MA	¾” Asphaltic Concrete	34

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Material Code Combinations			
Material	Code	Type	Code
Mineral Aggregate	MA	¾" Fine Band 417 AC	34F
Mineral Aggregate	MA	¾" Coarse Band 417 AC	34K
Mineral Aggregate	MA	AZ409 Miscellaneous Structural	409MI
Mineral Aggregate	MA	AZ409 Misc. Structural Special Mix	409SP
Mineral Aggregate	MA	Asphaltic Concrete Friction	FC
		Course (ACFC)	
Mineral Aggregate	MA	Asphalt-Rubber Asphaltic	RD
		Concrete (AR-AC)	
Mineral Aggregate	MA	Asphalt-Rubber Asphaltic	RF
		Concrete Friction Course	
		(AR-ACFC)	
Mineral Aggregate	MA	Base Mix	BM
Mineral Aggregate	MA	Other	OT
Mineral Aggregate	MA	Recycled Asphaltic Concrete	RC
Mechanically Stabilized Earth	ME	Reinforced Zone Material	R1
Mechanically Stabilized Earth	ME	Retained Zone Material	R2
Natural Ground	NG		
Natural Ground	NG	Requiring 95% Compaction	95
Other	OT		
Pipe Plating	PM		
Pneumatically Placed Mortar	NM		
Reclaimed Asphalt Pavement	RP	Coarse	C
Reclaimed Asphalt Pavement	RP	Fine	F
Reclaimed Asphalt Pavement	RP	Other	O
Rip Rap	RR		
Rock Mulch	RM		
Slurry	SL	3/8" Aggregate	38
Slurry	SL	#4 Aggregate	4
Structure Backfill	SB		
Subgrade	SG		
Subgrade	SG	Requiring 95% Compaction	95
Subgrade	SG	Requiring 100% Compaction	100
Subgrade Seal	SS		
Top Soil	TS		
Water	HO		
Winter Cinders	WC		

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Example Sample Ticket



Purpose Codes:

A	Acceptance
M	Miscellaneous
C	Control
P	Independent Assurance
I	Informational

Testing Lab Codes:

C	Central Lab
R	Regional Lab
P	Project Lab

Size Codes – Stockpiles:

B	Blend
F	Fine
I	Intermediate
C	Coarse
K	Coarsest

Roadway Codes:

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NB	Northbound
SB	Southbound
EB	Eastbound
WB	Westbound
RA	Ramp A
RB	Ramp B, etc.
FR	Frontage Road
XR	Crossroad

Bins:

9	Composite of Bins
1	Bin #1
2	Bin #2, etc.

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Appendix F

Owner Verification Levels of Testing Verification

Level 1 **Level 2** **Level 3**

Soils

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
SOILS (For this Material Category, the Level 1 Analysis uses α = 0.01)			
Embankment (any depth)	Proctor Density	ARIZ 225a or 245	3
	Optimum Moisture	ARIZ 225a or 245	3
	Compaction	ARIZ 230a or 235	1
Embankment for Metal Pile	pH	ARIZ 236c	3
	Resistivity	ARIZ 236c	3
Natural Ground below Embankment	Proctor Density	ARIZ 225a or 245	3
	Optimum Moisture	ARIZ 225a or 245	3
	Compaction	ARIZ 230a or 235	1
Subgrade	Proctor Density	ARIZ 225a or 245	3
	Optimum Moisture	ARIZ 225a or 245	3
	Compaction	ARIZ 230a or 235	1
Subgrade top 3' Subgrade Acceptance Chart	Gradation (-#200 only)	ARIZ 201c	2
	PI	AASHTO T-89 & T-90	2
Soil for Shoulder Build-up	Gradation	ARIZ 201c	3
	PI	AASHTO T-89 & T-90	3
	pH	ARIZ 236c	3
	Soluble Salts	ARIZ 237b	3
	Compaction	ARIZ 230a or 235	1
Trench Backfill	Proctor Density	ARIZ 225a or 245	3
	Optimum Moisture	ARIZ 225a or 245	3
	Compaction	ARIZ 230a or 235	1
Granite Mulch	Gradation	ARIZ 201c	3

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Decomposed Granite	Gradation	ARIZ 201c	**3**
Top Soil	Gradation	ARIZ 201c	**3**
	PI	AASHTO T-89 & T-90	**3**
	pH	ARIZ 236c	**3**
	Soluble Salts	ARIZ 237b	**3**
	Calcium Carbonate	AASHTO T-217	**3**
	Exchangeable Sodium in % & ppm	ARIZ 729	**3**

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Aggregates

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
AGGREGATES (For this Material Category, the Level 1 Analysis uses α = 0.01)			
Structure Backfill or Pipe Backfill	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
	Resistivity	ARIZ 236c	**3**
	pH	ARIZ 236c	**3**
	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**
Aggregate Base Class 1, Class 2, and Class 3	Abrasion	AASHTO T-96	**3**
	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**
Aggregate Subbase Class 4, Class 5, and Class 6	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Class 4	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**
	Abrasion	AASHTO T-96	**3**
Class 5 and Class 6	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**

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Aggregate for Cement Treated Base or Lean Concrete Base	Gradation	ARIZ 201c	**2**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Abrasion	AASHTO T-96	**3**
for Cement Treated Base	PI	AASHTO T-89 & T-90	**2**
for Lean Concrete Base	Sand Equivalent	ARIZ 242a	**3**
Cover Material	Abrasion	AASHTO T-96	**3**
	Bulk O.D. Specific Gravity	ARIZ 210	**3**
	Percent Carbonates	ARIZ 238	**3**
	Dry Unit Weight	AASHTO T-19	**3**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Flakiness Index	ARIZ 233	**3**
	Gradation	ARIZ 201c	**3**
	Moisture Content	AASHTO T-265	**3**
Blotter Material	Gradation	ARIZ 201c	**3**
Mineral Aggregate for Micro-Surfacing	Abrasion	AASHTO T-96	**3**
	Percent Carbonates	ARIZ 238a	**3**
	Gradation	ARIZ 201c	**3**
	Sand Equivalent	ARIZ 242a	**3**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Uncompacted Void Content	ARIZ 247	**3**
	Moisture Content	AASHTO T-265	**3**
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC)	Abrasion	AASHTO T-96	**3**
	Percent Carbonates	ARIZ 238a	**3**
	Specific Gravity	ARIZ 210b	**3**
	Sand Equivalent	ARIZ 242a	**2**
	Flakiness Index	ARIZ 233	**3**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete Friction Course (Miscellaneous Structural)	Abrasion	AASHTO T-96	**3**
	Percent Carbonates (if required)	ARIZ 238a	**3**
	Sand Equivalent	ARIZ 242a	**3**

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		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**3**
Mineral Aggregate for Asphaltic Concrete Friction Course (Miscellaneous Structural - Special Mix)		Abrasion	AASHTO T-96	**3**
		Percent Carbonates (if required)	ARIZ 238a	**3**
		Sand Equivalent	ARIZ 242a	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**3**
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC) - Miscellaneous		Abrasion	AASHTO T-96	**3**
		Sand Equivalent	ARIZ 242a	**3**
		Flakiness Index	ARIZ 233	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**3**
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) [AR-AC]		Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
		Specific Gravity	ARIZ 210b	**3**
		Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete Friction Course (Asphalt-Rubber)[AR-ACFC]		Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
		Specific Gravity	ARIZ 210b	**3**
		Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Flakiness Index	ARIZ 233	**3**
		Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**

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	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - End Product [without RAP]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**
	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - End Product [with RAP]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**
	Individual RAP Stockpiles	Gradation	ARIZ 201c	**2**
		Binder Content	ARIZ 427	**3**
		Moisture Content	ARIZ 427	**3**
	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete- End Product (SHRP)[without RAP]	Sourceor Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**

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	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - End Product (SHRP) [with RAP]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**
	Individual RAP Stockpiles	Gradation	ARIZ 201c	**2**
		Binder Content	ARIZ 427	**2**
		Moisture Content	ARIZ 427	**3**
	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - Miscellaneous Paving		Abrasion	AASHTO T-96	**3**
		Sand Equivalent	ARIZ 242a	**3**
		Gradation	ARIZ 201c	**3**
Bedding Material for Pipe		Gradation	ARIZ 201c	**2**
		PI	AASHTO T-89 & T-90	**2**
		pH	ARIZ 236c	**3**
		Resistivity	ARIZ 236c	**3**
		Proctor Density	ARIZ 225a or 245	**3**
		Optimum Moisture	ARIZ 225a or 245	**3**
		Compaction	ARIZ 230a or 235	**1**
Filter Material for Perforated Pipe		Gradation	ARIZ 201c	**2**
Plating Material for Pipe Ends		Gradation	ARIZ 201c	**3**
		PI	AASHTO T-89 & T-90	**3**
		Proctor Density	ARIZ 225a or 245	**3**

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	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**3**
Crash Barrel Sand	Gradation	ARIZ 201c	**3**
	Dry Unit Weight	AASHTO T-19	**3**
	Moisture Content	AASHTo T-265	**3**
Bedding Material for PVC Irrigation Pipe	Gradation	ARIZ 201c	**3**
Rock for Wire Tied Riprap, Gabions, Slope Mattress, Rail Bank Protection	Specific Gravity	ARIZ 210b	**3**
	Gradation (Visual)	Visual	**3**
Rock for Grouted Riprap & Dumped Riprap	Specific Gravity	ARIZ 210b	**3**
	Gradation	ARIZ 201c	**3**
Fine Aggregate for Portland Cement Concrete (PCC) Classes P, S, & B	Gradation	ARIZ 201c	**2**
	Sand Equivalent	ARIZ 242a	**2**
	Organic Impurities	AASHTO T-21	**3**
	Mortor Strength	AASHTO T-176	**3**
	Deleterious Substances	AASHTO T-112 & T-113	**3**
Coarse Aggregate for Portland Cement Concrete (PCC) Classes P, S, & B	Gradation	ARIZ 201c	**2**
	Abrasion	AASHTO T-96	**3**
	Deleterious Substances	AASHTO T-112 & T-113	**3**
	Fractured Coarse Aggregate Particles		**3**
Aggregate for Arrestor Bed	Abrasion	AASHTO T-96	**3**
	Specific Gravity	ARIZ 210b	**3**
	Gradation	ARIZ201c	**2**
	Fractured Coarse Aggregate Particles	ARIZ 212	**2**
	Flakiness Index	ARIZ 233c	**3**
Aggregate for Soil-Cement or Cement Stabilized Alluvium	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**

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Bituminous

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
BITUMINOUS MATERIAL (NOT MIXES)			
Recycling Agent	Per Specifications	Certificate of Compliance	**3**
Liquid Asphalt (Cutback Asphalt -Medium Curing) for Prime Coat	Per Specifications	Certificate of Compliance	**3**
	Per Specifications	Certificate of Compliance	**3**
Emulsified Asphalt for Chip Seal	Per Specifications	Certificate of Compliance	**3**
	Residue	ARIZ 504	**3**
	Per Specifications	Certificate of Compliance	**3**
Emulsified Asphalt for Tack Coat and Fog Coat	Per Specifications	Certificate of Compliance	**3**
	Residue	ARIZ 504	**3**
	Per Specifications	Certificate of Compliance	**3**
Asphalt Cement PG XX-XX)	Per Specifications	Certificate of Compliance	**2**
for Tack Coat	Per Specifications	Certificate of Compliance	**3**
for Asphaltic Concrete	Per Specifications	Certificate of Compliance	**2**
for Asphaltic Concrete or ACFC	Per Specifications	Certificate of Compliance	**2**
Emulsified Recycling	Per Specifications	Certificate of Compliance	**3**
	Residue	ARIZ 504	**3**
ERA	Residue	ARIZ 504	**3**
for Fog Coat	Per Specifications	Certificate of Compliance	**3**
Asphalt Cement (PG XX-XX) for Asphalt -Rubber (Sprayed Applications)	Per Specifications	Certificate of Compliance	**2**
Asphalt Cement (PG XX-XX) for Asphalt - Rubber for AR-AC or AR-ACFC	Per Specifications	Certificate of Compliance	**2**

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Crumb Rubber for Asphalt - Rubber Type A or Type B	Gradation	ARIZ 714	**3**
Asphalt - Rubber [CRA (5)] Type 1, Type 2, or Type 3 (Sprayed Applications)	Per Specifications	Certificate of Compliance	**3**
Asphalt - Rubber [CRA (5)] Type 1, Type 2, or Type 3 For AR-AC or AR-ACFC	Penetration	ASTM D5	**3**
	Softening Point	ASTM D36	**2**
	Resilience	ASTM D5329	**2**
	Rotational Viscosity	AASHTO T-316	**3**
	Rotational Viscosity (at plant)	AASHTO T-316	**3**

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Portland Cement Concrete

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
PORTLAND CEMENT CONCRETE (For this Material Category, the Level 1 Analysis uses α = 0.025)			
Portland Cement Concrete Pavement (PCCP) Class P	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
	Thickness	AASHTO T-148 & ARIZ 317a	**1**
Portland Cement Structural Concrete Class S and B	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
Portland Cement Concrete (PCC) Class S (with a compressive strength req't equal to or greater than 4,000 psi)	Compressive Strength	ARIZ 314b	**1**
	Slump/Spread (for SCC)	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
Portland Cement Concrete (PCC) Class B	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
Portland Cement Structural Concrete for Minor Precast Structures	Rebound Hammer	ASTM C805	**3**
Prestressed Concrete	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
Shotcrete	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Air Content	ASTM C1064	**3**

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Materials Used With Portland Cement Concrete

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
MATERIALS USED WITH PORTLAND CEMENT CONCRETE			
Prestressing Steel (Spiral, Bars, Strand Wire, or Wire)	Tensile Strength	AASHTO M203 & M204	**3**
Post-Tensioning Steel	Tensile Strength	AASHTO M203 & M204	**3**
Reinforcement Bars	Tensile Strength	AASHTO M31	**3**
Welded Wire Fabric (Smooth)	Per Specifications	Certificate of Compliance	**Inspection**
Welded Wire Fabric (Deformed)	Per Specifications	Certificate of Compliance	**Inspection**
Admixtures	Per Specifications	Certificate of Compliance	**Inspection**
Curing Compound	Per Specifications	Certificate of Compliance	**Inspection**
Curing Compound	Water Loss		**Inspection**
	% Solids		**Inspection**
Fly Ash and Natural Pozzolan	Per Specifications	Certificate of Compliance	**Inspection**
Silica Fume	Per Specifications	Certificate of Compliance	**Inspection**
Water	Soluble Salts	AASHTO T-26	**Inspection**
	pH	AASHTO T-26	**Inspection**
Hydraulic Cement	Per Specifications	Certificate of Compliance	**Inspection**
Hydraulic Cement (All Type)	Chemical & Physical	ASTM C465 & ASTM C595	**Inspection**
Joint Materials	Per Specifications	Certificate of Compliance	**Inspection**
Bearing Pads (All Type)	Thickness	Measurement	**3**
	Compression Load	Certificate of Analysis	**3**

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Stabilized Soils and Bases

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
STABILIZED SOILS & BASES (For this Material Category, the Level 1 Analysis uses α = 0.01)			
Lime Treated Subgrade	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Cement Treated Subgrade	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Cement Treated Base	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
	Compressive Strength	ARIZ 241a	**1**
Lean Concrete Base	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Air Content (when required	AASHTO T-152	**2**
	Thickness	AASHTO T-148	**1**
Cement Stabilized Alluvium	Compressive Strength	ARIZ 314b	**1**
Soil-Cement Bank Protection	Compressive Strength	ARIZ 314b	**1**

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Bituminous Mixtures

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
BITUMINOUS MIXTURES (For this Material Category, the Level 1 Analysis uses α = 0.025)			
Asphaltic Concrete Friction Course [ACFC] (407)	% Asphalt	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete [AC] Marshall Mixes Misc. Structural (409 & 409 Special)	% Asphalt	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Marshall), Stab, Flow	ARIZ 410e	**2**
	Gradation (only 409 Special)	ARIZ 427	**2**
Asphaltic Concrete Friction Course [ACFC] - Misc. (411)	% Asphalt	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete (Asphalt-Rubber) [AR-AC] (413)	% Asphalt Rubber	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete Friction Course (Asphalt – Rubber) [AR-ACFC] (414)	% Asphalt Rubber	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete (Asphalt-Rubber) [AR-AC] End Product (415)	% Asphalt Rubber	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Marshall), Stab, Flow	ARIZ 410e	**2**
	Calculated Lab Voids	ARIZ 424	**1**
	Gradation	ARIZ 427	**2**
	Compaction (in place field voids)	ARIZ 415c	**1**
Asphaltic Concrete [AC] Marshall Mixes End Product (416)	% Asphalt	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Marshall), Stab, Flow	ARIZ 410e	**2**
	Calculated Lab Voids	ARIZ 424	**1**
	Gradation	ARIZ 427	**2**
	Compaction (in place field voids)	ARIZ 415c	**1**

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Asphaltic Concrete SHRP Volumetric Mixes (417)	% Asphalt	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Gyratory Compactor)	AASHTO 312	**2**
	Calculated Lab Voids	ARIZ 424	**1**
	Gradation	ARIZ 427	**2**
	Compaction (in place field voids)	ARIZ 415c	**1**

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Miscellaneous

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
MISCELLANEOUS MATERIALS (For this Material Category, the Level 1 Analysis uses α = 0.025)			
Lime	Per Specifications	Certificate of Compliance	**Inspection**
Hydrated Lime	Per Specifications	Certificate of Compliance	**Inspection**
Hydraulic Cement	Per Specifications	Certificate of Compliance	**Inspection**
Portland Cement and Blended Hydraulic Cement	Per Specifications	Certificate of Compliance	**Inspection**
Corrugated Metal Pipe (CMP)	Per Specifications	Certificate of Compliance	**Inspection**
Non-Reinforced, Cast-in-Place Concrete Pipe	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Air Content (when required)	ASTM C1064	**2**
	Temperature	AASHTO T-152	**3**
	Wall Thickness		**2**
Precast Reinforced or Non-Reinforced Concrete Pipe	Compressive Strength	ARIZ 314b	**2**
	Thickness	Measurement	**2**
Vitrified Clay Pipe	Compression	ARIZ 314b	**3**
Brick for Manholes	Compression	ARIZ 314b	**3**
Paving Brick	Compression	ARIZ 314b	**3**
	Absorption	ARIZ 251	**3**
Cinder Block	Compression	ARIZ 314b	**3**
	Absorption	ARIZ 251	**3**
Slump Block	Compression	ARIZ 314b	**3**
	Absorption	ARIZ 251	**3**
High Strength Bolts, Nuts, Washers, or Anchor Bolts	Rockwell Hardness	ASTM E18	**3**
	Wedge Tensile Strength	ASTM F606	**3**
Retroreflective Sheeting	Per Specifications	Certificate of Compliance	**3**
Sign Panel Silk-Screened Characters	Per Specifications	Certificate of Compliance	**3**
Glass Beads	Roundness	ASTM D1155	**3**

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	Gradation	ASTM D1214	**3**
	Refractive Index		**3**
	Moisture Resistance		**3**
	Heavy Metal Concentration (if required)		**3**
Preformed Plastic Pavement Marking	Per Specifications	Certificate of Compliance	**3**
Thermoplastic Pavement Markings	Per Specifications	Certificate of Compliance	**3**
Raised Pavement Markers	Per Specifications	Certificate of Compliance	**Inspection**
Permanent Pavement Markings (Painted)	Per Specifications	Certificate of Compliance	**3**
Dual Component Pavement Markings	Per Specifications	Certificate of Compliance	**3**
Polyvinyl Chloride (PVC) Pipe for Electrical Conduit	Per Specifications	Certificate of Compliance	**Inspection**
Polyvinyl Chloride (PVC) Pipe for Water	Per Specifications	Certificate of Compliance	**Inspection**
Chain Link Fabric	Per Specifications	Certificate of Compliance	**Inspection**
Fence Post and Rails	Per Specifications	Certificate of Compliance	**Inspection**
Miscellaneous Fence Hardware	Per Specifications	Certificate of Compliance	**Inspection**
Post Clips, Hog Rings, Tie Wire, or Tension Wire	Per Specifications	Certificate of Compliance	**Inspection**
Barbed Wire or Barbless Wire	Per Specifications	Certificate of Compliance	**Inspection**
Fence Stays	Per Specifications	Certificate of Compliance	**Inspection**
T-Post	Per Specifications	Certificate of Compliance	**Inspection**
Woven Wire Fabric	Per Specifications	Certificate of Compliance	**Inspection**
Wire Rope	Per Specifications	Certificate of Compliance	**Inspection**
Paint	Per Specifications	Certificate of Compliance	**Inspection**
Guardrail Elements	Per Specifications	Certificate of Compliance	**Inspection**
Guardrail Fasteners	Rockwell Hardness	ASTM E18	**3**
	Tensile Strength	ASTM F606	**3**

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Guardrail Posts and Blocks	Per Specifications	Certificate of Compliance	**Inspection**
Geosynthetics	Per Specifications	Certificate of Compliance	**3**
Pavement Fabric	Per Specifications	Certificate of Compliance	**3**
Geogrid	Per Specifications	Certificate of Compliance	**3**
Separation Geotextile Fabric	Per Specifications	Certificate of Compliance	**3**
Bank Protection Fabric	Per Specifications	Certificate of Compliance	**3**
Geocomposite Wall Drain System	Per Specifications	Certificate of Compliance	**3**
Geocomposite Edge Drain System	Per Specifications	Certificate of Compliance	**3**
Geomembrane	Per Specifications	Certificate of Compliance	**3**
Grout	Compressive Strength	ARIZ 314b	**2**

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Appendix G

Independent Assurance Test Methods

The following test methods will be evaluated annually as part of the independent assurance program.

Field Sampling and Testing

1. Density of Soils
    i. ARIZ 230 – Field Density (Sand Cone)
    ii. ARIZ 235 – Field Density (Nuclear)

2. Plastic Concrete
    i. ASTM C143 – Concrete Slump
    ii. ASTM C231 – Concrete Air Content
    iii. ASTM C31 – Concrete Cylinder Fabrication

Note: Field technicians will be evaluated annually based on observation.

Laboratory Testing

1. Soil and Aggregate
    i. ARIZ 201c – Sieve Analysis of Soils & Aggregates
    ii. AASHTO T176 – Sand Equivalent
    iii. AASHTO T90 – Plastic Limit & Plasticity Index

2. Hardened Concrete
    i. ARIZ 314b – Compressive Strength of Concrete

3. Bituminous Mixture Compaction
    i. ARIZ 410e – Compaction/Testing HMA by Marshall Method
    ii. AASHTO T312 – HMA Density by Gyratory Compactor

4. Bituminous Mixture Other
    i. ARIZ 415c – Bulk Specific Gravity of Compacted Bituminous Mixtures
    ii. ARIZ 417d – Maximum Theoretical Specific Gravity of HMA (Rice Test)
    iii. ARIZ 427 – Asphalt Binder Content (Ignition)

Note: Laboratory technicians will be evaluated annually based on either observation, an individual's IA split test results (small groups), or an individual's proficiency test result (large group). Technicians will be evaluated for the test method they will perform.

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OV and IQ firms are required to request IA evaluations a minimum of two weeks in advance. ADOT will try to accommodate requests made with less than two weeks' notice.

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Appendix H

Independent Quality Firm Data Transfer Requirements

The IQF transmits their test results to ADOT to allow ADOT to perform the required owner verification (including statistical analyses). This appendix provides direction on how to transmit this data to ADOT's Uncle Sam system.

Definitions
Third party: this is the client who will provide the deliverable described in this document.

ADOT analysis project: this refers to an instance of web application along with data import tasks configured to accept data from two parties: ADOT and the third party above. The main purpose of the project is to group and aggregate imported tests based on certain attributes of the tests, resulting in statistical analyses.

Data import / sync: this refers to the scheduled task configured to perform an ETL (extract, transform, load) on the source .bacpac tables into the target (master) database.

Master database: this is the database into which the ADOT data and third-party data will sync. The ADOT analysis project utilizes this database as its backend to perform analyses on the test data, among other things.

Purpose
The purpose of this document is to provide details on the deliverable database file which a third party will need to provide for import into an ADOT analysis project. Information included in this document is: the database schema and table definitions expected to be provided by the third party; additional notes on how tables should be populated; and the delivery method to which the third party should adhere.

This document references a sample deliverable .bacpac file and an analysis configuration view (see below for more information) that should be provided in conjunction.

Deliverable and Delivery Method
The expectation is that the third party will provide a database that matches the table schema described below and contained in the sample file. The database should be compatible with Microsoft SQL Server 2016 and exported in .bacpac format.

The third party will coordinate with the administrator of the ADOT analysis project to determine the expected schedule as well as export location. There is a scheduled task that can be deployed to grab the third party's .bacpac file via FTP or SFTP.

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Tables Summary

The following is a summary of each schema in the expected deliverable. This is meant to aid the third party in understanding the purpose of the tables in addition to the table definitions provided afterward.

Configuration table (config.ConfigurationSettings):

This table is not used in the master database, it is purely for tracking purposes of the third party.

Reference data tables (schema of "ref")

These tables house reference data which the header and result tables have relations. These tables are also synced to the master database upon import.

Note that the records in these tables will need to be manually kept in sync with the records used in the same tables in ADOT's import (the records should mirror exactly the records in ADOT's import tables). The third party is not expected to add or remove any records from this table, but if absolutely necessary, the third party must coordinate with ADOT to ensure that records are properly added in both their and ADOT's imports. Properly adding a record in each database means the key value in the reference table matches as well as any other description data. If they do not match, there will almost surely be issues when the data is imported into the master database.

Sample reference data configuration from ADOT's last project import is available in the accompanying .bacpac file.

Header and result tables (schema of "test")

These tables house the test headers and accompanying results that the third party would like to import into the master database for analysis.

Versioning: Versioning is an important concept regarding these two tables. The data sync is wired to only perform inserts on new records regarding the third party's headers and results; update to existing records are not accepted. The reasoning behind this logic is that the third party must implement a new version of a header / result set to be recognized by the ADOT analysis project if an update needs to be made. Additionally, when performing analyses of the test data, only the "latest" version of the header / result sets will be evaluated.

To create the initial version of a header / result set, add a test.Header record with a new, unique Lab_Test_Nbr value; the Version value should be 1. Also, add the appropriate linked test.Result records as well.

To increment the version, add another test.Header record with the same Lab_Test_Nbr value. Increment the Version value by 1 from the previous version; you will need to add the test.Result records to be used with this latest version as well, in addition to any other data changes that may differentiate version 2 from version 1.

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See sample .bacpac file for versioning examples.

Validation: It is additionally important to understand the concept of header / result validation as only valid third-party data is applicable for analysis in the master database. For clarity, we have broken this down into two different types of validation: root data validation and analysis configuration validation.

Root validation: Certain test header fields must be "whitelisted" in the master database in order to be recognized as valid. The third party will need to coordinate with the administrator of the ADOT analysis project regarding this. These fields are denoted with "Subject to root validation" in the table notes below.

Analysis configuration validation: Not all test headers and result sets are necessarily valid for analysis; the material code / material grade, test type, and test result specifier combination must be expected so that the ADOT analysis system knows which level of verification and analysis category into which it falls. (See accompanying spreadsheet that shows a view of how these fields are joined together, and see "Analysis Configuration View" below for additional information.) The affected fields are denoted with "Subject to analysis configuration validation" in the table notes below.

Name formatting: The two fields which include technician names (test.Header.SampledBy and test.Result.TestedBy) both require a delimiter between the first name and the last name so the names are parsed correctly by the data import. The delimiter is "###" – so an example of the expected name provided is "John###Smith" for technician with a first name of John, and a last name of Smith. Additionally, for test.Result.TestedBy, there may be multiple technicians provided in one record. The technicians are delimited by "^". An example of two technicians in this field is "John###Smith^Tom###Sawyer" which would denote that two technicians – one technician with a first name of John and a last name of Smith and another technician with a first name of Tom and a last name of Sawyer.

Trace log tables (schema of "dbo")
The trace log tables are not used directly in the application for the third-party submission, but are meant to be an audit of the changes to the header and result records throughout time.

For the most part, the fields in the audit table should mirror the fields for the main table (TraceLogHeader for test.Header and TraceLogResult for test.Result) at the time of the audit, with the addition of the two audit fields, TraceLogType and TraceLogDT.

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Accompanying Data

1. Sample .bacpac

See .bacpac file (attached file to this appendix) for a mockup of the expected deliverable from the third party.

2. Analysis Configuration View

The accompanying spreadsheet provides a look at the view in the ADOT analysis project with which header and result sets must join to be considered for analysis. While we have provided additional fields that may or may not be useful in understanding the data, the columns in the view pertinent to the data import are the following: “Materials,” “TestTypeDescription,” and “TestResultSpecifiers.”

The third party should provide headers and result sets whose header materials and result test types and test result specifiers match this view, if they want the record to be used in analysis in the master database.

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Table Definitions

Table: **config.ConfigurationSettings**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
ProjectNumber	char	8	False		Primary Key

Table: **ref.AnalysisType**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
AnalysisTypeID	int		False		Primary Key
AnalysisTypeDescription	varchar	255	True	Description of the different category (type) of test (concrete, soil, and aggregates)	

Table: **ref.Feature**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
FeatureID	int		False		Primary Key
FASTFeatureCode	char	20	False	FAST code for the roadway feature	
FASTFeatureDescription	char	100	False	Full English description of the feature	

Table: **ref.Purpose**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
PurposeID	int		False		Primary Key
FASTPurposeCode	char	1	False	Code for the purpose of the sample testing	
FASTPurposeDescription	char	25	False	Full English description of the purpose	

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Table: **ref.SieveSize**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SieveSizeSuffix	nvarchar	123	False		Primary Key
SieveSizeDescription	nvarchar	255	False		

Table: **ref.TestType**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
TestTypeID	int		False		Primary Key
TestTypeDescription	varchar	60	False	Full English description of the various types of concrete and soil and aggregate tests.	

Table: **ref.UnitOfMeasure**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
UnitOfMeasureID	int		False		Primary Key
UnitOfMeasureDescription	varchar	50	False	Description of the unit of measure.	

Table: **test.Header**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
ID	int		False		Primary Key
HeaderID	int		True		Unique key used to identify header in master database.
AnalysisTypeID	int		False		Foreign Key referencing ref.AnalysisType. AnalysisTypeID
CourseLift	char	6	True	Sample Lift Number.	
Direction	char	10	True	Travel direction.	
FeatureID	int		True		Foreign Key referencing ref.Feature.FeatureID

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Field Name	Data Type	Length	Nullable	Notes	Key / Relational
MaterialGrade	varchar	15	True	Material Grade - 2, 12A, 34B, etc. *Subject to root validation.* *Subject to analysis configuration validation.*	
MaterialCode	char	10	True	Material Code - AC, FA, BM, etc. *Subject to root validation.* *Subject to analysis configuration validation.*	
Misc	varchar	255	True	Sample Remarks	
Roadway	varchar	285	True	Project Location and/or Highway Termini Description	
SampleID	varchar	30	True	Surrogate Key / ID / Number to identify specific sample	
SampleLocation	varchar	60	True	Location where the sample is take from	
SampleTypeCode	varchar	4	True	Purpose of the sample (Acceptance, Correlation, etc.) See the [ref].[Purpose] table for the definition of the purpose code. *Subject to root validation.*	

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Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SampledBy	varchar	50	True	The name of the person who took the sample. *Subject to name formatting.*	
SampledDate	date		True	The date on which the sample was taken.	
SectionID	int		True	The section ID where the sample is taken from. Corresponds to "Segment": enter 1 for "A"; 2 for "B"; 3 for "C"; 4 for "D"; 6 for "Offsite"	
SplitSampleID	varchar	30	True	Surrogate Key / ID / Number to identify the sample split from this sample.	
Station	varchar	21	True		
StructureNumber	varchar	50	True		
SupplierName	varchar	128	True	Full supplier name. *Subject to root validation.*	
PlantName	varchar	128	True		
ProductCode	varchar	50	True	*Subject to root validation.*	
Lab_Test_Nbr	varchar	20	True	*Used for versioning.*	
ProjectNumber	varchar	8	True		
SurrogateKey	int		False	Internal tracking field – not used for third party submissions.	
SurrKeySource	varchar	5	True	Internal tracking field – not used for third party submissions.	
Version	int		True	*Used for versioning.*	

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Field Name	Data Type	Length	Nullable	Notes	Key / Relational
OriginalSource	varchar	50	True	Internal tracking field – not used for third party submissions.	

Table: **test.Result**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
ResultID	int		False		Primary Key; key used to identify result in master database.
HeaderID	int		False		Foreign Key referencing test.Header.HeaderID.
TestTypeID	int		False	*Subject to analysis configuration validation.*	Foreign Key referencing ref.TestType.TestTypeID.
UnitOfMeasureID	int		True		Foreign Key referencing ref.UnitOfMeasure. UnitOfMeasureID
TestResultSpecifier	varchar	255	True	*Subject to analysis configuration validation.*	
TestResultSize	varchar	255	True	Valid values: 1", 1-1/2", 1/2", 1/4", 2", 2-1/2", 3", 3/4", 3/8", No. 10, No. 100, No. 16, No. 200, No. 30, No. 4, No. 40, No. 50, No. 8, Negative No. 4, Negative No. 200, Oversize 3, Oversize 6	
TestResultValueNumeric	float		True	When the result of the measurement is a number, this is the measurement value.	
TestResultValueString	varchar	255	True	When the result of the measurement is a string, this is the measurement result.	

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Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SurrogateKey	int		True	Internal tracking field – not used for third party submissions.	
TestedBy	varchar	100	True	The name of the person(s) who performed the test. *Subject to name formatting.*	
SurrKeySource	varchar	4	True	Internal tracking field – not used for third party submissions.	
AuditKey	varchar	568	True	Internal tracking field – not used for third party submissions.	
StampCode	int		True	Enter: 1 for pass; 2 for engineer decision; 5 for fail; 9 for informational; 0 for not assigned.	

Table: **dbo.TraceLogHeader**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
TraceLogHeaderID	int		False		Primary Key
TraceLogType	char	1	False	Enter: “I” for insert; “U” for update; “D” for delete.	
TraceLogDT	smalldatetime		False	Date of audit log entry.	
HeaderID	int		True		
AnalysisTypeID	int		True		
CourseLift	char	6	True		
Direction	char	10	True		
FeatureID	int		True		
MaterialGrade	varchar	15	True		
MaterialCode	varchar	100	True		
Misc	varchar	255	True		
Roadway	varchar	285	True		

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Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SampleID	varchar	30	True		
SampleLocation	varchar	250	True		
SampleTypeCode	varchar	4	True		
SampledBy	varchar	100	True		
SampledDate	date		True		
SectionID	int		True		
SplitSampleID	varchar	30	True		
Station	varchar	21	True		
StructureNumber	varchar	50	True		
SupplierName	varchar	128	True		
PlantName	varchar	128	True		
ProductCode	varchar	50	True		
Lab_Test_Nbr	varchar	20	True		
ProjectNumber	varchar	8	True		
SurrogateKey	int		True		
SurrKeySource	varchar	5	True		
Version	int		True		
OriginalSource	varchar	50	True		

Table: **dbo.TraceLogResult**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
TraceLogResultID	int		False		Primary Key
TraceLogType	char	1	False	Enter: “I” for insert; “U” for update; “D” for delete.	
TraceLogDT	smalldatetime		False	Date of audit log entry.	
ResultID	int		True		
HeaderID	int		True		
TestTypeID	int		True		
UnitOfMeasureID	int		True		
TestResultSpecifier	varchar	255	True		
TestResultSize	varchar	255	True		
TestResultValueNumeric	float		True		
TestResultValueString	varchar	255	True		
SurrogateKey	int		False		
TestedBy	varchar	100	True		
SurrKeySource	varchar	4	True		
AuditKey	varchar	568	True		
StampCode	int		True		

Certificate Of Completion

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Certificate Pages: 5
Initials: 0
AutoNav: Enabled
EnvelopeId Stamping: Enabled
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Phoenix, AZ 85007
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Jesus A Sandoval-Gil jsandoval-gil@azdot.gov State Materials Engineer ADOT Security Level: Email, Account Authentication (None)	DocuSigned by: Jesus A Sandoval-Gil F9A6FBCB94A6460... Signature Adoption: Pre-selected Style Using IP Address: 184.103.172.32	Sent: 11/24/2020 1:25:52 PM Viewed: 11/24/2020 1:38:06 PM Signed: 11/24/2020 1:39:45 PM
Electronic Record and Signature Disclosure: Not Offered via DocuSign		
Ammon Heier ammon.heier@dot.gov Security Level: Email, Account Authentication (None)	DocuSigned by: Ammon Heier FEF6E4414BAF4AE... Signature Adoption: Pre-selected Style Using IP Address: 152.119.227.92	Sent: 11/24/2020 1:39:48 PM Viewed: 11/24/2020 1:53:00 PM Signed: 11/24/2020 1:53:23 PM
Electronic Record and Signature Disclosure: Accepted: 11/24/2020 1:53:00 PM ID: 55c32fcf-9f27-4180-9826-cfc880668972		

In Person Signer Events	Signature	Timestamp

Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp

Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps
Envelope Sent	Hashed/Encrypted	11/24/2020 1:25:52 PM
Certified Delivered	Security Checked	11/24/2020 1:53:00 PM

Envelope Summary Events	Status	Timestamps
Signing Complete	Security Checked	11/24/2020 1:53:23 PM
Completed	Security Checked	11/24/2020 1:53:23 PM

Payment Events	Status	Timestamps

Electronic Record and Signature Disclosure

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Required hardware and software

Operating Systems:	Windows2000? or WindowsXP?
Browsers (for SENDERS):	Internet Explorer 6.0? or above
Browsers (for SIGNERS):	Internet Explorer 6.0?, Mozilla FireFox 1.0, NetScape 7.2 (or above)
Email:	Access to a valid email account
Screen Resolution:	800 x 600 minimum
Enabled Security Settings:	•Allow per session cookies •Users accessing the internet behind a Proxy Server must enable HTTP 1.1 settings via proxy connection

** These minimum requirements are subject to change. If these requirements change, we will provide you with an email message at the email address we have on file for you at that time providing you with the revised hardware and software requirements, at which time you will have the right to withdraw your consent.

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To confirm to us that you can access this information electronically, which will be similar to other electronic notices and disclosures that we will provide to you, please verify that you were able to read this electronic disclosure and that you also were able to print on paper or electronically save this page for your future reference and access or that you were able to e-mail this disclosure and consent to an address where you will be able to print on paper or save it for your future reference and access. Further, if you consent to receiving notices and disclosures exclusively in electronic format on the terms and conditions described above, please let us know by clicking the 'I agree' button below.
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TP Attachment 113-2

ADOT Construction Bulletins

- *ADOT Construction Bulletin 15-01*
- *ADOT Construction Bulletin 16-01*

CONSTRUCTION BULLETIN 15-01

TO: Dallas Hammit, Deputy Director for Transportation
Robert J. Samour, Sr. Deputy State Engineer, Major Projects
Steve Boschen, Deputy State Engineer, ITD Division Director
Todd Emery, Deputy State Engineer, Statewide Operations
Brent Cain, Deputy State Engineer, Urban Operations
Barry Crockett, Deputy State Engineer, Contracts & Clearances
Paula Gibson, Chief Right-of-Way Agent, Right-of-Way Group
Paul Burch, Acting Asst. State Engineer, Materials
Lonnie Hendrix, Asst. State Engineer, Maintenance
Trent Kelso, Asst. State Engineer, Urban Project Management
Vincent Li, Asst. State Engineer, Statewide Project Management
Maysa Hanna, Asst. State Engineer, Traffic Engineering Group
Annette Riley, Asst. State Engineer, Roadway Design Group
Shafi Hasan, Asst. State Engineer, Bridge Group
Paul O'Brien, Environmental Planning Group Manager
District Engineers
Resident Engineers
FHWA

FROM: Julie E. Kliewer, Assistant State Engineer, Construction

DATE: January 5, 2015

Pavement Marking Layout & Testing

(Supersedes Construction Bulletin 11-03)

Purpose

1. To reiterate the purpose of Construction Bulletin 05-02, *Pavement Markings* and Standard Specification 925-3, *Construction Surveying and Layout*. The centerline layout for the final surface course requires instrument survey by the contractor prior to the placement of the final pavement markings.
2. To clarify and standardize ADOT's acceptance testing practices related to the inspection of the retroreflectance and thickness of thermoplastic and dual component (epoxy) pavement markings.

Background

1. The requirements in Standard Specification 925-3 and guidance in Construction Bulletin 05-02 address adequate survey control for the placement of temporary and permanent striping. Survey control is not being provided uniformly.
2. Guidelines for testing striping in Construction Bulletin 11-03 have been modified and expanded after input from the pavement marking industry, ADOT Traffic Operations, ADOT Materials Group and ADOT Construction Group.

Process

Pavement Marking Survey and Layout

The striping subcontractor and the contractor's surveyor shall be invited to a pavement marking preactivity meeting which may be held in conjunction with the paving preactivity meeting. Construction Bulletins 05-02 and 14-03 shall be reviewed with the contractor at the pavement marking preactivity meeting. The preactivity meeting shall be conducted a minimum of two weeks prior to any paving activity. The meeting shall emphasize that the Contractor is responsible for providing instrument controlled survey points for permanent pavement markings and pavement marking application will not begin until this criteria is met (Std. Spec. 925-3.01).

On projects that include no-passing zones, ADOT's Traffic Operations' No Passing Zone (NPZ) crew is responsible to layout related markings. The specifications, unless superseded by the plans, require the contractor to contact the NPZ crew at least 5 days prior to placement. However, the RE should provide the NPZ crew a schedule of planned operations at least two weeks prior to the application of any temporary, initial or final striping.

Thickness Testing

The Resident Engineer is responsible for verifying that pavement markings meet the minimum thickness requirements.

Thermoplastic

Thickness shall be tested at a minimum of two locations, randomly selected in any given mile, using the "Dried" method. This is done by placing a flat sheet of metal or duct tape ahead of the striping apparatus [reference 704-3.02(G)]. Thickness measurement includes glass beads. The gaps created by thickness sampling do not require reapplication of thermoplastic.

Thickness will be measured with a digital caliper capable of measuring to the nearest thousandth of an inch. Each Construction Org is responsible for the purchase of this piece of equipment. If you have any questions regarding this equipment contact the Structural Materials Testing Section at (602) 712-7418.

For thermoplastic measured 0.088" or less in thickness, a second application of extruded 0.080" thick thermoplastic (meeting all the requirements of the specifications) shall be placed over the original application.

Bag and label each sample separately (include all thermoplastic from the plate/tape). The label should include the TRACS number, date and location. Also include the surface and air temperatures, and wind

conditions. Do not discard failing samples until final acceptance is documented (should disputes arise regarding thickness or material properties).

Dual Component (Epoxy)

In accordance with the Standard Specifications and the Material Sampling Guide, random wet film thickness checks are required [Std. Spec 709-3.02, (F) (1) & (2)].

Retroreflectance Testing

Retroreflectance shall be measured with a LTL-X Delta Retroreflectometer or similar device approved by Construction Operations. Each district will ensure a minimum of two employees are trained to use this device – Construction Group will assist by providing training. A device will be housed with each of the Regional Traffic Engineers. Each device requires calibration by the manufacturer annually. Usage needs to be coordinated through the Regional Traffic Engineer. Construction Operations has one device and will initially assist the districts with measurement as schedule permits. Construction Operations' role is primarily Independent Assurance. The following link contains a video on the operation of the LTL-X Delta Retroreflectometer:
http://www.ennisflintamericas.com/by-category/retroreflectometers/ltl-x-markii

Prior to testing with the retroreflectometer, a nighttime visual inspection shall be done by the Construction Org to identify any areas of concern. These areas of concern should be part of the retroreflectance acceptance testing.

Retroreflectance should be tested within 30 days of application, but no sooner than three days after application, unless loose beads are hand swept from test locations. Raw test results shall be provided to the contractor within 24 hours of testing.

In addition to the MUTCD traffic control requirements, the use of law enforcement is recommended and encouraged when testing.

Testing will be performed every 0.2 miles, with four readings (averaged) taken at each location. After each reading, the retroreflectometer is picked up and moved forward before taking another reading; the four readings shall be taken randomly within a 10 foot section. The average of the four readings shall be the result for that location. Should the average of these readings not meet the required retroreflectance values, a second test of four readings will be performed 50' forward from the failing test. The higher average value of the two tests will determine the results for that location.

Retroreflectance testing is always in the direction of traffic. On roadways where yellow stripes separate opposing traffic, testing is done in both directions (two locations per 0.2 miles, one in each direction for each line). This will ensure that minimum retroreflectance values are met in both directions.

Example: for one mile on a two-lane highway, five tests are required on each edge line and 20 tests are required for a double yellow centerline (five each direction per line). Since each test consists of four readings, a total of 120 readings are required in this one mile segment.

Longitudinal lines less than 0.2 miles (such as 12" white turn lanes), regardless of length, must be tested. A single test of four readings shall be taken at the approximate midpoint of each line. Should the average of these readings not meet the required retroreflectance values, a second test of four readings will be performed at the approximate half way point between the midpoint and end. The higher average value of the two tests will determine the results for that location. Retroreflectance is not tested on transverse markings, symbols or legends. **Note:** All long line pavement markings (longitudinal striping) must be applied with a truck-mounted unit. Push carts are allowed for all other applications (transverse markings, symbols).

The retroreflectance values detailed in the contract specifications for thermoplastic, 704-2.03(C), and dual component (epoxy), 709-2.02(J), are minimum values. Markings that fail to meet these minimums will require reapplication and retesting of striping materials. Reapplication shall start from the location of a passing test, across the failure area(s), to the next passing test location. For thermoplastic sections applied on asphalt determined to be deficient in retroreflectance, a second application of 0.080 inches shall be applied For epoxy applied on asphaltic pavements determined to be deficient in retroreflectance, a second application of 0.025 inches thick shall be applied. In both cases the reapplication does not require removal of the deficient section. For both thermoplastic and epoxy sections applied on PCCP or concrete bridge decks that are determined to be deficient in retroreflectance - the failing application must be removed and reapplied.

Depending on the extent of failing pavement markings, it may not be practical to retest with the reflectometer. In that case, the Construction ORG may perform a visual nighttime inspection. If the striping appears as bright as or brighter than the adjacent striping that meets the required retroreflectance, the engineer may accept the reapplication. This visual inspection must be documented.

Should retests for the reapplication of either thermoplastic or epoxy pavement markings fail to meet the required minimum retroreflectance, the contractor shall be required to remove the reapplied striping. Prior to removal the contractor shall demonstrate to the Resident Engineer that the removal can be done without scarring the pavement.

In situations where striping is the final item of work prior to substantial completion of the project, contract time shall be stopped upon completion of the striping. Contract time shall resume when testing commences. Substantial completion will not occur until all testing meets the specified requirements.

Traffic Control and associated costs needed for restriping are the responsibility of the contractor.

CONSTRUCTION BULLETIN 16-01

TO: Dallas Hammit, Deputy Director for Transportation/State Engineer
Steve Boschen, Assistant Director, Infrastructure Delivery and Operations
Brent Cain, Assistant Director, TSMO
Robert J. Samour, Sr. Deputy State Engineer, Major Projects
Todd Emery, Deputy State Engineer, Project Delivery
Barry Crockett, Deputy State Engineer, Contracts & Clearances
Jesse Gutierrez, Deputy State Engineer, Operations
Paula Gibson, Chief Right-of-Way Agent, Right-of-Way Group
Lonnie Hendrix, Asst. State Engineer, TSMO System Management
Annette Riley, Asst. State Engineer, Project Management Group
Maysa Hanna, Asst. State Engineer, Traffic Engineering Group
Greg Byers, Asst. State Engineer, Roadway Engineering Group
David Eberhart, Asst. State Engineer, Bridge Group
Paul O'Brien, Environmental Planning Group Manager
District Engineers
Assistant District Engineers
Resident Engineers
FHWA

FROM: Julie E. Kliewer, Assistant State Engineer, Construction & Materials

DATE: February 2, 2016

Thermoplastic Striping Retroreflectance Acceptance

(Supersedes Construction Bulletin 14-03)

Purpose

To extend the interim procedure for statewide retroreflectance acceptance of thermoplastic pavement markings.

Background

ADOT has experienced instances where some projects had failed the retroreflectance requirements as specified in the contracts.

Process

- For yellow thermoplastic only, a 10 percent tolerance variation from the contract requirements on retroreflectivity will be permitted before restriping of the roadway is required. There will be no variation from the contract requirements permitted for the white thermoplastic retroreflectivity.
- For projects that fail to meet retroreflectivity requirements, the State Traffic Engineer and the State Construction & Materials Engineer must be consulted.
- The tolerance of the 10 percent variation on yellow striping has been extended to February 1, 2017.

TP Attachment 118-1 – Acquisition and Relocation Status Report

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
1	7-10620	12213017	Illini LLC	3427 E Illini St	Business	ROW – Partial Take	• **ADOT:** Demolition (business signs, asphalt) • **Developer:** N/A • **Cost to Cure paid to Owner:** Removal of containers	12/31/2020
2	7-10621	12213018A	Freeway Display Properties LLC	3501 E Illini St	Business	ROW – Partial Take	• **ADOT:** Demolition (asphalt) • **Developer:** N/A • **Cost to Cure paid to Owner:** Removal of containers	12/31/2020
3	7-10621-S1	12213018A	Iheartmedia + entertainment, Inc., et al	3501 E Illini St	Billboard	Billboard	• **ADOT:** Demolition (billboard foundation) • **Developer:** N/A • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	1/31/2021
4	7-10623	12213022B	Caz Enterprises LLC	3848 S 36th St	Business	ROW – Total Take	• **ADOT:** Demolition (asphalt) • **Developer:** Protect in place billboard • **Cost to Cure paid to Owner:** N/A	12/31/2020
5	7-10624	12211038	Eastgroup Properties Lp	3825 S 36th St	Business	Perm Maint Easement	• **ADOT:** N/A • **Developer:** Developer to remove 450 LF of fencing and restore easement to existing condition. Fencing per Table 200-4 in TP. • **Cost to Cure paid to Owner:** N/A	12/31/2020
6	7-10626	12210005B	Pbl Revocable Trust	3830 S 38th St	Business	Access Easement Perm Maint Easement	• **ADOT:** N/A • **Developer:** Developer to remove 170 LF of fencing and restore permanent maintenance easement to existing condition. Two existing drywells within parcel to be protected in place. Fencing per Table 200-4 in TP. • **Cost to Cure paid to Owner:** N/A	12/31/2020
7	7-10627-S1	12454028B	Teton River Properties LLC	4114 E Wood St	Billboard	Billboard	• **ADOT:** Demolition (billboard foundation) • **Developer:** N/A • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	1/31/2021

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
8	7-10628	12208050A	Argyle Holdings LLC	3801 E Illini St	Business	ROW – Total Take	• **ADOT:** Demolition (building, asphalt, concrete, drywell) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
9	7-10630	12208046B	Landmark Infrastructure Asset Opco LLC	3835 E Illini St	Business	ROW – Partial Take	• **ADOT:** Demolition (asphalt, concrete) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
10	7-10630-S1	12208046B	Iheartmedia + entertainment, Inc., et al	3835 E Illini St	Billboard	Billboard	• **ADOT:** N/A • **Developer:** N/A • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	12/31/2020
11	7-10716	12205045	State of Arizona	3845 E Illini St	Business	Previously acquired	• **ADOT:** Demolition (building, asphalt, fencing, containers) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
12	7-10631	12208044	State of Arizona	3845 E Illini St	Business	Previously acquired	• **ADOT:** Demolition (building, asphalt, concrete, fencing) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
13	7-10651	12454013B	Mccreary Pew Inc	4121 E Raymond St	Business	ROW – Partial Take & Drainage Easement	• **ADOT:** Demolition (tree, business sign) • **Developer:** Developer to restore easement to existing condition • **Cost to Cure paid to Owner:** Paid for business sign	2/28/2021
14	7-10459	12208049	State of Arizona	3801 E Illini St	Business	Previously acquired	• **ADOT:** Demolition (building, asphalt, concrete, fencing) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
15	7-10683-S1	12455001k	Viel Gluck Lp Et Al	4425 E Elwood St	Billboard	ROW – Total Take	• **ADOT:** Demolition (billboard foundation) • **Developer:** N/A • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	1/31/2021

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
16	7-10654	12455646B	Exeter 4425-4535 East Elwood LLC	4425 E Elwood St	Business	Previously acquired	• **ADOT:** Demolition completed • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
17	7-10654-S1	12455646B	Clear Channel Billboard	4425 E Elwood St	Billboard	Billboard	• **ADOT:** Demolition (billboard foundation) • **Developer:** N/A • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	1/31/2021
18	7-10652	12454015A	Raymond Trust Partners LLC	4221 E Raymond St	Business	ROW – Partial Take	• **ADOT:** Demolition (building, business sign and foundation, asphalt, curb, transformer). • **Developer:** N/A • **Cost to Cure paid to Owner:** Replacement of on-premise business sign	2/28/2021
19	7-10652-S1	12454015A	Raymond Trust Partners LLC	4221 E Raymond St	Billboard	Billboard	• **ADOT:** Demolition (billboard foundation) • **Developer:** N/A • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	2/28/2021
20	7-10629	12208047	State of Arizona	3833 E Illini St	Business	Previously acquired	• **ADOT:** Demolition (building, asphalt, concrete, fencing) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
21	7-10661	12454032B	State of Arizona	4134 E Wood St	Business	Previously acquired	• **ADOT:** Demolition (asphalt, curb, fencing, business sign and foundation) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
22	7-10662	12454031	State of Arizona	4010 S 43rd Pl	Business	Previously acquired	• **ADOT:** Demolition completed • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
23	7-10662-S1	12454031	State of Arizona	4010 S 43rd Pl	Billboard	Billboard	• **ADOT:** Demolition (billboard foundation) • **Developer:** N/A • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	1/31/2021
24	7-10663	12454005D	State of Arizona	4015 S 43rd Pl	Business	Previously acquired	• **ADOT:** Demolition (business sign and foundation, asphalt, concrete, fencing) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
25	7-10693	12453028D	University Airport Parking LLC	N/A	Business	ROW- Partial Take & TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition • **Cost to Cure paid to Owner:** Minor cure will include repair of the irrigation system at the south end of the property near the area of the proposed acquisition.	12/31/2020
26	7-12437	12456039A	Thomas J Mccarthy Family	2640 W 10th Pl	Business	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition • **Cost to Cure paid to Owner:** N/A	12/31/2020
27	7-10694	12456040D/ 12456040C	Concrete Pumping Property Holdings LLC	1025 S 48th St	Business	ROW – Partial Take & TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** Repair of irrigation system and relocating mailbox	12/31/2020
28	7-10696	12458090C	State of Arizona	N/A	Business	Previously acquired	• **ADOT:** Demolition (building, asphalt, concrete, fencing, clearing, transformer) • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
29	7-10695	N/A, 12456005C, 12456005D, 12456006A	Icon Owner Pool 1 West/Southwest LLC	N/A, 1220 S Park Dr, 2445 W 12th St, 1220 S Park Dr	Business	ROW – Partial Take & TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** Minor cure will include replacement of signs, landscaping and irrigation system.	12/31/2020
30	7-11761	12458091	Maricopa County Community College	2419 W 14th St	College	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. See Section 118.05 in TP for additional requirements. • **Cost to Cure paid to Owner:** N/A	12/31/2020
31	7-11961	12325004A	G6 Hospitality Property LLC	4909 S Wendler Dr	Business	ROW – Partial Take & TCE	• **ADOT:** Demolition (fencing, clearing) • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2021
32	7-12392	12458096b	Tempe Hospitality Ventures LLC	1600 S 52nd St	Business	ROW – Partial Take	• **ADOT:** Demolition (south concrete wall, clearing) • **Developer:** Coordination with utility companies for utility relocations • **Cost to Cure paid to Owner:** N/A	12/31/2020
33	7-12000	30143145	Acosta Lorenzo T/Sandra G	9202 S Calle Maravilla	Private Residential	No Acquisition – ADOT ROW within this parcel limits is not available	• **ADOT:** N/A • **Developer:** Developer to avoid impacts to this parcel. See TP Attachment 118-4. • **Cost to Cure paid to Owner:** N/A	N/A
34	7-12387-S1	12328159B	Lamar Advertising Southwest	2900 S Diablo Wy	Billboard	Billboard	• **ADOT:** Demolition (billboard foundation) • **Developer:** N/A. Demolition of billboard foundation (5' diam, remove top 3') • **Cost to Cure paid to Owner:** Billboard relocation including power service reconnection	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
35	7-12432	30142021, 30142022	SKDR Holdings LLC	1900 W Carmen St	Business	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
36	7-12433	30142023 30142024 30142025 30142026 30142027 30142027 30142028 30142029 30142030	Hubbard Radio Phoenix LLC	9430 S Calle Bella Vista	Business	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
44	7-12434	30142032A	Realty Associates Fund XI	6718 S Harl Ave	Business	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
45	7-12435	30142033	Town of Guadalupe	9600 S 54th St	Town	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
46	7-12436	N/A	S Calle Bella Vista	S Calle Bella Vista	Town	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
47	7-12396	30111006k	Ca Phoenix Pointe Owner LLC	8809 S Pointe Pkwy	Subdivision	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
48	7-11988	12325002B	Arc Cafehld001 LLC	5101 S Wendler Dr	Business	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
49	7-10709	12325064	Ireland Miller Inc	5005 S Wendler Dr	Business	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
50	7-12390	12325066	Eleven Investments LLC	4415 S Wendler Dr	Business	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
51	7-10702	12328073B, 12328072, 12328071	Bar Jcr Phx Flex Investors LLC	N/A	Business	ROW – Total Take & TCE	• **ADOT:** Demolition (partial building, asphalt up to ROW line, curb, fencing, fire connections) • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	06/11/2021
52	7-12387	12328159B	Tempe Diablo LLC	2900 S Diablo Wy	Business	ROW – Previously acquired & TCE	• **ADOT:** Demolition (parking lot asphalt, curb, landscaping, north wall, streetlights). Existing driveways to remain. Existing streetlights within TCE to remain. Paperwork for drywell removal. • **Developer:** Developer to restore existing landscaped areas up to ROW within TCE. Demolition of 3 drywells located in ADOT ROW. Relocation of water vault, backflow preventer and water vault with FDC.	3/31/2021
53	7-11959	12333005B	City of Tempe	2000 W Westcourt Wy	Stadium	ROW – Partial Take	• **ADOT:** Demolition (billboard power reconnection, street lighting, asphalt, fencing, concrete wall) • **Developer:** N/A • **Cost to Cure paid to Owner:** Survey, engineering, permits, site preparation, asphalt paving striping, lighting, basic landscaping, general contractor overhead including bond, taxes, and fee. Cure for windows and parking. Driveway relocation.	06/11/2021

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
54	N/A	12457002F	State of Arizona	2600 W Broadway Rd	ADOT	See TP Attachment 118-3	• **ADOT:** Demolition (Existing ECD Building) • **Developer:** Developer to redevelop site per TP Attachment 118-3 • **Cost to Cure paid to Owner:** N/A	09/30/2021
55	7-10660	12454028B	Forever Nutraceutical LLC	4114 E Wood St	Business	ROW – Partial Take	• **ADOT:** Demolition (business sign and foundation, asphalt, curb, fencing, clearing) • **Developer:** N/A • **Cost to Cure paid to Owner:** Repair landscape irrigation system, Replace concrete curb and gutter, Restripe 5 parking spaces.	12/31/2020
56	7-10659	12454095	Maricopa County Community College District	4110 E Wood St	College	TCE	• **ADOT:** N/A • **Developer:** Developer to restore easement to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
57	N/A	N/A	SRP	Western Canal	Canal	IGA	• **ADOT:** ADOT/SRP to complete box culvert strengthening improvements • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	09/30/2021
58	7-10366	12328159B	Muller-Diablo Mott LLC, ET AL	2900 S Diablo Wy	Business	ROW-TCE Partial take Previously acquired	• **ADOT:** • **Developer:** N/A • **Cost to Cure paid to Owner:** Paid for parking structure to be built to replace loss of parking from ROW take.	12/31/2020
59	7-10491	12209035	Kalil Bottling Co	4045 S 38th St	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
60	7-10615	12214006C, 12214026B, 12214024A, 12214002B, 12214018E	City of Tempe	3938 S 38th St	Canal	TCE	• **ADOT:** • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
61	7-10625	12210005D	Vanwood Investment Company (Leased by George Brazil)	3643 E Anne St	Business	ROW Partial take Previously acquired New TCE and Access Easement	• **ADOT:** • **Developer:** N/A. Developer to restore TCE to existing condition. • **Cost to Cure paid to Owner:** N/A	12/31/2020
62	7-10627	12210004A	Teton River Properties LLC (Tuff Shed)	3745 E Illini St	Business	ROW Partial take Previously acquired	• **ADOT:** • **Developer:** N/A • **Cost to Cure paid to Owner:** Drywells and slab removal	12/31/2020
63	7-10647	12210011	Presson Broadway LLC	3751 E Maricopa Fwy	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
64	7-10650	12454012B	River of Life Trabernacle	4039 E Raymond St	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
65	7-10653	12454100	Bottling Group LLC	4242 E Raymond St	Business	ROW-TCE Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
66	7-10655	12455650	WBCMT 2006-C23 Elwood Office LLC	4575 E Elmwood St	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
67	7-10657	12454018A	Maricopa Business Park LLC	4022 E Broadway Rd	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
68	7-10683	12455001J	Boa Sorte Limited Partnership ET AL	4598 E Broadway Rd	Business	ROW	• **ADOT:** N/A • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
69	7-10699	12333049A	Tempe Fountainhead Corp LLC	1620 W Fountainhead Pkwy	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
70	7-10704	12328074A	Jimasia Ll c	2104 W Southern Ave	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
71	7-10705	12327781	Galleria Palms Associates Inc	1600 W La Jolla Dr	Residential	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
72	7-10706	12327782	Tempe Village Homeowners Association Inc	N/A	Residential	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
73	7-10707	12325066	Jpmc 2007-LDP10 Corporate Fountains LLC	4415 E Wendler Dr	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
74	7-10714	12333058A	Us Real Estate Limited Partnership	1650 W Alameda Dr	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
75	7-10877	12333056B	Park Corners LLC	1625 W Fountainhead Pkwy	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
76	7-10885	12453040	Aum Hospitality Ventures LLC	3220 S 48th St	Business	ROW Partial take Previously acquired	• **ADOT:** N/A • **Developer:** N/A • **Cost to Cure paid to Owner:** Electric work	12/31/2020
77	7-11355	12327725	Damien Barrios-Lopez	1804 W Village Wy	Residential	ROW Total Take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
78	7-11960	12333053A	1665 Alameda Property Owner LLC	1665 W Alameda Dr	Business	ROW Partial take Previously acquired	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
79	7-12404	N/A	Hohokam Development Company, a partnership	W 12th St	Business	ROW Partial Take	• **ADOT:** N/A • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-1 Acquisition and Relocation Status Report								
No.	**Parcel No.**	**APN**	**Owners Name**	**Site Address**	**Property Type**	**Acquisition Type**	**Activity**	**Est. Date Parcel Available for Developer Use**
80	7-12461	30112145	Town of Guadalupe	9050 S Calle Bella Vista	Residential	TCE	• **ADOT:** Demolition Complete • **Developer:** N/A • **Cost to Cure paid to Owner:** N/A	12/31/2020
81	7-11749	30112145	U.S.A. (S.R.P.)	Tempe Drain on SR 143	Canal	License Agreement	• **ADOT:** N/A • **Developer:** Coordinate with ADOT to obtain License Agreement from SRP • **Cost to Cure paid to Owner:** N/A	12/31/2020

TP Attachment 118-2

Twin Buttes Cemetery Aerial Easement Requirements

TP Attachment 118-2
Twin Buttes Cemetery Aerial Easement Requirements
Developer's Requirements

The following table includes the Project-specific requirements as written in the Aerial Easement 07-10689, with minor modifications for clarification purposes. As it relates to these Technical Provisions, references to project, Interstate 10 and improvements mean the Project, and references to Plaintiff mean Developer. Developer is responsible for performing and complying with all obligations of ADOT, except those obligations that are specifically identified below as being the obligations of ADOT.

Page Number	Aerial Easement Requirements	Description of ADOT-Retained Obligations
PDF Page 6/20	Plaintiff, State of Arizona does hereby have judgement condemning for its use the aerial easement described in Exhibit A.	None retained; all delegated to Developer.
PDF Page 6/20 and Page 7/20	Plaintiff will be constructing a bridge over the area described in Exhibit A to widen Interstate 10. The real property below the aerial easement is owned and shall remain under the ownership of Defendant Maricopa County, who uses the real property as a cemetery for is citizens ("Property"). In order to maintain the dignity of the area for the citizens of Defendant and their families, Plaintiff shall provide, at Plaintiff's sole cost and expense, the following improvement(s) and aesthetic treatment(s) to the area in, on and under the bridge ("Improvements") a) Plaintiff shall provide electricity and lighting underneath the bridge twenty-four (24) hours a day, seven (7) days a week. Plaintiff shall maintain the lighting fixture(s) and replace any and all bulbs or tubes necessary. b) Plaintiff shall install decorative rock landscaping and decorative fencing. Plaintiff further agrees to provide fencing to keep trespassers from underneath the bridge substantially similar to the type and design of fencing and in the location depicted in Exhibit B. Plaintiff shall ensure the area in, on and under the bridge is neat, clean and free of weeds, grass trash and debris. Plaintiff further ensures that all fencing installed by Plaintiff is maintained in good and workable condition. c) Plaintiff shall provide aesthetic treatment to the bridge abutment and retaining walls substantially similar to the type and design as depicted in Exhibit C. Plaintiff shall ensure the bridge, its abutments and retaining walls are free of graffiti and Plaintiff shall further be responsible for removing any and all graffiti.	None retained; all delegated to Developer.
PDF Page 7/20	Defendant MARICOPA COUNTY shall have judgement against Plaintiff in the sum of Fifteen Thousand Dollars and N0/100 Dollars ($15,000.00) as total compensation for damages of any kind as a result of the take and construction of a highway bridge for which the aerial easement was taken. Said sums shall be paid directly to Defendant MARICOPA COUNTY.	Previously paid by ADOT; Does not apply to Developer

OFFICIAL RECORDS OF
MARICOPA COUNTY RECORDER
HELEN PURCELL
20110067549,01/25/2011 11:16,7010698-4-2-1--,N
ELECTRONIC RECORDING

When recorded return to
ARIZONA DEPARTMENT
OF TRANSPORTATION
R/W OPERATIONS SEC.
205 S. 17TH AVE., MD 612E
Phoenix, AZ 85007-3212

This space reserved for recording information

FINAL ORDER OF CONDEMNATION

STATE OF ARIZONA
DEPARTMENT OF TRANSPORTATION

VS.

MARICOPA COUNTY

PARCEL NUMBER: 7-10698

CERTIFIED COPY

FILED
1/18/11 3:10 PM
MICHAEL K. JEANES, Clerk
By M. Hovorka
M. Hovorka, Deputy

TERRY GODDARD
Attorney General
Ron J. Aschenbach, SBA 013742
Assistant Attorney General
1275 West Washington Street
Phoenix, Arizona 85007
Telephone: (602) 542-8850
Fax: (602) 542-3646
Attorneys for Plaintiff
transportation@azag.gov

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR MARICOPA COUNTY

STATE OF ARIZONA ex rel. JOHN HALIKOWSKI, Director, Department of Transportation,

Plaintiff,

v.

MARICOPA COUNTY, a political subdivision of the State of Arizona; and FRIENDS, RELATIVES, AND OTHER PERSONS INTERESTED IN THE PERSONS BURIED AT THE TWIN BUTTES CEMETERY, f/k/a BELLE BUTTES CEMETERY, 1 THROUGH 200,

Defendants.

No. CV2010-016135
(Eminent Domain)

FINAL ORDER OF CONDEMNATION

(Assigned to The Honorable Jeanne Garcia)

It appearing to the Court that the Judgment heretofore entered in this action has been fully complied with,

IT IS ORDERED that the aerial easement described in Exhibit A is condemned for state highway purposes and that title to said aerial easement, as indicated in Exhibit A, be

vested in the State of Arizona upon recording of this Order with the Office of the County Recorder of the county in which the property is located.

DONE IN OPEN COURT this 11th day of January, 2011.

Jeanne Garcia
JUDGE OF THE SUPERIOR COURT

Hon. Jeanne Garcia

Final Order of Condemnation lodged with the Court this 2nd day of December, 2010.

COPY of the foregoing mailed this 2nd day of December, 2010, to:

Adrian Gough
Maricopa County Office of General Litigation
301 W. Jefferson, Suite 3200
Phoenix, Arizona 85003
Attorney for Defendant

By Linda Mahan

The foregoing instrument is a full, true and correct copy of the original on file in this office.

Attest January 18, 2011
MICHAEL K. JEANES, Clerk of the Superior Court of the State of Arizona, in and for the County of Maricopa.

By M. Hovorka Deputy

PROJECT: 010 MA 151 H7441 01R
HIGHWAY: PHOENIX - CASA GRANDE
LOCATION: Salt River - Baseline Rd.
PARCEL: 7-10698
DATE: April 30, 2010

MARICOPA COUNTY CONDEMNATION

For State highway purposes, an aerial easement over and across that certain parcel of real property situated in Maricopa County, Arizona, described as follows:

That portion of TWIN BUTTES CEMETERY located in the West half of the Northeast quarter (W½NE¼) of Section 29, Township 1 North, Range 4 East, Gila and Salt River Meridian, Maricopa County, Arizona, described as follows:

Commencing at a 3/8 inch iron bar with 13/16 inch washer tag stamped RLS 42014 marking the Center of said Section 29, being South 89°40'03" West 2676.43 feet from a City of Tempe (COT) brass cap in hand hole marking the East quarter corner of said Section 29;

thence along the East - West mid section line of said Section 29, North 89°40'03" East 799.18 feet to the existing easterly right of way line of Interstate Highway 10 (PHOENIX - CASA GRANDE HIGHWAY);

thence along said existing easterly right of way line, North 0°35'19" East 201.01 feet;

thence continuing along said existing easterly right of way line, from a Local Tangent Bearing of North 1°00'23" West, along a curve to the Left, having a radius of 3969.72 feet, a length of 801.85 feet;

thence continuing along said existing easterly right of way line, North 9°23'36" West 240.83 feet to the POINT OF BEGINNING on the southerly line of said TWIN BUTTES CEMETERY;

thence along said southerly line, North 70°23'31" East 31.27 feet;

thence from a Local Tangent Bearing of North 16°02'57" West, along a curve to the Left, having a radius of 4021.72 feet, a length of 153.40 feet to said existing easterly right of way line of Interstate Highway 10;

thence along said existing easterly right of way line, from a Local Tangent Bearing of South 1°31'06" East, along a curve to the Left, having a radius of 1131.07 feet, a length of 119.52 feet;

thence continuing along said existing easterly right of way line, South 9°23'36" East 38.50 feet to the POINT OF BEGINNING.

2791 square feet, more or less.

CR

EXHIBIT "A"

COPY FOR CERTIFICATION

FILED
11/18/10 3:07PM
MICHAEL K. JEANES, Clerk
By A. Mellone
Deputy

TERRY GODDARD
Attorney General
Ron J. Aschenbach, SBA 013742
Assistant Attorney General
1275 West Washington Street
Phoenix, Arizona 85007
Telephone: (602) 542-8850
Fax: (602) 542-3646
transportation@azag.gov
Attorneys for Plaintiff

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR MARICOPA COUNTY

STATE OF ARIZONA, ex rel. JOHN HALIKOWSKI, Director, Department of Transportation,

Plaintiff,

v.

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Defendants.

No. CV2010-016135
(Eminent Domain)

STIPULATED JUDGMENT

(Before the Honorable Jeanne Garcia)

Pursuant to stipulation of the Parties and good cause appearing, Judgment is entered as follows:

1. Plaintiff, State of Arizona, does hereby have judgment condemning for its use the aerial easement described in **Exhibit A**.

2. Plaintiff will be constructing a bridge over the area described in **Exhibit A** to widen Interstate 10. The real property below the aerial easement is owned and shall remain under the ownership of Defendant Maricopa County, who uses the real property as a cemetery for its citizens ("Property"). In order to maintain the dignity of the area for the citizens of Defendant and their families, Plaintiff shall provide, at Plaintiff's sole cost and expense, the following

improvement(s) and aesthetic treatment(s) to the area in, on and under the bridge ("Improvements"):

a) Plaintiff shall provide electricity and lighting underneath the bridge twenty-four (24) hours a day, seven (7) days a week. Plaintiff shall maintain the lighting fixture(s) and replace any and all bulbs or tubes as necessary.

b) Plaintiff shall install decorative rock landscaping and decorative fencing. Plaintiff further agrees to provide fencing to keep trespassers from underneath the bridge substantially similar to the type and design of fencing and in the location depicted in **Exhibit B**. Plaintiff shall ensure the area in, on and under bridge is neat, clean and free of weeds, grass, trash and debris. Plaintiff shall further ensure that all fencing installed by Plaintiff is maintained in good and workable condition.

c) Plaintiff shall provide aesthetic treatment to the bridge abutments and retaining walls substantially similar to the type and design as depicted in **Exhibit C**. Plaintiff shall ensure the bridge, its abutments and retaining walls are free of graffiti and Plaintiff shall further be responsible for removing any and all graffiti.

3. Defendant MARICOPA COUNTY shall have judgment against Plaintiff in the sum of Fifteen Thousand Dollars and N0/100 Dollars ($15,000.00) as total just compensation for damages of any kind as a result of the take and construction of a highway bridge for which the aerial easement was taken. Said sums shall be paid directly to Defendant MARICOPA COUNTY.

4. Immediately upon receipt of these funds, Defendant MARICOPA COUNTY shall execute and file with the Court a Satisfaction of Judgment.

5. Each party to this action shall bear its own costs and fees.

6. Upon compliance with the foregoing terms of this Judgment, the Court shall enter its Final Order of Condemnation, vesting in Plaintiff title in fee simple to the real property and improvements described in Exhibit A.

Stipulated Judgment

DONE IN OPEN COURT this 9th day of Nov., 2010.

Jeanne Garcia
Judge Jeanne Garcia

TERRY GODDARD
Attorney General

DATED October 21, 2010

/s/ Ron J. Aschenbach
Ron J. Aschenbach
Assistant Attorney General
Attorneys for Plaintiff

MARICOPA COUNTY
OFFICE OF GENERAL LITIGATION SERVICES

DATED October 21, 2010

/s/ Adrian M. Gough
Adrian M. Gough
Assistant General Counsel
Attorneys for Maricopa County

Original lodged with the Court on
the 21st day of October, 2010, with

Judge Jeanne Garcia
Maricopa County Superior Court
125 W. Washington, OCH-303
Phoenix, Arizona 85003

/s/ Grace Naranjo
RJA:ln #957126

EXHIBIT A

PROJECT: 010 MA 151 H7441 01R
HIGHWAY: PHOENIX - CASA GRANDE
LOCATION: Salt River - Baseline Rd.
PARCEL: 7-10698
DATE: April 30, 2010

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thence along the East - West mid section line of said Section 29, North 89°40'03" East 799.18 feet to the existing easterly right of way line of Interstate Highway 10 (PHOENIX - CASA GRANDE HIGHWAY);

thence along said existing easterly right of way line, North 0°35'19" East 201.01 feet;

thence continuing along said existing easterly right of way line, from a Local Tangent Bearing of North 1°00'23" West, along a curve to the Left, having a radius of 3969.72 feet, a length of 801.85 feet;

thence continuing along said existing easterly right of way line, North 9°23'36" West 240.83 feet to the POINT OF BEGINNING on the southerly line of said TWIN BUTTES CEMETERY;

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thence along said existing easterly right of way line, from a Local Tangent Bearing of South 1°31'06" East, along a curve to the Left, having a radius of 1131.07 feet, a length of 119.52 feet;

thence continuing along said existing easterly right of way line, South 9°23'36" East 38.50 feet to the POINT OF BEGINNING.

2791 square feet, more or less.

CR

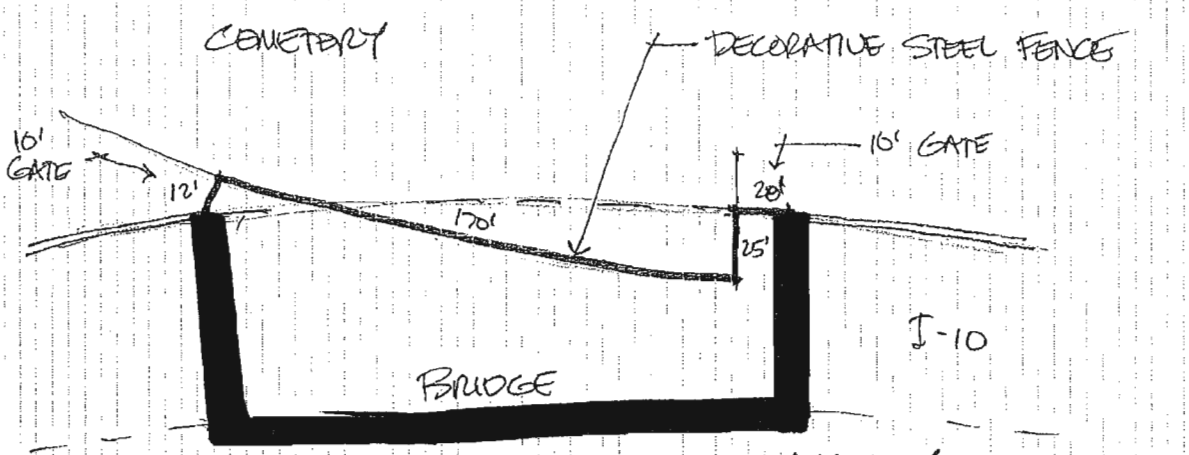
EXHIBIT "A"

EXHIBIT B



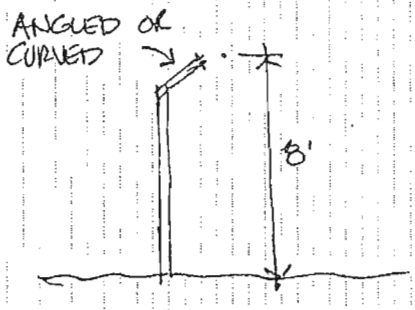

NO
PARKING

DMJM HARRIS | AECOM	PROJECT: I-10 / Cemetery	JOB NO.	SHEET of
		DESIGNED BY RWG	DATE
SUBJECT: Decorative Fence		CHECKED BY	DATE



TOTAL LENGTH = 230' ±
(2) GATES @ 10 LF
210 LF FENCE

DECORATIVE WALL



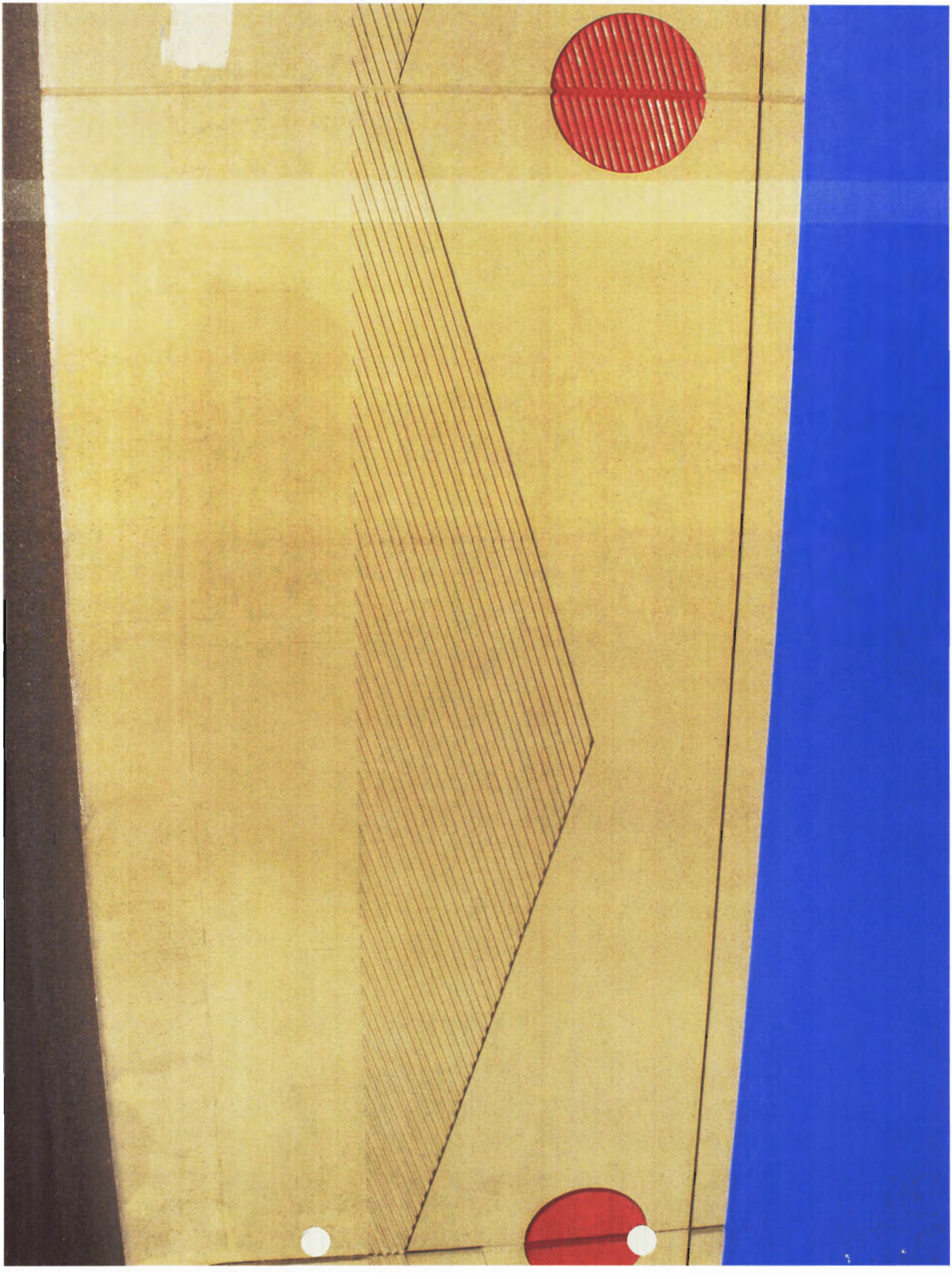
CONTACT: JIM @ AMERICAN FENCE (602) 821-4453

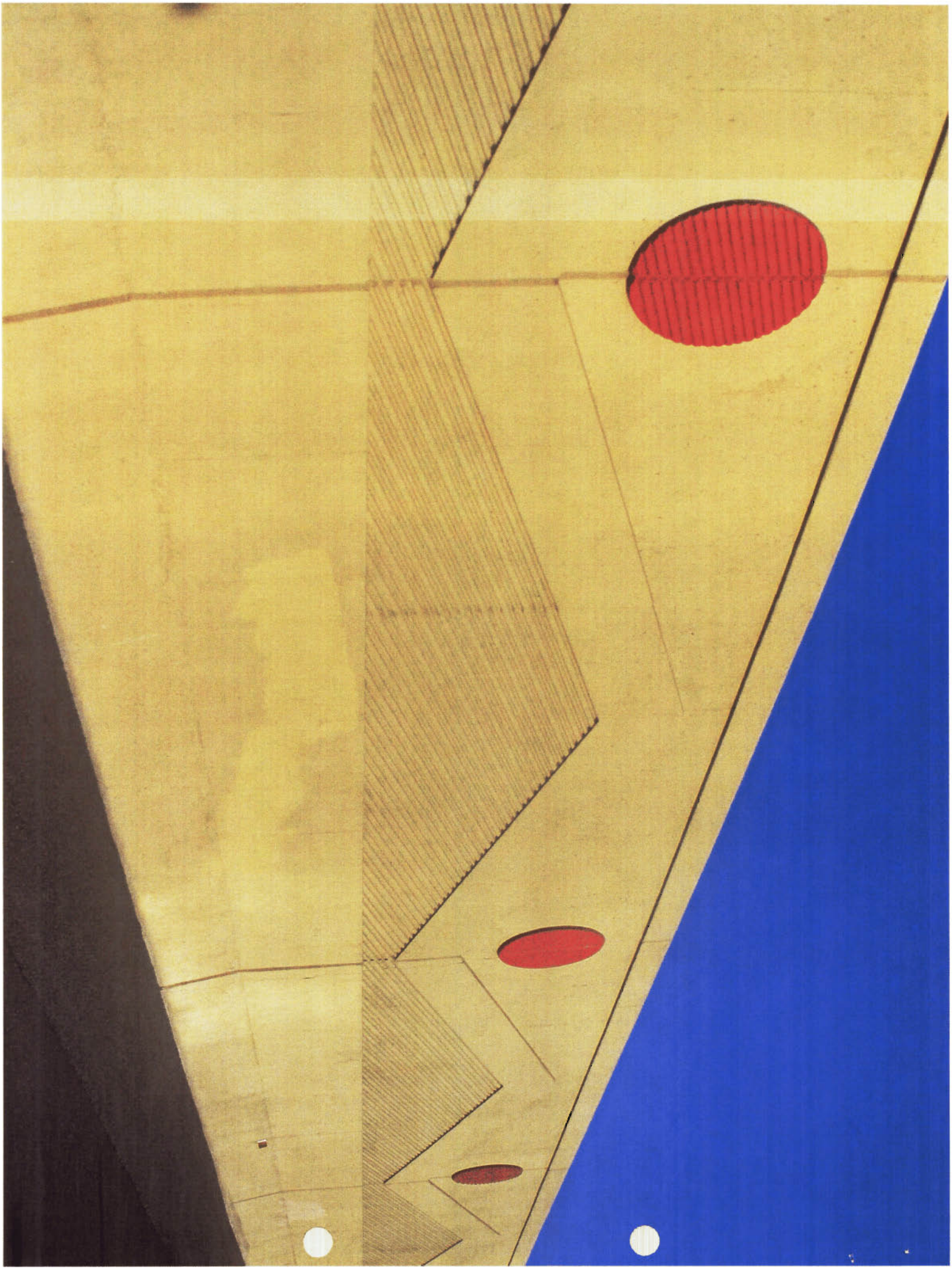
1. A-FENCE DID THE SECURITY FENCING AT THE RENTAL CAR FACILITY @ AIRPORT.
2. PERIMETER FENCE WAS DESIGNED BY AN ARTIST - VERY EXPENSIVE
3. INTERIOR SECURITY FENCE IS STANDARD DESIGN:
   - TUBULAR STEEL
   - NO GALVANIZING
   - POWDER COATED COLOR
   - WILL RUST AT WELDS, REQUIRING MAINTENANCE
   - ESTIMATED COST IS $70.00 / LF ; GATES @ (2x) $140.00 / LF

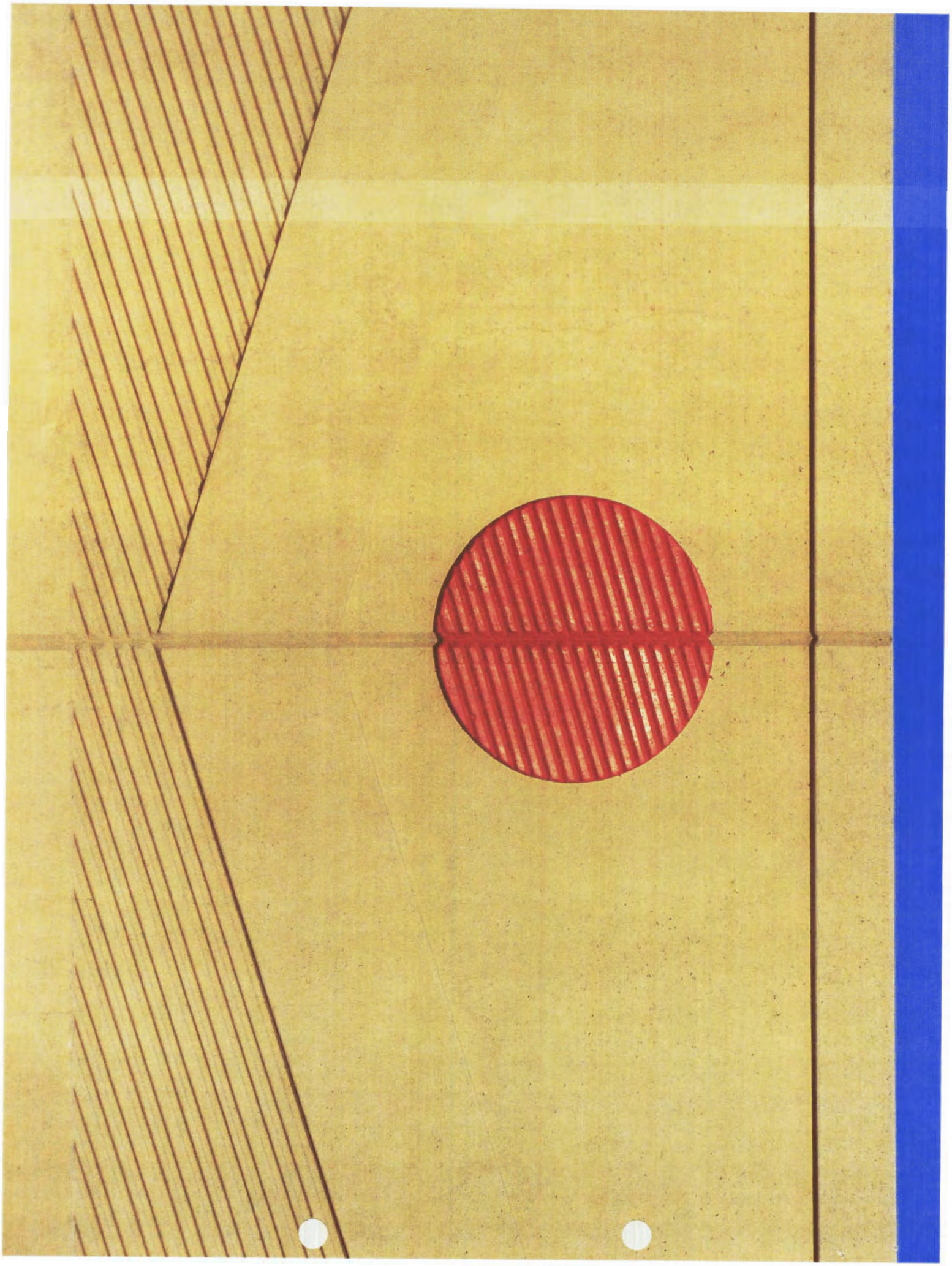
     210 LF FENCE @ $70.00 = $14,700.00
     20 LF GATES @ $140.00 = $ 2,800.00
     $17,500.00 (PLUS CONTINGENCY?)

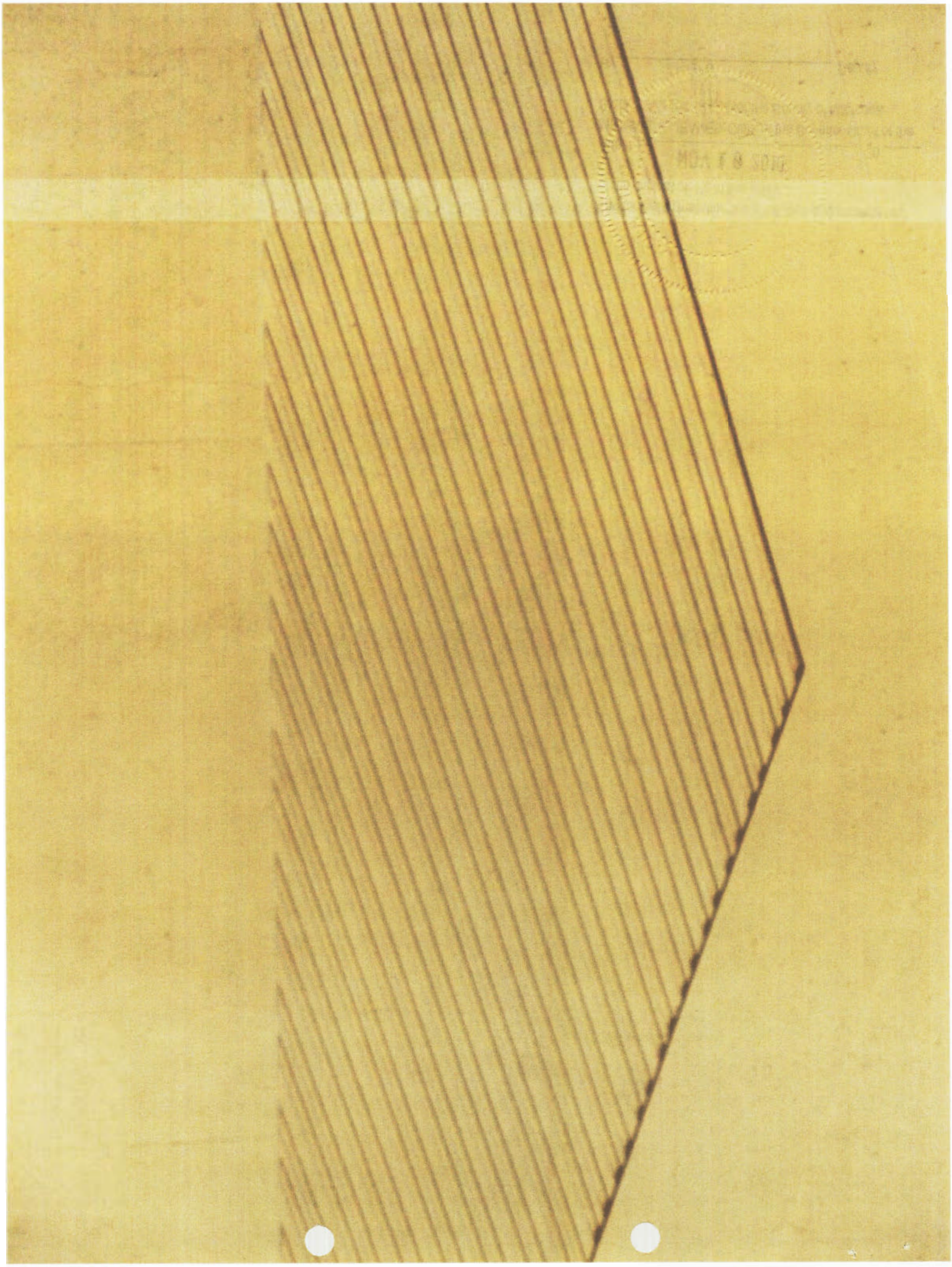
4. THEY DON'T MAKE TRUE WROUGHT IRON FENCING ANY MORE. NEED SPECIALIZED FABRICATION. HE ESTIMATES THAT THE COST MIGHT BE 3x THE TUBULAR STEEL FENCE.

EXHIBIT C









The foregoing instrument is a full, true and correct copy of the original on file in this office.

Attest NOV 19 2010 20 ____

MICHAEL K. JEANES, Clerk of the Superior Court of the State of Arizona, in and for the County of Maricopa.

By _____ Deputy

OFFICIAL RECORDS OF
MARICOPA COUNTY RECORDER
ADRIAN FONTES
20200577040 06/30/2020 09:34
ELECTRONIC RECORDING

COB1479-3-1-1--
Wadel

When recorded, return to:
Maricopa County Real Estate Department
Attn: General Government PM Supervisor
2801 W. Durango St
Phoenix, AZ 85009

RESOLUTION APROVING AESTHETIC DESIGN

C-18-11-007-8-01

WHEREAS, in 2010, the State of Arizona (State) brought an action in eminent domain, CV 2010-016135, against Maricopa County (County) to acquire an Aerial Easement (Easement) from the County for improvements to the existing Interstate Highway 10 (I-10); and

WHEREAS, the State and the County resolved said court action via a Stipulated Judgment (Judgement) done in open court on November 9, 2010, and the court issued a Final Order of Condemnation (FOC) in open court on January 18, 2011, which was filed of record in the Official Records of the Maricopa County Recorder as Document Number 2011-0067549 on January 25, 2011; and

WHEREAS, said Easement is located within a portion of the Twin Buttes Cemetery in the West half of the Northeast Quarter (W1/2NE1/4) of Section 29, Township 1 North, Range 4 east, Gila and Salt River Base and Meridian; and

WHEREAS, Paragraph 2 of the Judgment says that the State will construct a bridge within the Easement to widen I-10 and the State, at its sole cost and expense, shall: (1) provide electricity and lighting under the bridge twenty-four (24) hours a day seven (7) days a week; (2) install decorative rock landscaping and fencing; and (3) provide aesthetic treatment to the bridge abutments and retaining walls; and

WHEREAS, the State is in the process of completing its design for the State's F0072 01D (I-10, I-17 to SR 202) project (Project), and because there are minor changes to the agreed upon aesthetic treatments, the State submitted preliminary plan excerpts, attached hereto and made a part hereof as Exhibit A to this Resolution, depicting the abutment and retaining wall aesthetics for the for the County's review and approval; and

WHEREAS, the County has reviewed the State's submitted preliminary aesthetics plan excerpts and agrees that said design is consistent with the terms of the Judgment and FOC entered in CV2010-016135 as well is consistent with the ongoing use of the land as a cemetery; and

NOW THEREFORE, BE IT RESOLVED that the Board of Supervisors hereby approves the State's proposed aesthetic design depicted in Exhibit A for the Project abutments and retaining walls in the Easement; and

BE IT FURTHER RESOLVED that the Board of Supervisors hereby delegates to the Director of Real Estate Department the authority to execute, on behalf of the County, administrative documents that are "approved as to form" by the Maricopa County Attorney's Office, that are required by the State to indicate that the County approves of the design proposed by the State.

C-18-11-007-8-01

ADOPTED by the Maricopa County Board of Supervisors, Maricopa County, Arizona, this 24 day of June 2020.

Maricopa County

By: _____ JUN 24 2020
Chairman, Board of Supervisors Date

ATTEST:

By: _____ JUN 24 2020
Clerk of the Board Date

Approved as to form:

_____ 6-17-2020
Deputy County Attorney Date

EXHIBIT A

CAN BE VIEWED AT THE

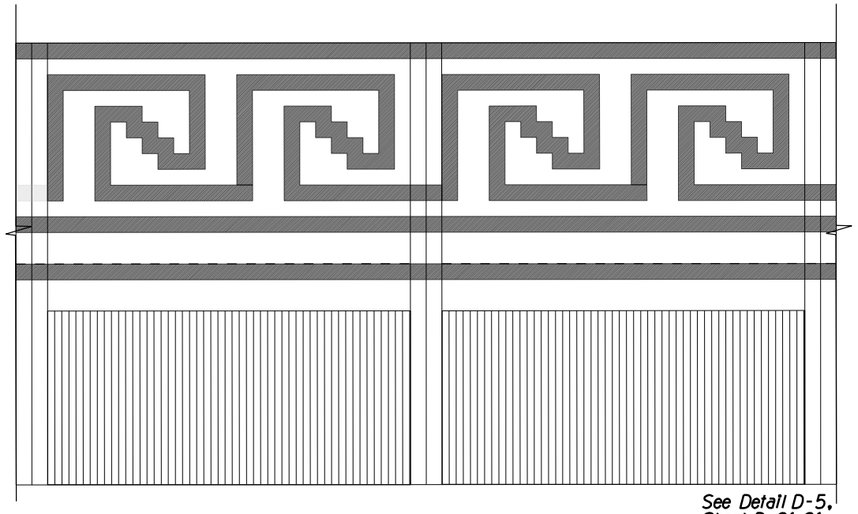
MARICOPA COUNTY CLERK OF THE BOARD OFFICE

LOCATED AT 301 WEST JEFFERSON STREET, 1OTH FLOOR

PHOENIX. AZ 85003

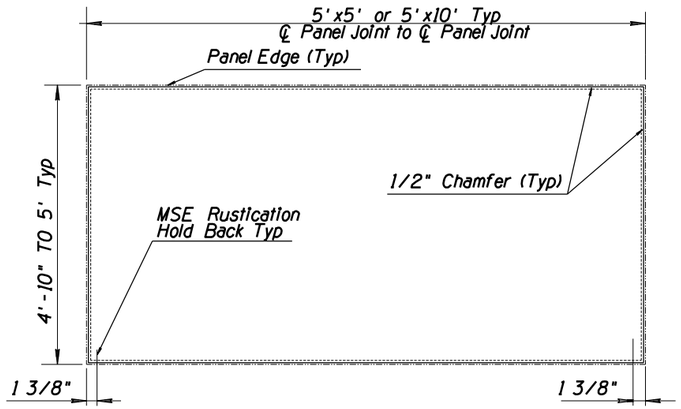
C-18-11-07-8-01

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	010-C(220)T			
		010 MA 149			



See Detail D-5, Sheet D-01.01

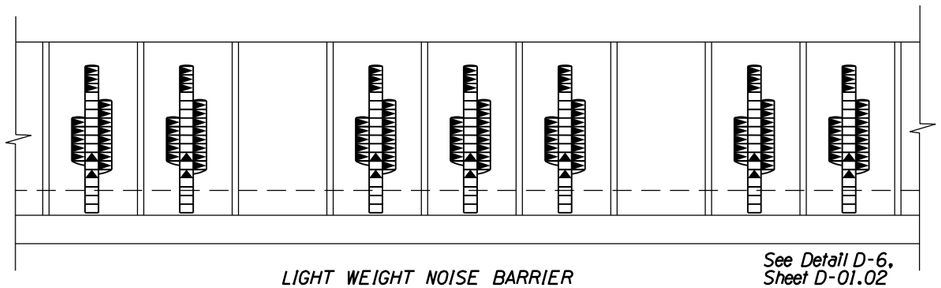
NOISE BARRIER
NTS



NOTE:
1. MSE Panel Dimensions Schematic, Developer to Provide Shop Drawings.

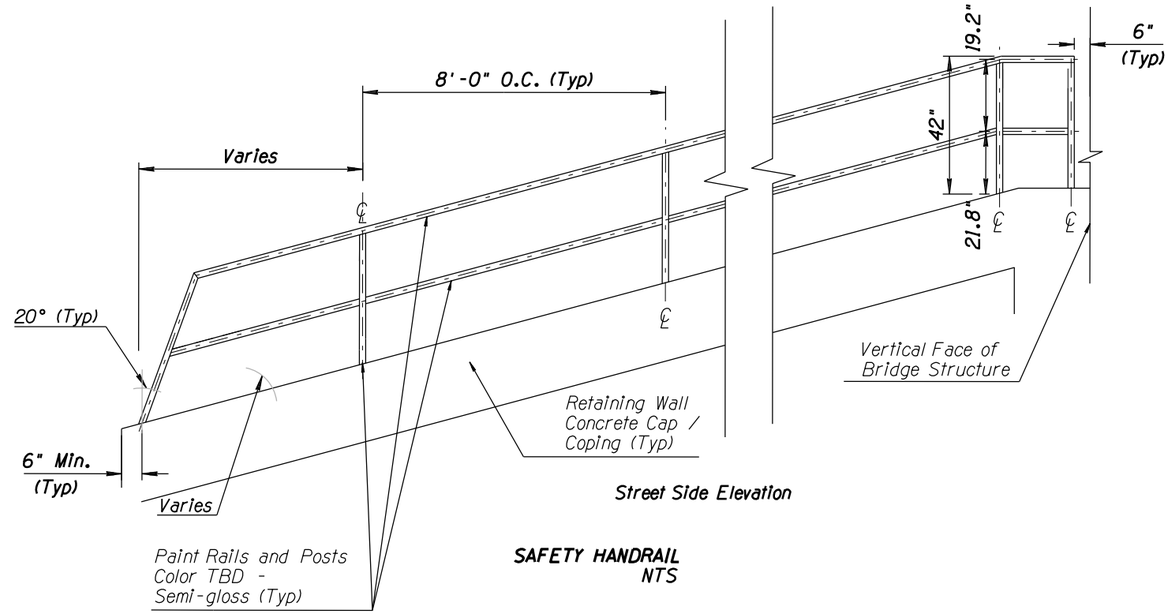
MSE PANEL
NTS

See Detail D-6, Sheet D-01.02



See Detail D-6, Sheet D-01.02

LIGHT WEIGHT NOISE BARRIER
NTS



Street Side Elevation

SAFETY HANDRAIL
NTS

PROJECT WIDE AESTHETICS

Exhibit A

	NAME	DATE
DESIGN	AS	10/19
DRAWN	STAFF	10/19
CHECKED	ECC	10/19

corral design group, inc. CDG

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

AESTHETICS
DETAIL SHEET
PROJECT WIDE DETAILS

PRELIMINARY
DRAFT
REVIEW
NOT FOR
CONSTRUCTION
OR RECORDING

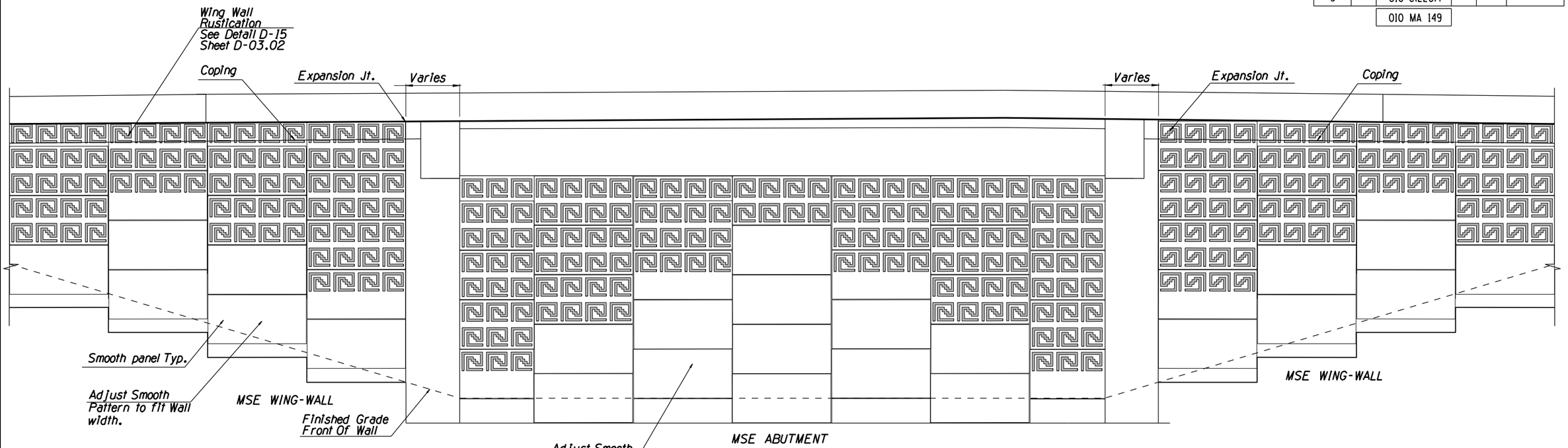
DWG NO. D-01.00

ROUTE	LOCATION		
I-10	GEC I-10, I-17 to SR 202		
TRACS NO. F0072 01D		010-C(220)T	___ OF ___

SURVEY NO. | FINISHED PLANS- | REVISIONS- | LOCATION- | DATE-

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	010-C(220)T			
		010 MA 149			



RUSTCATION FOR ABUTMENT
HOHOKAM POTTERY PATTERN
NTS

GENERAL NOTES:

1. Rustication Batter or Draft is 1/4" to 1".
2. Rustication Patterns Shall Extend a Minimum of 2' Below Finish Grade or to Top of Foundation.
3. Developer Shall Paint Rustication as per Section 800 of the Technical Provisions.
4. Paint Shall Extend a Minimum of 2' Below Finish Grade or to Top of Foundation.
5. Cast Concrete Rustication Patterns Shown in Details. If Developer Proposes Post-Applied Rustication, Finish, Patterns, and Colors to Match Intent Of Details As Shown and Approved by ADOT.
6. Paint Numbers Shown in the Landscape Aesthetics Concepts are for Paint Color Reference and Control Samples Only. The Developer May Apply any Paint Color, Brand Names, or Trademarks such as: Sherwin-Williams (Frazee), and Dunn-Edwards Paint as Long as They Demonstrate Equivalent Color Effects As Per the Technical Provisions and Approval from ADOT.
7. Developer to Field Verify All Dimensions/Layout.
8. Developer Shall Provide Shop Drawings for All Aesthetics Patterns and Fabrication Details for Approval by ADOT prior to Fabrication.

WALL NOTES:

1. See Structural Retaining Wall Details and Plans for Final Engineering.
2. MSE/CIP Walls Shown in Elevations Are Sample Types Only.
3. Size and Shape of MSE Panels Per Wall Manufacturer.
4. Rustication Accents Shall be Recessed a Minimum 2" When Accent is Ccast into Concrete.Post Applied Rustication Accents Shall Have a Mminimum 2" Extruded Surface.
5. Rustication Shall Occur on Walls With a Clear Height Distance of 12' or Greater When Measured From Finished Grade/Top of Adjacent Barrier to the Bottom of Wall Coping/Cap.

DETAIL D-14 NTS

CHARACTER AREA 2 -
WING WALL/ABUTMENT RUSTICATION

	NAME	DATE
DESIGN	AS	10/19
DRAWN	STAFF	10/19
CHECKED	ECC	10/19

corral design group, inc. CDG

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES
AESTHETICS
DETAIL SHEET
CA 2 - WING WALLS & ABUTMENTS

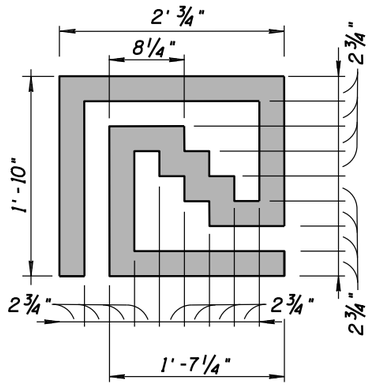
PRELIMINARY
DRAFT
REVIEW NOT FOR CONSTRUCTION OR RECORDING

ROUTE	LOCATION	DWG NO. D-03.01
I-10	GEC I-10, I-17 to SR 202	
TRACS NO. F0072 01D		010-C(220)T ___ OF ___

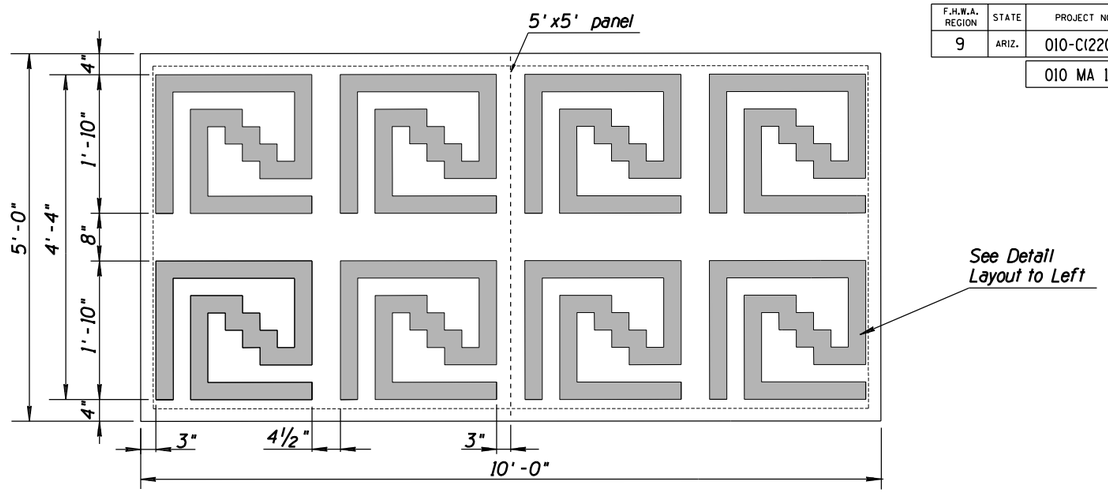
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DATE- LOCATION- REVISIONS- FINISHED PLANS- SURVEY NO.

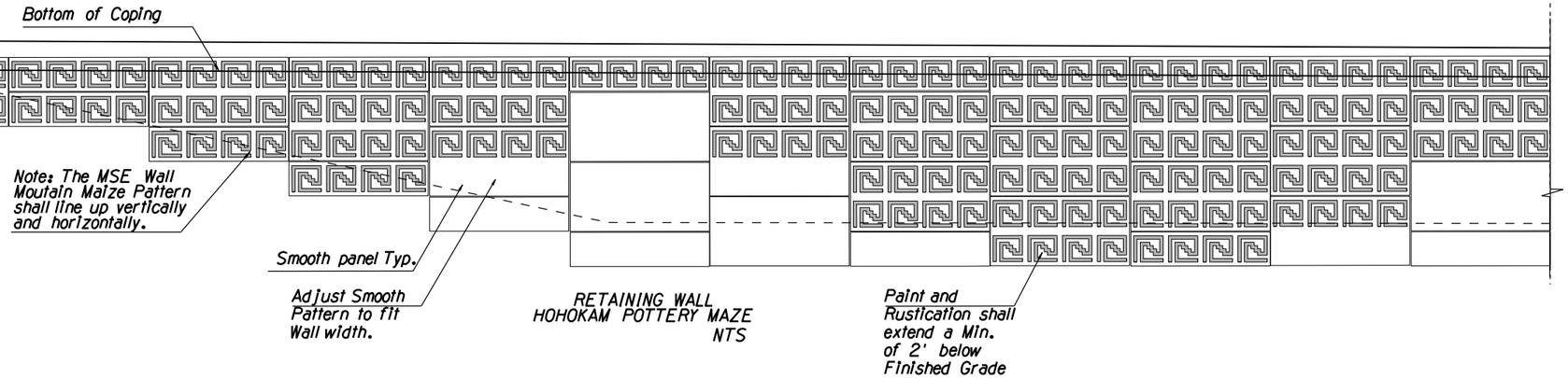
F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	010-C(220)T			
		010 MA 149			



DETAIL LAYOUT -
HOHOKAM POTTERY MAZE
NTS



TYPICAL MSE PANEL - 5' X 10' NOMINAL SIZE
NTS



RETAINING WALL
HOHOKAM POTTERY MAZE
NTS

GENERAL NOTES:

1. Rustication Batter or Draft is 1/4" to 1".
2. Rustication Patterns Shall Extend a Minimum of 2' Below Finish Grade or to Top of Foundation.
3. Developer Shall Paint Rustication as per Section 800 of the Technical Provisions.
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5. Cast Concrete Rustication Patterns Shown in Details. If Developer Proposes Post-Applied Rustication, Finish, Patterns, and Colors to Match Intent Of Details As Shown and Approved by ADOT.
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7. Developer to Field Verify All Dimensions/Layout.
8. Developer Shall Provide Shop Drawings for All Aesthetics Patterns and Fabrication Details for Approval by ADOT prior to Fabrication.

WALL NOTES:

1. Walls Shorter than 150' in Length or Shorter than 12' from Bottom of Coping to Finished Grade Shall be Maze Rustication Only.
2. See Structural Retaining Wall Details and Plans for Final Engineering.
3. MSE/CIP Walls Shown in Elevations Are Sample Types Only.
4. Size and Shape of MSE Panels Per Wall Manufacturer.
5. Rustication Accents Shall be Recessed a Minimum 2" When Accent is Cast Into Concrete. Post Applied Rustication Accents Shall Have a Minimum 2" Extruded Surface.
6. Stepped Rustication Patterns Shall Occur on Walls With a Clear Height Distance of 12' or Greater When Measured From Finished Grade/Top of Adjacent Barrier to the Bottom of Wall Coping/Cap.

DETAIL D-15 NTS

CHARACTER AREA 2 - RETAINING WALL

	NAME	DATE
DESIGN	AS	10/19
DRAWN	STAFF	10/19
CHECKED	ECC	10/19

corral design group, inc. CDG

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

AESTHETICS
DETAIL SHEET
CA 2 - RETAINING WALLS

ROUTE	LOCATION
I-10	GEC I-10, I-17 to SR 202

PRELIMINARY
DRAFT
REVIEW
NOT FOR
CONSTRUCTION
OR RECORDING

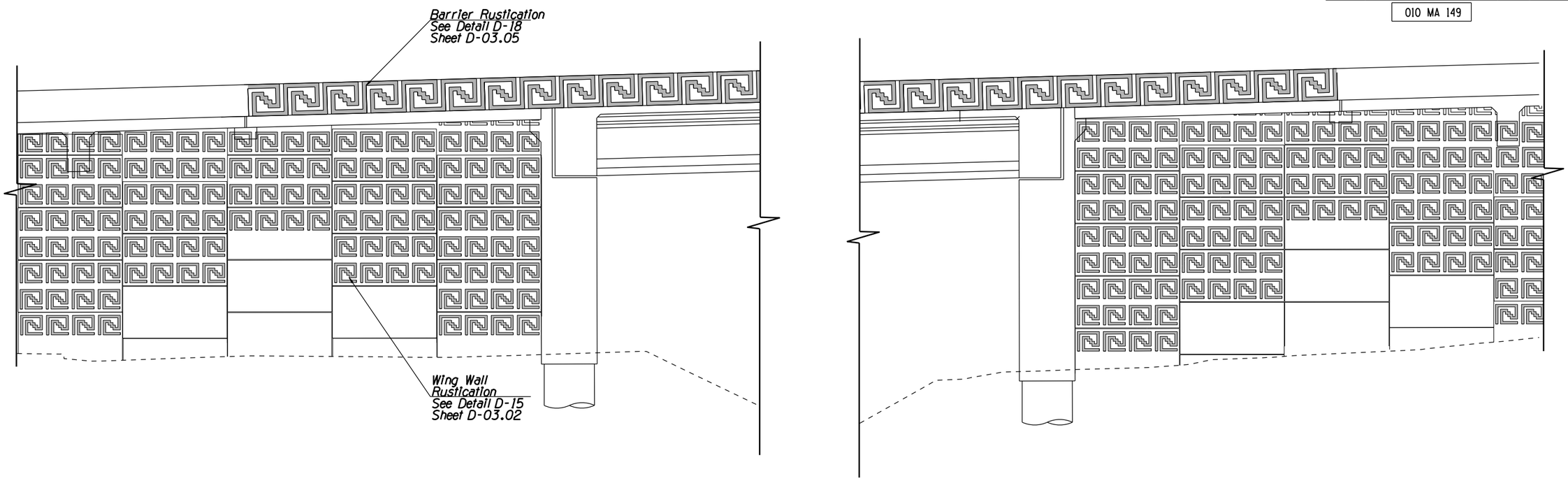
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TRACS NO. F0072 01D | 010-C(220)T | ___ OF ___

SURVEY NO. | FINISHED PLANS- | REVISIONS- | LOCATION- | DATE-

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	010-C(220)T			
		010 MA 149			



STANDARD CA2 -BRIDGE NTS
(WB C-D ROAD SHOWN)

DETAIL D–16 NTS

CHARACTER AREA 2 -
STANDARD BRIDGE ELEVATION

GENERAL NOTES:

1. Rustication Batter or Draft is 1/4" to 1".
2. Rustication Patterns Shall Extend a Minimum of 2' Below Finish Grade or to Top of Foundation.
3. Developer Shall Paint Rustication as per Section 800 of the Technical Provisions.
4. Paint Shall Extend a Minimum of 2' Below Finish Grade or to Top of Foundation.
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8. Developer Shall Provide Shop Drawings for All Aesthetics Patterns and Fabrication Details for Approval by ADOT prior to Fabrication.

	NAME	DATE
DESIGN	AS	10/19
DRAWN	STAFF	10/19
CHECKED	ECC	10/19

corral design group, inc. CDG

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

AESTHETICS
DETAIL SHEET
CA 2 - BRIDGE ELEVATION

PRELIMINARY
DRAFT
REVIEW
NOT FOR
CONSTRUCTION
OR RECORDING

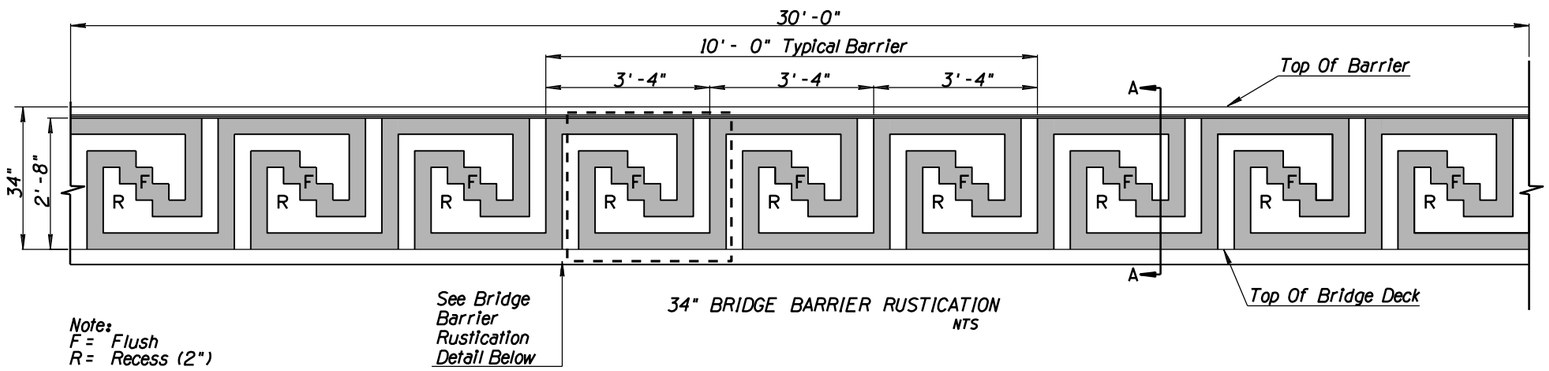
DWG NO. D-03.03

ROUTE	LOCATION		
I-10	GEC I-10, I-17 to SR 202		
TRACS NO. F0072 01D		010-C(220)T	___ OF ___

SURVEY NO. | FINISHED PLANS- | REVISIONS- | LOCATION- | DATE-

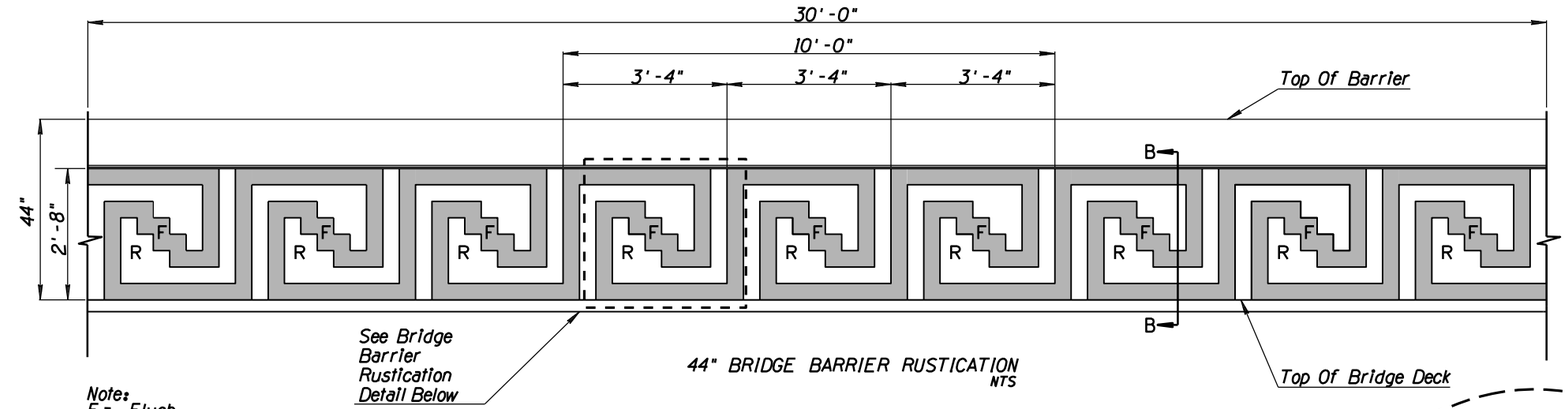
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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	010-C(220)T			
		010 MA 149			



Note:
F = Flush
R = Recess (2")

34" BRIDGE BARRIER RUSTICATION
NTS



Note:
F = Flush
R = Recess (2")

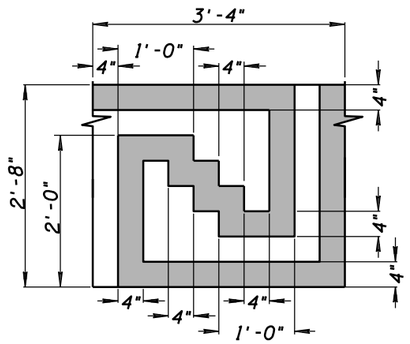
44" BRIDGE BARRIER RUSTICATION
NTS

BARRIER NOTES:

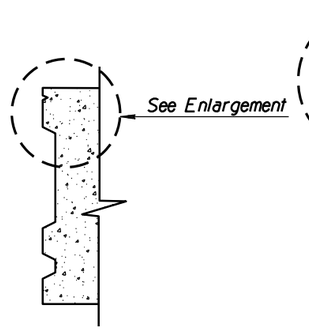
1. *Developer Shall Rusticate Bridge Barriers as Per Section 800.03.01.01 of the Technical Provisions.*
2. *Locate Barrier Panels to Minimzie Partial Panels That Occur at the Ends of Approaches.*
3. *Partial Panels Shall Be Painted The Base Color Without Rustication.*

GENERAL NOTES:

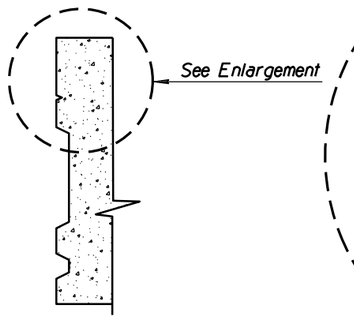
1. *Rustication Patterns Shall Extend a Minimum of 2' Below Finish Grade or to Top of Foundation.*
2. *Developer Shall Paint Rustication as per Section 800 of the Technical Provisions.*
3. *Paint Shall Extend a Minimum of 2' Below Finish Grade or to Top of Foundation.*
4. *Cast Concrete Rustication Patterns Shown in Details. If Developer Proposes Post-Applied Rustication, Finish, Patterns, and Colors to Match Intent Of Details As Shown and Approved by ADOT.*
5. *Paint Numbers Shown in the Landscape Aesthetics Concepts are for Paint Color Reference and Control Samples Only. The Developer May Apply any Paint Color, Brand Names, or Trademarks such as: Sherwin-Williams (Frazee), and Dunn-Edwards Paint as Long as They Demonstrate Equivalent Color Effects As Per the Technical Provisions and Approval from ADOT.*
6. *Developer to Field Verify All Dimensions/Layout.*
7. *Developer Shall Provide Shop Drawings for All Aesthetics Patterns and Fabrication Details for Approval by ADOT prior to Fabrication.*



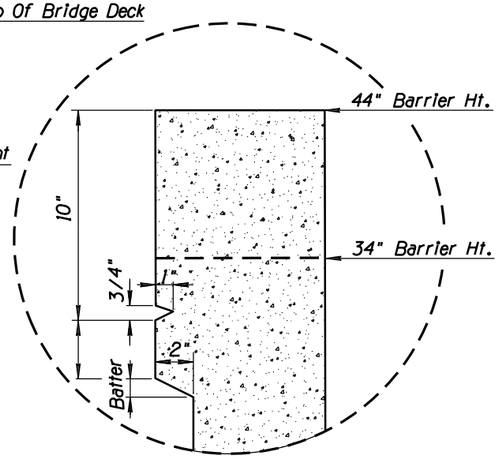
BRIDGE BARRIER RUSTICATION DETAIL
NTS



SECTION A-A
NTS



SECTION B-B
NTS



ENLARGEMENT
NTS

DETAIL D-18 NTS

CHARACTER AREA 2 - BARRIER RUSTICATION

	NAME	DATE
DESIGN	AS	10/19
DRAWN	STAFF	10/19
CHECKED	ECC	10/19

corral design group, inc. CDG

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

AESTHETICS
DETAIL SHEET
CA 2 - BARRIER

PRELIMINARY
DRAFT
REVIEW NOT FOR CONSTRUCTION OR RECORDING

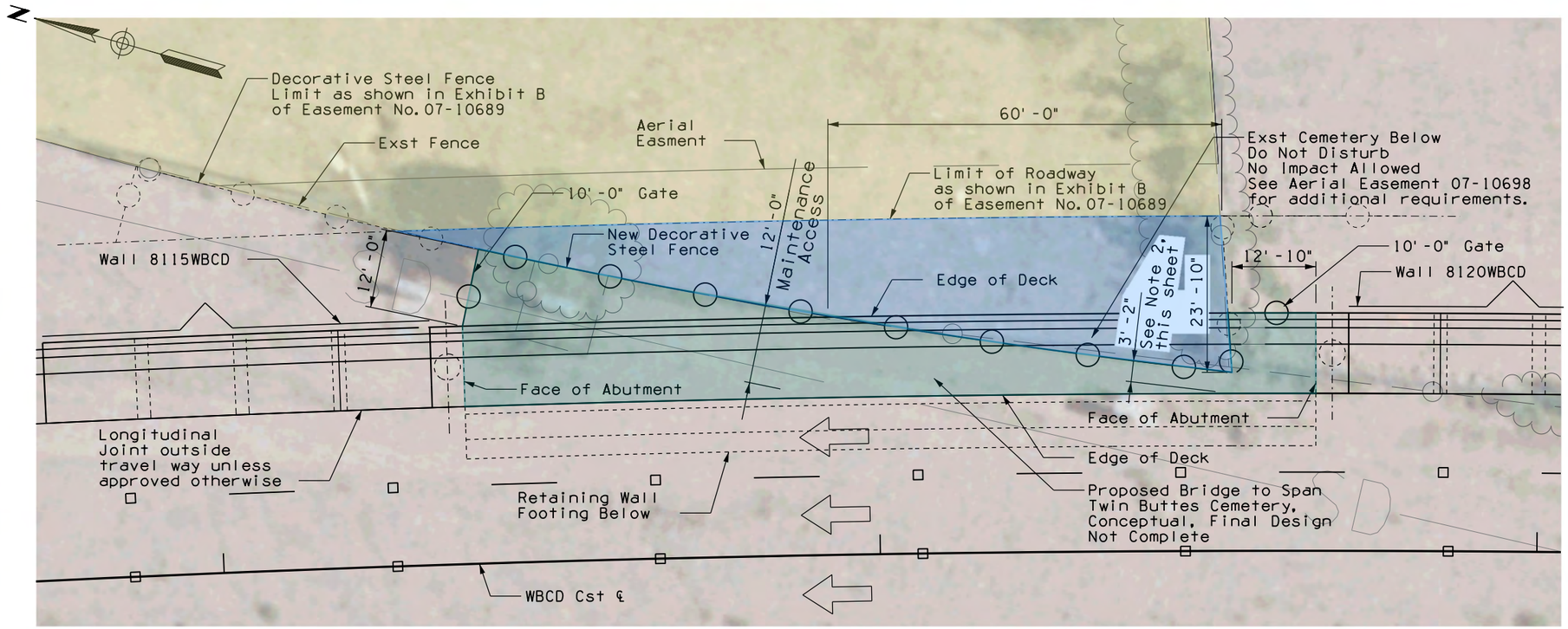
ROUTE: I-10
LOCATION: GEC I-10, I-17 to SR 202
DWG NO. D-03.05

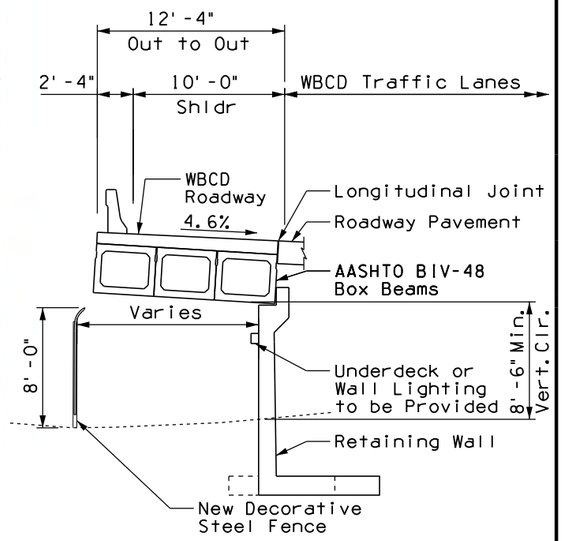
TRACS NO. F0072 01D | 010-C(220)T | ___ OF ___

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STA 8115+ Bridge 65 – WBCD CEMETERY OP

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			



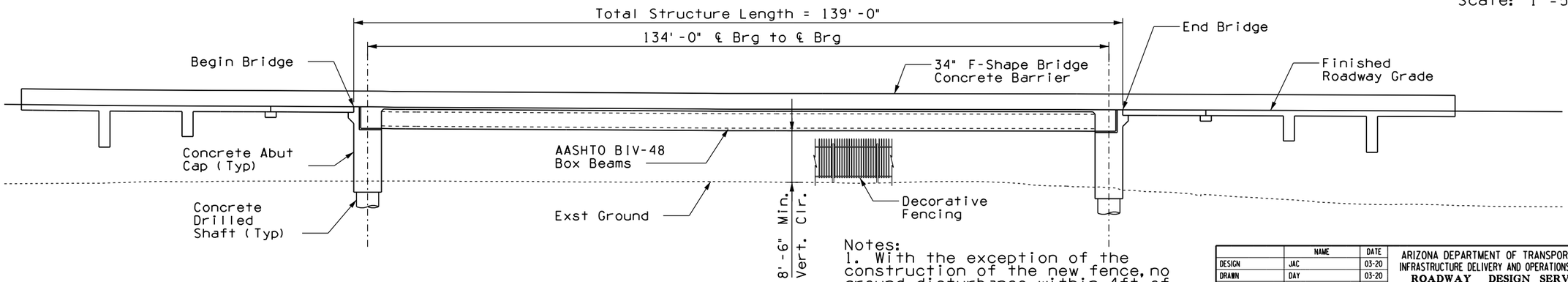


Legend:

- Twin Buttes Cemetery
- Maintenance Area
- Aerial Easement No. 07-10689

PLAN
New Single Span Precast Prestressed Concrete Box Beam Bridge
No Skew
Scale: 1" =20' -0"

TYPICAL SECTION
Looking Ahead Station
Scale: 1" =5' -0"



ELEVATION
Scale: 1" =20' -0"

Notes:
1. With the exception of the construction of the new fence, no ground disturbance within 4ft of the aerial easement will be allowed.

2. Technical Provisions will require 4ft min clear for access. Developer will be responsible for meeting this requirement.

	NAME	DATE
DESIGN	JAC	03-20
DRAWN	DAY	03-20
CHECKED		03-20

WSP

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

WCBD CEMETERY BRIDGE
EXHIBIT

ROUTE I-10 | LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)

TRACS NO. F0072 01D | 202-D-(200)S

SCHEMATIC #5
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING
DWG NO.
___ OF ___

DATE- | LOCATION- | REVISIONS- | FINISHED PLANS- | SURVEY NO. | DATE-

TP Attachment 118-3

ADOT Yard at 48th Street and Broadway Road (APN 12457002F)

2500 W Broadway Road, Tempe AZ 85282

118-3.1 Description

The existing ADOT Yard located at 2500 West Broadway Road, Tempe AZ 85282 is impacted by the current schematic design. The developer shall reconstruct the site based on the requirements outlined in 118-3.2 through 118-3.3. The ADOT Yard is currently occupied by 4 ADOT Units:

- Construction
- Maintenance
- Landscaping
- Enforcement Compliance Division (ECD)

ECD will be relocated by ADOT prior to the reconfiguration of this site. The building currently occupied by ECD will be demolished by ADOT per TP Attachment 118-1. Construction, Maintenance and Landscaping units shall remain on the site.

118-3.2 ADOT Yard Reconstruction Requirements

The developer shall develop site layout and plans based on the following requirements:

- Design of Warehouse (B5) and office building (B7) shall adhere to the following building codes:
    - *NEC (National Electric Code)*
    - *NFPA (National Fire Protection Association)*
    - *IBC (International Business Code)*
    - *IPC (International Plumbing Code)*
    - *ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) 90.1*
    - *IECC (International Energy Conservation Code)*
- Construction (B2) and Landscape (B3) office buildings to remain
- Roadway Maintenance (B7) office building, warehouse (B5) and stockpiles to be relocated within the site.
    - The replacement for office building (B7) shall match the existing building type in kind (min. 4000 sqft) with the following spaces/rooms:
        - Bathroom stalls to accommodate 15 staff equipped with lockers and showers
        - Conference room that will accommodate 15 people
        - Admin front desk space and office
        - Supervisor Office
        - Office/Janitorial Supplies closet
        - 200-square-foot break room/kitchen, with ice machine and sink with hot and cold running water including waste disposer. Existing fridge and microwave to be relocated from existing building (B7). Seating for 15 staff shall be provided.
        - Minimum of 11 office cubicles at 54” height
        - Computer closet (minimum 5’ x 8’)
        - All contents of existing building shall be relocated to the new replacement building
    - The replacement for warehouse (B5) shall be:
        - 50’W x 70’L x 25’H
        - Located to allow turning radiuses for trailer access
        - Built over PCCP
    - The material stockpiles shall be moved to an appropriate location on-site and shall have:

    - 8 bays each with the following dimensions: 12.5'W x 30'D x 7.5'H
    - Concrete wall dividers
    - Paved ground surface
- Conex boxes to be relocated per new site layout
- Drainage Plan to be prepared for reconfigured site
- Entire site to be paved with 4" 409AC over compacted subgrade per ADOT guidelines
- Provide a minimum of 82 parking stalls and 6 dedicated parking stalls for trucks/trailers. Parking stalls shall be provided in accordance to the *2010 ADA Standards for Accessible Design.* Existing shaded parking spots that are impacted by project shall be relocated within the site. Table 118-3.2-1 presents the parking stalls required for each building.

Table 118-3.2-1
Minimum Parking Stalls Required for each Building

Type	Construction (B2)	Landscape (B3)	Roadway (B7)
Personal	15	11	16
ADOT trucks	15	4	21
Truck/Trailer	-	-	6

- Access driveway to be regraded to adhere to driveway slope requirements per *ADOT Roadway Design Guidelines.*
- New 24' electronic entrance gate shall be installed with:
    - Intercom Station with badge access with an upper reader/intercom for tall vehicles (trailer trucks) and a lower reader for automobiles and sedan type cars. The recommended height shall be 72 inches and 47 inches respectively.
    - Intercom access points (to open gate from the office) from within each building (3 total).
- 6' tall chain link fence with barb wire protection around perimeter of site.
- New fill stand for water trucks including new supply lines and water meter. There is an existing 2" water line at the northeast corner of the intersection of Broadway and 48th St. The ADOT ECD office is supplied by a 2" line from the Double Butte Cemetery. The exhibit in 118-3.4 shows the esmitated locations of the existing 2" water supply lines servicing the site. A 10' x 20' concrete pad base shall be built for the new fill stand.
- Provide parking lighting for site per 2018 AASHTO Roadway Lighting Design Guide: 1.0 foot-candles average (or higher), and an average/minimum ratio of 4.0 (or lower).

118-3.3 Implementation Requirements

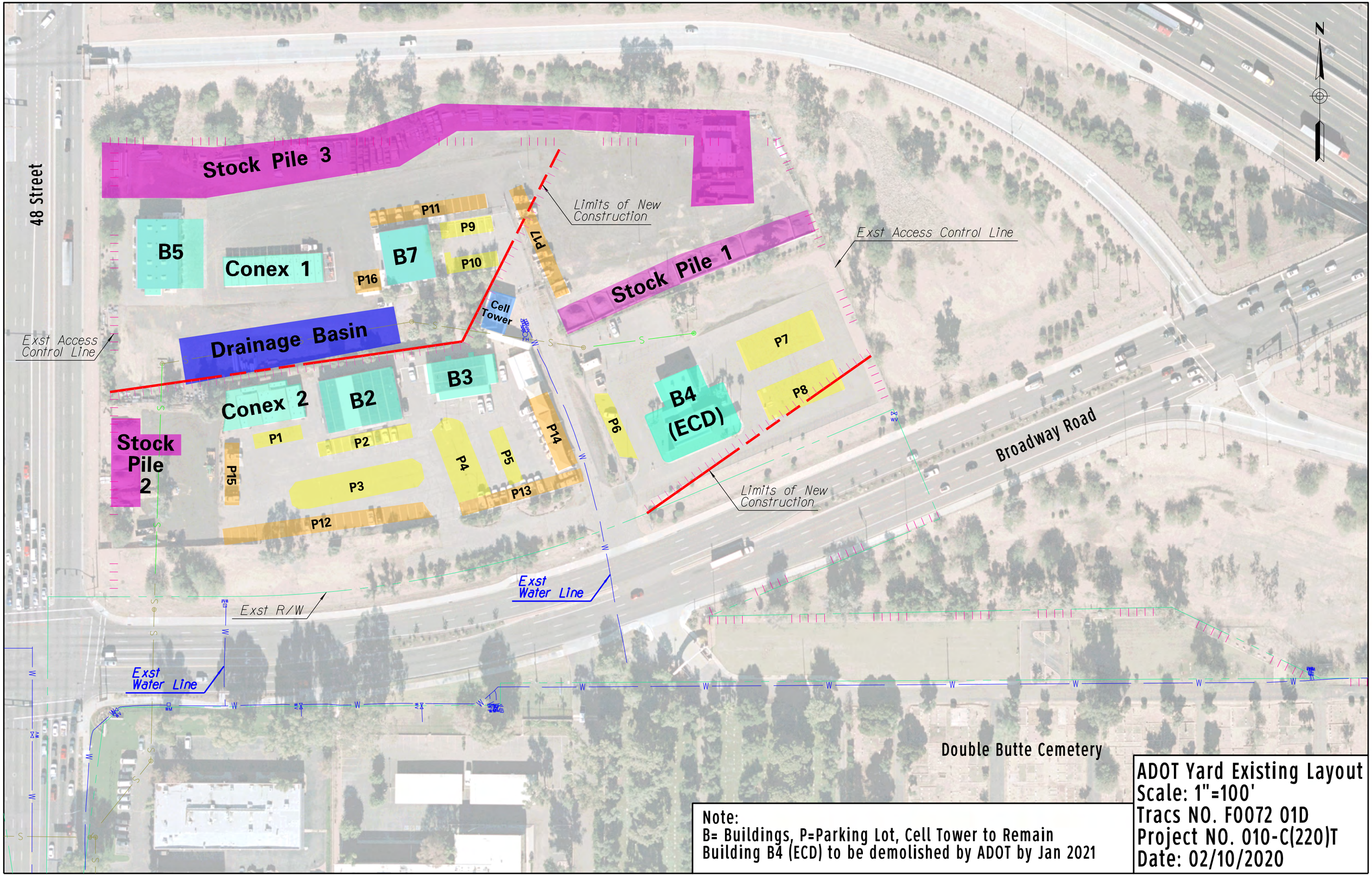
Developer shall adhere to the following implementation requirements:

- Developer shall schedule a site visit with ADOT, then prepare and submit an ADOT Yard Layout Plan and Proposed Schedule at least 60 Business Days prior to disturbance of the site for review and comment
- 10-day review period
- Developer to schedule monthly progress meetings as needed
- ADOT Yard shall remain operational at all times
- Cell tower to remain in place and operational throughout construction

- Developer to coordinate Internet installation with ADOT IT Group
- Obtain all permits necessary for the work described and abide by all setback and ADA requirements
- New site layout shall be designed to allow navigation of oversized equipment throughout the site

118-3.4 ADOT Yard Existing Site Layout

See Attached Exhibit

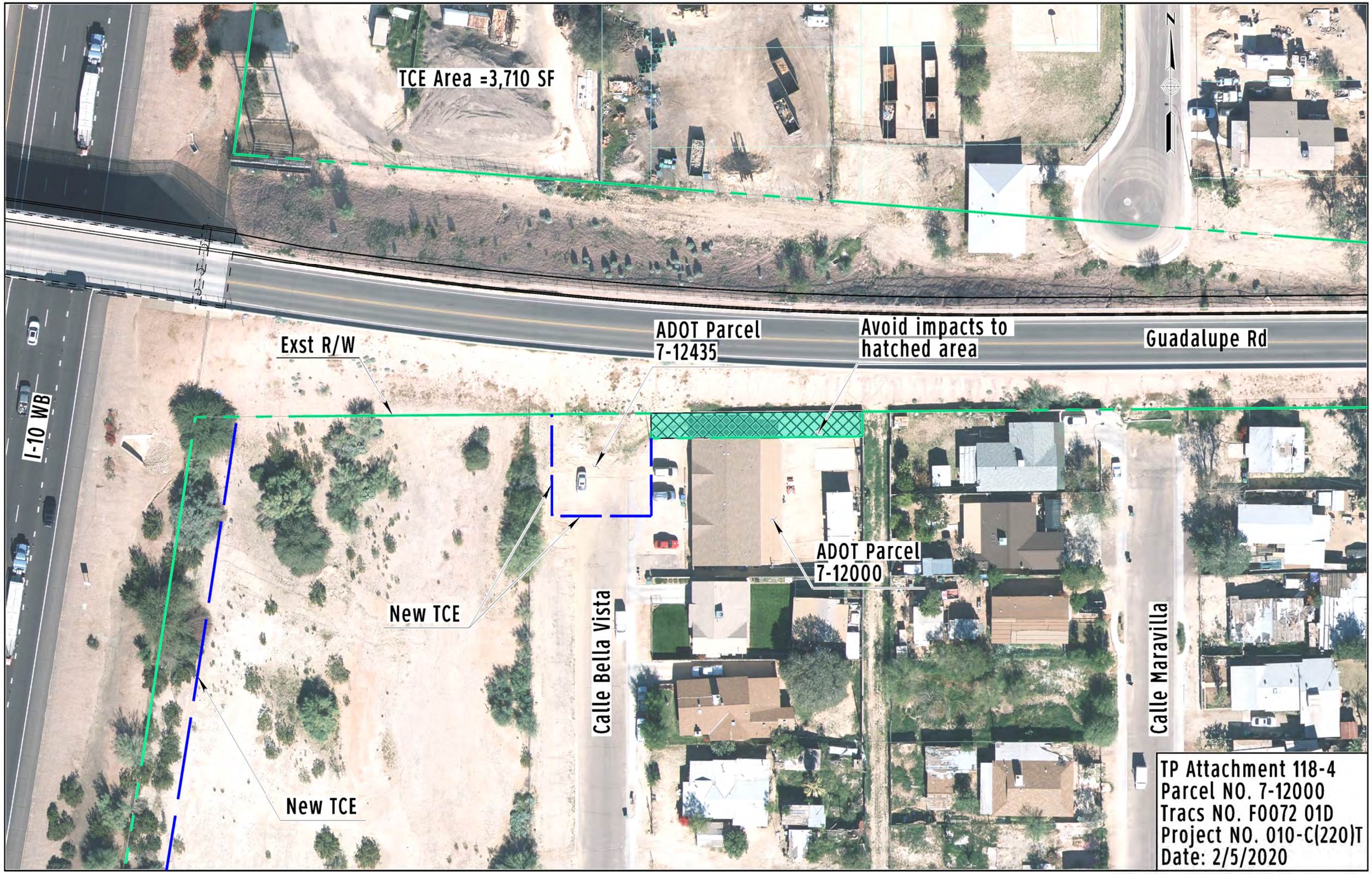


Note:
B= Buildings, P=Parking Lot, Cell Tower to Remain
Building B4 (ECD) to be demolished by ADOT by Jan 2021

ADOT Yard Existing Layout
Scale: 1"=100'
Tracs NO. F0072 01D
Project NO. 010-C(220)T
Date: 02/10/2020

TP Attachment 118-4

Parcel 7-12000 No Impact Exhibit


TCE Area =3,710 SF
N
Exst R/W
ADOT Parcel
7-12435
Avoid impacts to
hatched area
Guadalupe Rd
I-10 WB
New TCE
New TCE
Calle Bella Vista
ADOT Parcel
7-12000
Calle Maravilla
TP Attachment 118-4
Parcel NO. 7-12000
Tracs NO. F0072 01D
Project NO. 010-C(220)T
Date: 2/5/2020

TP Attachment 119-1 – Environmental Mitigation Commitments

TP Attachment 119-1
Environmental Mitigation Commitments

The following table includes the Project-specific environmental mitigation measures and commitment requirements documented in the Final Environmental Assessment. Developer is responsible for performing and complying with all obligations of ADOT, except those obligations that are specifically identified below as being the obligations of ADOT.

Developer's Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
The Developer will contact the ADOT Environmental Planning Historic Preservation Team (602.712.4232 or 602.712.7767) and the ADOT Project Team at least 10 (ten) business days prior to construction to ensure that the terms and stipulations of Attachment Six (6) of the Programmatic Agreement have been fulfilled.	
The Developer will contact the ADOT Environmental Planning Historic Preservation Team (602.712.4232 or 602.712.7767) at least 10 (ten) business days prior to the start of ground-disturbing activities to arrange for qualified personnel to monitor and be present during construction.	
Where feasible, the noise barriers required as mitigation measures will be constructed as early as possible in the construction phasing to shield adjacent properties from construction-related noise. Prior to construction, the Contractor shall prepare construction noise assessment memo for specific noise sensitive areas identified in the noise technical analysis that will include a description of the planned construction methods and operations, any basic measures that have been identified to reduce construction noise impacts, and a process to address public comments during construction.	
If a Section 404 permit is required, impacts to Waters of the U.S. will be mitigated prior to construction as required by the U.S. Army Corps of Engineers; this may include compensatory mitigation (in-lieu fees).	
Floodplain impacts will be coordinated with Maricopa County Flood Control District.	ADOT will coordinate with the Developer for floodplain impacts that need to be coordinated with Maricopa County Flood Control District.
The Developer shall comply with all terms and conditions of the Clean Water Act Section 404/401 permit and certification.	

TP Attachment 119-1
Environmental Mitigation Commitments

The following table includes the Project-specific environmental mitigation measures and commitment requirements documented in the Final Environmental Assessment. Developer is responsible for performing and complying with all obligations of ADOT, except those obligations that are specifically identified below as being the obligations of ADOT.

Developer's Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
If vegetation clearing would occur during the migratory bird breeding season (March 1- August 31), the Developer will avoid any active bird nests. If active nests cannot be avoided, the Developer will notify the Environmental Compliance Manager to evaluate the situation. During the non-breeding season (September 1- February 28), vegetation removal is not subject to this restriction.	If any active bird nests cannot be avoided by vegetation clearing or construction activities, ADOT District will contact ADOT Environmental Planning biologist (602.712.4232) to evaluate the situation.
Prior to construction, all personnel who will be on-site, including, but not limited to, contractors, Developer's employees, supervisors, inspectors, and subcontractors, will review the Arizona Department of Transportation Environmental Planning "Western Burrowing Owl Awareness" flyer.	
If any burrowing owls or active burrows are identified, the Developer will notify the Environmental Compliance Manager immediately. No construction activities will take place within 100 feet of any active burrow.	
If ADOT, in cooperation with the Environmental Planning Biologist, determines that burrowing owls cannot be avoided, the Developer will employ a qualified biologist holding a permit from the US Fish and Wildlife Service to relocate burrowing owls from the project area, as appropriate.	
The Developer shall not cause injury or death to swallows, including eggs and nestlings. If work will occur that will directly impact nesting swallows from February 1 to August 31 of any calendar year.	
The Developer shall completely remove all existing swallow nests within 100 feet of work areas after August 31 but prior to February 1 to prevent swallows from reusing those nests.	

TP Attachment 119-1
Environmental Mitigation Commitments

The following table includes the Project-specific environmental mitigation measures and commitment requirements documented in the Final Environmental Assessment. Developer is responsible for performing and complying with all obligations of ADOT, except those obligations that are specifically identified below as being the obligations of ADOT.

Developer's Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
The Developer shall implement exclusionary measures to prevent swallows from building new nests within areas directly impacted by construction activities. Exclusionary measures shall be implemented in all areas where swallows are likely to nest, and may include: (a) continually removing nesting materials during early nest construction when eggs or nestlings are not present, (b) installing deterrent spike strips, and/or (c) installing polytetrafluoroethylene (Teflon) sheeting.	
The Developer shall not disturb any active swallow nests (completed or partially completed nests that contain eggs or nestlings). If any active nest is discovered within 100 feet of construction activities, work shall stop and the Arizona Department of Transportation Environmental Planning biologist shall be contacted (602.712.7134 or 602.341.9331) to evaluate the potential for disturbance of nests.	
The Developer shall monitor and maintain the effectiveness of exclusionary measures daily. Spike strips shall be maintained such that they remain in place. Teflon sheeting shall be reapplied as often as necessary to remain effective.	

TP Attachment 119-1
Environmental Mitigation Commitments

The following table includes the Project-specific environmental mitigation measures and commitment requirements documented in the Final Environmental Assessment. Developer is responsible for performing and complying with all obligations of ADOT, except those obligations that are specifically identified below as being the obligations of ADOT.

Developer's Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
If swallow exclusion measures fail, the Developer shall: – Inform the Environmental Compliance Manager as soon as swallow nest building occurs and determine whether the area can be avoided until nests are no longer active. – Hire a qualified biologist to survey bird nests within 100 feet of construction areas and provide a report to the Environmental Planning biologist (602.712.7134 or 602.341.9331) with the number of affected nests for each species of bird. The resume for the selected biologist shall be approved by the Environmental Compliance Manager in coordination with the ADOT Biologist prior to conducting the survey. – Determine whether to wait for the nestlings to fledge or apply for a US Fish and Wildlife Service Migratory Bird Treaty Act Special Purpose permit from the USFWS Regional office in Albuquerque, New Mexico. – If the permit is approved, hire a wildlife rehabilitator licensed by USFWS to relocate and rehabilitate all affected eggs or nestlings. – Any costs incurred as a result of delays related to failure of swallow exclusion measures, including waiting until the nests are not active. and/or time required to obtain a Migratory Bird Treaty Act relocation permit and the eggs or nestlings to be relocated from the work area shall be the contractor's responsibility.	
The Developer shall remove all swallow exclusionary measures after project completion to the satisfaction of the Engineer.	

TP Attachment 119-1 Environmental Mitigation Commitments The following table includes the Project-specific environmental mitigation measures and commitment requirements documented in the Final Environmental Assessment. Developer is responsible for performing and complying with all obligations of ADOT, except those obligations that are specifically identified below as being the obligations of ADOT.	
Developer's Environmental Commitment Record Requirements	**Description of ADOT-Retained Obligations**
To prevent the introduction of invasive species seeds, all earthmoving and hauling equipment shall be washed prior to entering the construction site and the Developer shall inspect all construction equipment and remove all attached debris, including plant parts, soil, and mud, prior to the equipment entering the construction site.	
To prevent invasive species seeds from leaving the site, the Developer will inspect all construction and hauling equipment and remove all debris, including plant parts, soil, and mud, prior to leaving the construction site.	
No pavement marking obliteration shall occur until the existing pavement markings are tested for lead based paint, and if present, a Lead-Based Paint Removal and Abatement Plan is approved by the ADOT Environmental Planning hazardous materials coordinator and implemented.	

TP Attachment 119-2 – Environmental Study Area

Interstate 10
Broadway Curve P3

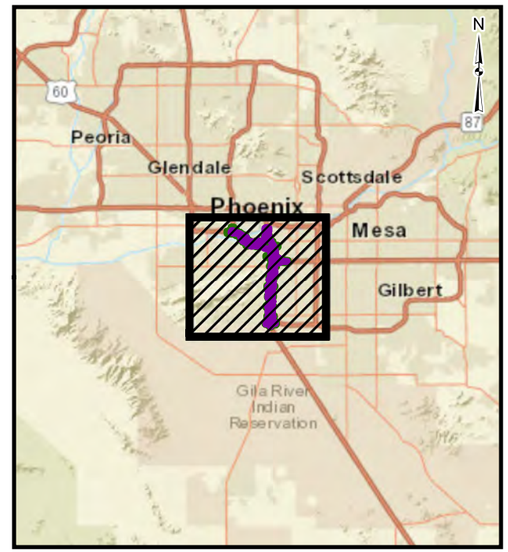
Environmental Study Area

TP Attachment 119-2

Legend

- Area of Potential Effect (APE)
- Environmental Study Area

Index Map



N

1 inch = 6,000 feet

0 3,000 6,000 Feet

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY WSP USA, INC. SHALL BE WITHOUT LIABILITY TO WSP USA, INC.

1230 W Washington Street #405
Tempe, Arizona 85281 (480) 966-8295

DATE: 11/7/2019

TP Attachment 120-1 – Summary Index of Standard Specifications and Stored Specifications

TP Attachment 120-1 Summary Index of Standard Specifications and Stored Specifications				
ADOT STD SPECS Section #	ADOT Stored Specifications		General Notes	Item Description
	Name	Date		
100				GENERAL
101	101ABRV 101DEFN	03/15/18 02/22/16		DEFINITIONS AND TERMS
102	102NOBID	09/19/12		BIDDING REQUIREMENTS AND CONDITIONS
104	104APA 104DUST 104MTBRN 104MAGDET	02/26/99 11/01/95 06/04/96 05/03/16		SCOPE OF WORK
105	105PLNS	10/18/10		CONTROL OF WORK
106	106SRP 106QCMAT 106CERT 106APL 106DMAT	05/29/08 05/03/16 02/26/19 03/19/20 02/15/11		CONTROL OF MATERIAL
107	107SRPCL 107PCS 107FINA	09/04/98 02/13/17 09/19/12		LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC
201	201MTBRN	10/18/10		CLEARING AND GRUBBING
202	202RMVL 202ASB 202LEAD	10/03/14 01/26/16 02/20/20		REMOVAL OF STRUCTURES AND OBSTRUCTIONS
203	203QCEW 203EWRK	07/15/05 03/23/11		EARTHWORK
204				RESHAPING AND GRADING EXISTING IMPROVEMENTS
205				GRADING ROADWAY FOR PAVEMENT
208	208GEOM	12/03/91		GEOMEMBRANE
209	209WTR	03/17/08		FURNISH WATER
301				LIME TREATED SUBGRADE
303	303QCAB	07/15/05		AGGREGATE SUBBASES AND AGGREGATE BASES
306				GEOGRID BASE REINFORCEMENT
401				PORTLAND CEMENT CONCRETE PAVEMENT
402				PORTLAND CEMENT CONCRETE PAVEMENT REPAIRS
403				ASPHALTIC CONCRETE HOT PLANT REQUIREMENTS

TP Attachment 120-1 Summary Index of Standard Specifications and Stored Specifications				
ADOT STD SPECS Section #	ADOT Stored Specifications		General Notes	Item Description
	Name	Date		
404	404PRBRN	07/31/90		WATERPROOF MEMBRANE
406				ASPHALTIC CONCRETE
409				ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL)
414	414ACFAR	01/13/20		ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT-RUBBER)
416				ASPHALTIC CONCRETE-END PRODUCT
417				ASPHALTIC CONCRETE-END-SHRP VOLUMETRIC MIX
501	501PIPE 501QCDRN	01/14/20 07/15/05		PIPE CULVERTS AND STORM DRAINS
503				CONCRETE CATCH BASINS
504				STANDPIPES
505				MANHOLES
601	601PRCST 601FSWK 601CONC	03/31/05 08/07/18 08/07/18		CONCRETE STRUCTURES
602	602PRSTR	09/08/11		PRESTRESSING CONCRETE
604	604STLSTR	09/04/18		SHOP AND WORKING DRAWINGS
605				STEEL REINFORCEMENT
606	606OHST	05/08/19		OVERHEAD SIGN STRUCTURES
607	607POST	09/08/11		ROADSIDE SIGN SUPPORTS
608	608PANEL 608GRAFF	01/26/16 07/11/19		SIGN PANELS
609	609DRSFD	10/24/19		DRILLED SHAFT FOUNDATIONS
610	610PNT	08/29/12		PAINTING
701				MAINTENANCE AND PROTECTION OF TRAFFIC
702				ATTENUATION DEVICES
703				DELINEATORS AND MARKERS
704	704THRMO	01/16/18		THERMOPLASTIC PAVEMENT MARKINGS

TP Attachment 120-1 Summary Index of Standard Specifications and Stored Specifications				
ADOT STD SPECS Section #	ADOT Stored Specifications		General Notes	Item Description
	Name	Date		
705	705PVMRK	08/18/14		PREFORMED PLASTIC PAVEMENT MARKING
706				RAISED PAVEMENT MARKERS
707				TUBULAR MARKER (FLEXIBLE)
708	708WPM	09/06/09		WATERBORNE PAVEMENT MARKINGS
709				DUAL COMPOUND PAVEMENT MARKINGS
730				GENERAL REQUIREMENTS FOR TRAFFIC SIGNAL AND HIGHWAY LIGHTING SYSTEMS
731				STRUCTURAL SUPPORTS AND FOUNDATIONS FOR TRAFFIC SIGNAL AND HIGHWAY LIGHTING
732				ELECTRICAL UNDERGROUND MATERIAL
733				SIGNAL INDICATIONS AND MOUNTING ASSEMBLIES
734	734PATSC	07/01/14		TRAFFIC CONTROLLER ASSEMBLY
735	735LOOP	02/07/13		DETECTORS
736	736LED	12/10/19		HIGHWAY AND SIGN LIGHTING
737				INCIDENTAL ELECTRICAL WORK
801				LANDSCAPE EXCAVATION
802				LANDSCAPE GRADING
803				LANDSCAPE PLATING MATERIALS
804				TOPSOIL
805				SEEDING
806				TREES, SHRUBS, AND PLANTS
807				LANDSCAPING ESTABLISHMENT
808				WATER DISTRIBUTION
809				SEWERAGE SYSTEM
810	810ERCON	03/24/11		EROSION CONTROL AND POLLUTION PREVENTION

TP Attachment 120-1 Summary Index of Standard Specifications and Stored Specifications				
ADOT STD SPECS Section #	ADOT Stored Specifications		General Notes	Item Description
	Name	Date		
902				CHAIN LINK FENCE
903				WIRE FENCE
904				CHAIN LINK CABLE BARRIER
905	905GRDRL	06/14/19		GUARDRAIL
908	908CGSD	03/19/20		CONCRETE CURBS, GUTTERS, SIDEWALKS AND DRIVEWAYS
909				SURVEY MONUMENTS
910				CONCRETE BARRIERS
911				RIGHT-OF-WAY MARKERS
912				SHOTCRETE
913	913BKPRT	03/15/18		BANK PROTECTION
914				WALLS AND MISCELLANEOUS STRUCTURES
915				TEMPORARY SILT FENCE
919				CONCRETE GORE PAVING
921	921MEDPA	03/19/20		MEDIAN PAVING
922				UTILITY CONCRETE FOR MISCELLANEOUS CONSTRUCTION
923				CONTRACTOR BASED ON-THE-JOB TRAINING
924	924CQC	03/02/09		CONTRACTOR QUALITY CONTROL
925	925SRVY	08/16/19		CONSTRUCTION SURVEYING AND LAYOUT
1001				MATERIAL SOURCES
1002	1002PNT	11/06/12		PAINT
1003	1003REBAR	01/26/16		REINFORCING STEEL
1004				STRUCTURAL METALS
1005				BITUMINOUS MATERIALS FOR SURFACING
1006	1006PCC 1006QCPC	02/13/17 07/12/05		PORTLAND CEMENT CONCRETE
1007	1007REFS	11/05/13		RETROREFLECTIVE SHEETING

TP Attachment 120-1 Summary Index of Standard Specifications and Stored Specifications				
ADOT STD SPECS Section #	ADOT Stored Specifications		General Notes	Item Description
	Name	Date		
1008				PRISMATIC REFLECTORS
1009				ASPHALT-RUBBER MATERIAL
1010	1010PIPE	01/14/20		DRAINAGE PIPE
1011				JOINT MATERIALS
1012	1012GRDRL	01/25/18		GUARDRAIL MATERIALS
1013	1013BRPD	10/09/08		BEARING PADS
1014	1014FAB	05/07/13		GEOSYNTHETICS
1015	1015EPOX	03/15/18		EPOXY MATERIALS
1016				PACKAGED DRY CONCRETE AND MORTAR MATERIALS
1017	1017GRT	08/07/18		NONSHRINK GROUT MATERIALS

Note: Additional Stored Specifications are required in the Materials Design Report.

TP Attachment 200-1 – Roadway Design Criteria

- *TP Attachment 200-1.1 – Mainline, Collector-Distributor Road, and Ramp Design Criteria*
- *TP Attachment 200-1.2 – Crossroad and Local Street Design Criteria*

TP Attachment 200-1.1 Mainline, Collector-Distributor Road, and Ramp Design Criteria[1]						
	Mainline			Collector Distributor Road (C-D)	System Interchange Ramp	Service Interchange Ramp
	I-10	US 60	SR 143			
Minimum Design Speed[2]	65 MPH	65 MPH	65 MPH	55 MPH	55 MPH	Body: 50 MPH Terminus: 35 MPH Loop: 30 MPH
	At Mainline Entrance Gore:			55 MPH	55 MPH	55 MPH
	At Mainline Exit Gore:			60 MPH	60 MPH	60 MPH
	At C-D Entrance Gore:			55 MPH	55 MPH	50 MPH
	At C-D Exit Gore:			N/A	55 MPH	50 MPH
	At Non-Mainline/Non-C-D Gore:			N/A	N/A	45 MPH
Lane Width	12 feet[3]	12 feet	12 feet	12 feet	12 feet[4]	12 feet[5]
Left Shoulder Width[6]	12 feet[7]	Match Existing[9]	Match Existing[10]	6 feet	1-Lane: 6 feet 2-Lane: 4 feet[11] 3-Lane: 6 feet	2 feet
Right Shoulder Width[6]	12 feet[8]	12 feet[9]	12 feet[10]	10 feet	1-Lane: 10 feet 2-Lane: 8 feet[11] 3-Lane: 10 feet	Entrance Ramp: 2 feet Exit Ramp Body: 8 feet Exit Ramp Throat: 2 feet
Barrier Offset[12]	0 feet	0 feet	0 feet	0 feet	1-Lane: 0 feet 2-Lane: 2 feet[11] 3-Lane: 0 feet	2 feet
Maximum Superelevation Rate	6%	6%	6%	6%	6%	6%
Normal Cross-Slope	2%	2%	2%	2%	2%	2%
Maximum Grade Up	3%	3%	3%	3%[13]	4%	4%
Maximum Grade Down	3%	3%	3%	3%[13]	5%[14]	5%

TP Attachment 200-1.1 Mainline, Collector-Distributor Road, and Ramp Design Criteria[1]						
	Mainline			Collector Distributor Road (C-D)	System Interchange Ramp	Service Interchange Ramp
	I-10	US 60	SR 143			
Curb Type	ADOT Std C-05.10 Type B, E (or E-1) or C (or C-1)					
Vertical Clearance[15, 17]						
Over Roadway	16 feet - 6 inches[16, 17]					
Overhead Signs	18 feet - 6 inches; 18 feet - 6 inches to dynamic message signs					
Overhead Pedestrian Crossing	17 feet - 6 inches					
Over Canals and Channels	Per Canal / Channel Authority Requirements					
Design Vehicle[18]	WB-67					

TP Attachment 200-1.1
Mainline, Collector-Distributor Road, and Ramp Design Criteria[1]

	Mainline			Collector Distributor Road (C-D)	System Interchange Ramp	Service Interchange Ramp
	I-10	US 60	SR 143			

Notes:
1. See TP Attachment 200-3 for Design Exceptions and Design Variances.
2. Except as shown in TP Attachment 200-2.
3. Per TP Attachment 200-3, 11 feet on I-10 EB at 24th Street, I-10 EB at 32nd Street, I-10 EB between Baseline Road and Ray Road, and I-10 WB between US 60 and Ray Road.
4. Per TP Attachment 200-3, 11.5 feet on US 60 Ramp W-S.
5. 16 feet on 48th Street Loop Ramp.
6. Left and Right are in the direction of travel. Shoulder Width includes gutter pan.
7. 10 feet on I-10 EB at 32nd Street for the limits of Lane Width Design Exception per TP Attachment 200-3. 4 feet on I-10 EB and I-10 WB adjacent to US 60 DHOV Ramp per TP Attachment 200-3. 11 feet on I-10 EB and I-10 WB from Baseline Road to Ray Road.
8. 10 feet on I-10 EB at 32nd Street for the limits of Lane Width Design Exception per TP Attachment 200-3. 10 feet on I-10 EB and I-10 WB from Baseline Road to Ray Road with curb & gutter or edge of pavement condition (12 feet with barrier). 10 feet on I-10 WB from Sta 7977+97 to the back of gore of the I-10 WB 32nd Street Entrance Ramp with both curb and gutter and barrier.
9. Per TP Attachment 200-3, 4 feet Left Shoulder and 8 feet Right Shoulder.
10. Per TP Attachment 200-3, 0 feet Left Shoulder and 4 feet Right Shoulder.
11. Per TP Attachment 200-3, 4 feet Left Shoulder and 3 feet Right Shoulder with 0 feet Barrier Offset on US 60 Ramp W-S.
12. Does not apply to median shoulders. Does not apply to 12 foot shoulders. 12 feet is the maximum shoulder width.
13. 4% Maximum Grade Up and 5% Maximum Grade Down at SR 143 directional ramps.
14. 4% Maximum Grade Down for I-10/SR 143 DHOV.
15. The required vertical clearance shall be provided over the entire roadway width, including shoulders and bike lanes.
16. A minimum 16 feet - 0 inch vertical clearance is permitted along I-10 EB at the 32nd Street underpass.
17. A minimum 16 feet - 4 inches (match existing) vertical clearance is permitted along I-10 WB at the Guadalupe Road underpass.
18. Bicycles are not allowed on Mainlines, Collector-Distributor Roads, or Ramps.

TP Attachment 200-1.2 Crossroad and Local Street Design Criteria[1]					
	Crossroad (within Access Control)			Local Street	
	48th Street	Broadway Road	SB 40th Street	48th Street	Diablo Way
Minimum Design Speed	45 MPH	45 MPH	45 MPH	40 MPH	30 MPH
Lane Width[2]	12 feet[3]	12 feet[4]	Match Existing	12 feet	11 feet - 11 inches
Left Shoulder Width[2,5]	2 feet[6]	0 feet	Match Existing	2 feet	0 feet
Right Shoulder Width[2,5]	4 feet[6]	6 feet	Match Existing	2 feet	0 feet
Barrier Offset	2 feet[6]	0 feet	0 feet	0 feet	0 feet
Maximum Superelevation Rate	6%	6%	6%	6%	6%
Normal Cross-Slope	2%	2%	2%	2%	2%
Maximum Grade Up	4%	3%[7]	3%[7]	6%	6%
Maximum Grade Down	5%	3%[7]	3%[7]	6%	6%
Curb Type	ADOT Std C-05.10 Type A (or A1), D (or D-3) or D-1			Per Local Governmental Entity	
Vertical Clearance[8]					
Over Roadway	16 feet - 6 inches[9]				
Overhead Signs	18 feet - 6 inches; 18 feet - 6 inches to dynamic message signs				
Over Canals and Channels	Per Canal / Channel Authority Requirements				
Design Vehicle	WB-67				

TP Attachment 200-1.2 Crossroad and Local Street Design Criteria[1]					
	Crossroad (within Access Control)			Local Street	
	48th Street	Broadway Road	SB 40th Street	48th Street	Diablo Way

Notes:
1. See TP Attachment 200-3 for Design Exceptions and Design Variances.
2. Lane Width and Shoulder Width may be adjusted by adjacent Governmental Entity as long as the resulting roadway width is not greater than if these values are used.
3. 11 feet permitted south of I-10 EB Exit Ramp/48th Street intersection.
4. Inside through lane shall be 14 feet when adjacent to Curb & Gutter. Outside and middle through lanes shall be 11 feet.
5. Left and right are in the direction of travel. Shoulder width includes gutter pan.
6. 0 feet permitted for 48th Street SB south of I-10 EB Exit Ramp/48th Street intersection.
7. 4% Maximum Grade Up and 5% Maximum Grade Down permitted outside ramp termini.
8. The required vertical clearance shall be provided over the entire roadway width, including shoulders and bike lanes.
9. A minimum 16 feet - 0 inch vertical clearance is permitted along I-10 EB at the 32nd Street underpass.

TP Attachment 200-2 – Roadway Classification Exhibit

Urban Freeway

Directional Ramp (C-D) Reduced Speed

Directional Ramp (HOV) Reduced Speed

Service Ramp

Arterial

Vd = Design Speed

500 200 0 500

I-10

Broadway Rd

University Dr

48th St

SR143

N

Vd=40 mph

Vd=45 mph

Vd=45 mph

Vd=40 mph

Vd=45 mph

Vd=45 mph

Vd=45 mph

Vd=45 mph

Vd=45 mph

Vd=45 mph

Vd=30 mph

Vd=40 mph

Note:

1. All directional Ramps shall be designed per TP Attachment 200-1 requirements. Design Speed reductions are permitted at horizontal locations shown in TP Attachment 200-2.
2. Design Exceptions are in process for reduced speeds at the locations shown in TP Attachment 200-3.

TP Attachment 200-2
Roadway Classification Exhibit
I-10, I-17 (Split) to SR 202L (Santan)
I-10/SR 143 Interchange

TP Attachment 200-3 – Design Exceptions and Design Variances

- *TP Attachment 200-3.1 – Summary of AASHTO Design Exceptions*
- *TP Attachment 200-3.2 – Summary of ADOT Design Variances*

FHWA and ADOT have reviewed and approved several Design Exceptions based on the preliminary nature of the design and potential for design changes by the Developer. For additional information on the approved Design Exceptions and Design Variances, see Design Exception Request and Design Variance Request contained in the RIDs.

TP Attachment 200-3.1 Summary of AASHTO Design Exceptions		
Design Feature	**Location**	**Discrepancy from Required Design Value**
1.) Superelevation	Baseline Road EB Entrance Ramp*	1.2% less than 3.2%
	Elliot Road EB Entrance Ramp*	0.3% less than 2.3%
	Elliot Road WB Exit Ramp*	0.7% less than 2.7%
	Elliot Road WB Entrance Ramp*	3.0% less than 5.0%
	Warner Road EB Exit Ramp*	0.7% less than 2.7%
	Warner Road EB Entrance Ramp*	0.3% less than 2.3%
	Warner Road WB Exit Ramp*	0.7% less than 2.7%
	Warner Road WB Entrance Ramp*	0.3% less than 2.3%
	Ray Road EB Exit Ramp*	0.7% less than 2.7%
	Ray Road EB Entrance Ramp*	3.7% less than 5.7%
	Ray Road WB Entrance Ramp*	0.3% less than 2.3%
2.) Horizontal Sight Distance	EB C-D Curve east of US 60 Ramp SE	200’ less than 519’
	EB C-D Curve over the Western Canal	90’ less than 519’
	EB C-D to US 60 Ramp SE	154’ less than 485’
	WB C-D Curve at US 60 TI	170’ less than 519’
	US 60 Ramp NE Main Curve*	167’ less than 498’
	US 60 Ramp WN Main Curve	137’ less than 540’
	US 60 WB to WB C-D Main Curve	176’ less than 514’
	Broadway Road WB Exit Ramp	140’ less than 464’
	Broadway Road EB Entrance Ramp	108’ less than 442’
	DHOV, SR 143 SB to I-10 EB	134’ less than 385’
	DHOV, I-10 WB to SR 143 NB	101’ less than 385’
	SR 143 SB to EB C-D Main Curve	111’ less than 326’
	US 60 Ramp WS Main Curve*	318’ less than 547’
	US 60 WB at Priest Drive*	159’ less than 568’
	US 60 WB at HOV Crossover*	46’ less than 568’

TP Attachment 200-3.1 Summary of AASHTO Design Exceptions		
Design Feature	**Location**	**Discrepancy from Required Design Value**
	US 60 EB near Hardy Drive*	203’ less than 676’
3.) Vertical Alignment Stopping Sight Distance	US 60 Ramp WN at I-10 WB	48’ less than 540’
4.) Lane Width	I-10 EB at 24th Street	1’ less than 12’
	I-10 EB at 32nd Street	1’ less than 12’
	I-10, US 60 to Ray Road	1’ less than 12’
	US 60 Ramp WS*	0.5’ less than 12’
	US 60 Ramp WS Connection (Baseline Ramp)*	0.5’ less than 12’
5.) Minimum Shoulder Width	SR 143 NB at University Drive Left/Inside Shoulder*	10’ less than 10’
	SR 143 NB at University Drive Right/Outside Shoulder*	6’ less than 10’
	SR 143 SB at University Drive Left/Inside Shoulder*	10’ less than 10’
	SR 143 SB at University Drive Right/Outside Shoulder*	6’ less than 10’
	I-10 WB at US 60 HOV Ramp Inside Shoulder*	Up to 6’ less than 10’
	I-10 EB at US 60 HOV Ramp Inside Shoulder*	Up to 6’ less than 10’
	US 60 Ramp WS Connection (Baseline Ramp) Left/Inside Shoulder*	2’ less than 6’
	US 60 Ramp WS Connection (Baseline Ramp) Right/Outside Shoulder*	7’ less than 10’
	US 60 Ramp WS Left/Inside Shoulder*	2’ less than 6’
	US 60 Ramp WS Right/Outside Shoulder*	7’ less than 10’
	US 60 WB & EB Left Shoulder* EB Right Shoulder	 6’ less than 10’ 2’ less than 10’
	I-10/24th Street EB Entrance Ramp Combined Shoulder*	 6’ less than 10’
	I-10/32nd Street WB Entrance Ramp Combined Shoulder EB Entrance Ramp Combined Shoulder	 2’ less than 10’ 2’-4’ less than 10’

TP Attachment 200-3.1 Summary of AASHTO Design Exceptions		
Design Feature	**Location**	**Discrepancy from Required Design Value**
	I-10/40th Street WB Entrance Ramp Combined Shoulder EB Entrance Ramp Combined Shoulder	 2'-4' less than 10' 2'-4' less than 10'
	SR 143/University Drive SB Entrance Ramp Combined Shoulder	4' less than 10'
5.) Minimum Shoulder Width	I-10/Broadway Road WB Entrance Ramp Combined Shoulder WB Exit Ramp Combined Shoulder EB Entrance Ramp Combined Shoulder	 2' less than 10' 4' less than 10' 2' less than 10'
	I-10/Baseline Road WB Entrance Ramp Combined Shoulder* EB Entrance Ramp Combined Shoulder*	 6' less than 10' 6' less than 10'
	I-10/Elliot Road WB Entrance Ramp Combined Shoulder* EB Entrance Ramp Combined Shoulder*	 2' less than 10' 4' less than 10'
	I-10/Warner Road WB Entrance Ramp Combined Shoulder* EB Entrance Ramp Combined Shoulder*	 2' less than 10' 4' less than 10'
	I-10/Ray Road WB Entrance Ramp Combined Shoulder*	2' less than 10'
	US 60/Priest Drive EB Entrance Ramp Combined Shoulder	4' less than 10'
6.) Traveled Way Width	I-10/24th Street EB Entrance Ramp	2' less than 26'
	I-10/SR 143 TI SR 143 SB to WB C-D SR 143 SB to EB C-D	 3' less than 15' 2' less than 26'
	I-10/Baseline Road WB Entrance Ramp EB Entrance Ramp	 2' less than 26'

*Existing Condition

TP Attachment 200-3.2 Summary of ADOT Design Variances		
Design Feature	**Location**	**Discrepancy from Required Design Value**
1.) Level of Service	I-10 EB, Southern Avenue to SR 202L	Less than LOS D
	I-10 WB, SR 202L to Elliot Road	
	I-10 WB, Broadway Road to 32nd Street	
2.) Superelevation Transition Length	US 60 Ramp WN (US 60 WB interface with WB I-10)	23.5'/% less than 61'/%
3.) Ramp Width	Existing US 60 Ramp WS	10' less than 40'
4.) Access Control Limits	I-10/Broadway Rd TI West Leg	180' less than 660' minimum
5.) Detention Basin Emergency Spillway	Detention basins project-wide	Spillways not provided

TP Attachment 200-4 – Maintenance Access (Exceptions to Continuous Access)

TP Attachment 200-4.1 Maintenance Access (Exceptions to Continuous Access)					
Location No.	**Location Description**	**Roadway**	**Begin Station**	**End Station**	**Length (Ft.)**
1	I-10 EB north of Salt River	Existing I-10	7932+10, Lt	7934+35, Lt	225
2	I-10 WB north of Salt River	Existing I-10	7932+10, Rt	7934+35, Rt	225
3	I-10 WB between 32nd St. and 40th St.	Existing I-10	7996+45, Lt	8000+95, Lt	450
4	I-10 WB between 32nd St. and 40th St.	Existing I-10	8004+20, Lt	8005+90, Lt	170
5	I-10 WB at 40th St. WB Entrance Ramp	Existing I-10	8015+65, Lt	8018+30, Lt	265
6	I-10 WB at 40th St. WB Exit Ramp	Existing I-10	8023+30, Lt	8041+90, Lt	1,860
6A	WB C-D between 44th St. and 48th St.	Existing I-10	8053+40, Lt	8068+78, Lt	1,538
7	I-10 EB at 40th St. WB Entrance Ramp	Existing I-10	8022+75, Rt	8029+97, Rt	722
7A	I-10 EB between 44th St. and 48th St.	Existing I-10	8048+07, Rt	8061+20, Rt	1,313
8	SR 143 TI Ramp WN	Existing SR 143	22+20, Rt	22+50, Rt	30
9	48th St. Local east of SR 143	Existing SR 143	23+00, Rt	37+00, Rt	1,400
10	SR 143 SB between I-10 and University Dr. south of Tempe Drain	Existing SR 143	20+30, Lt	33+90, Lt	1,360
11	SR 143 SB between I-10 and University Dr. north of	Existing SR 143	34+75, Lt	51+95, Lt	1,720
12	Broadway Rd. EB Entrance Ramp	Existing I-10	8099+75, Rt	8100+35, Rt	60
13	Broadway Rd. WB Exit Ramp	Existing I-10	8102+20, Lt	8107+10, Lt	490
14	WB C-D between Alameda Dr. and Broadway Rd.	Existing I-10	8116+05, Lt	8121+90, Lt	585
15	WB C-D at Alameda Dr.	Existing I-10	8127+85, Lt	8130+75, Lt	290
16	I-10 WB north of Southern Ave.	Existing I-10	8154+85, Lt	8156+00, Lt	115
17	Guadalupe Rd. and S. Pointe Pkwy.	Existing I-10	8262+25, Rt	8262+25, Rt	0
18	Salt River Bridge	Existing I-10	7934+12, CL *	7945+33, CL **	1,121
19	I-10 EB between 32nd St. and 36th St.	Existing I-10	7976+20, Lt	7980+30, Lt	410
20	I-10 EB between 32nd St. and 36th St.	Existing I-10	7975+90, Rt	7995+45, Rt	1,955
* = West Approach Slab ** = East Approach Slab					

TP Attachment 200-4.2 Maintenance Access (Exceptions to Access Between Basins and Right-of-Way)					
Location No.	**Location Description**	**Roadway**	**Begin Station**	**End Station**	**Length (Ft.)**
101 *	I-10 EB Baseline Rd. to Guadalupe Rd.	Existing I-10	8232+80, Rt	8247+20, Rt	1,440
102	I-10 EB Guadalupe Rd. to Elliot Rd.	Existing I-10	8263+40, Rt	8291+00, Rt	2,760
103 *	I-10 EB Guadalupe Rd. to Elliot Rd.	Existing I-10	8291+00, Rt	8303+51, Rt	1,251

Notes:
* When 12 feet between the basin and Right-of-Way is not provided, maintenance access path is permitted to utilize the basin side slope adjacent to the Right-of-Way. Maintenance access path shall not be placed on side slopes that exceed 4:1.

TP Attachment 200-4.3 Maintenance Access Throughout System to System Interchanges (Exceptions to Continuous Access)					
Location No.	**Location Description**	**Roadway**	**Begin Station**	**End Station**	**Length (Ft.)**
201	Between Ramp SW and 48th St SB, North of WB C-D	Existing I-10	8066+22, Lt	8073+33, Lt	711
202	Between 48th St SB and 48th St NB, North of WB C-D	Existing SR 143	15+68, Lt	26+29, Lt	1,061
203	Between 48th St NB and SR 143 to EB C-D, North of WB C-D	Existing SR 143	15+62, Rt	22+25, Rt	663
204	Between SR 143 to EB C-D and DHOV, North of WB C-D	Existing SR 143	15+51, Rt	18+99, Rt	348
205	Between I-10 EB and SR 143 to EB C-D, West of Broadway Rd	Existing I-10	8078+83, Rt	8090+65, Rt	1,182
206	Between I-10 WB and WB C-D, East of Broadway Rd	Existing I-10	8092+07, Lt	8101+74, Lt	967
207	Between EB C-D and Ramp SE, North of Southern Ave	Existing I-10	8151+15, Rt	8156+66, Rt	551
208	Between EB C-D and Ramp SE, South of Southern Ave	Existing I-10	8157+99, Rt	8163+35, Rt	536
209	Between US 60 Ramp WN and WB C-D, South of Southern Ave	Existing I-10	8157+67, Lt	8169+50, Lt	1,183
210	Between EB C-D and Ramp SE, West of I-10 EB Baseline Rd Exit Ramp	Existing I-10	8161+42, Rt	8172+40, Rt	1,098
211	Between EB C-D Baseline Rd Exit Ramp and EB C-D, West of I-10 EB Baseline Rd Exit Ramp	Existing I-10	8170+36, Rt	8173+90, Rt	354
212	Between WB C-D and US 60 Interchange, North of US 60 DHOV	Existing I-10	8171+01, Lt	8173+95, Lt	294
213	Between WB C-D and US 60 Interchange, South of US 60 DHOV	Existing I-10	8174+23, Lt	8174+84, Lt	61
216	Between SR 143 to EB C-D and I-10 EB Broadway Rd Exit Ramp, East of 48th St NB	Existing I-10	8073+47, Rt	8085+03, Rt	1,156
217	Between WB C-D and US 60 Ramp WN and US 60 WB Exit Ramp to WB C-D	Existing I-10	8168+06, Lt	8174+20, Lt	614
250	Between Broadway Rd WB Entrance Ramp and I-10 WB, East SR 143	Existing I-10	8077+50, Lt	8090+56, Lt	1,306

TP Attachment 200-4.3 Maintenance Access Throughout System to System Interchanges (Exceptions to Continuous Access)					
Location No.	**Location Description**	**Roadway**	**Begin Station**	**End Station**	**Length (Ft.)**
251	Between WB C-D to SR 143 and WB C-D to University Dr Exit Ramp, South of Tempe Drain	Existing SR 143	a 27+34, Rt	a 31+33, Rt	399
252	Between SR 143 NB and 48th St NB, North of Tempe Drain	Existing SR 143	a 34+74, Rt	a 40+90, Rt	616
253	Between WB C-D to University Dr Exit Ramp and Local 48th St, South of Park Ln	Existing SR 143	a 27+08, Rt	a 29+89, Rt	281
254	Between WB C-D to University Dr Exit Ramp and Local 48th St, South of Tempe Drain	Existing SR 143	a 33+38, Rt	a 33+69, Rt	31
255	Between WB C-D to University Dr Exit Ramp and Local 48th St, North of Tempe Drain	Existing SR 143	a 34+73, Rt	a 35+18, Rt	45
256	Between WB C-D and US 60 WB Exit Ramp to WB C-D, South of Southern Ave	Existing I-10	8160+18, Lt	8163+02, Lt	284
300	Between I-10 WB and I-10 WB 40th St Exit Ramp	Existing I-10	8022+80, Lt	8029+16, Lt	636

TP Attachment 200-5 – ADA Asset Spreadsheet

TP Attachment 200-5 ADA Asset Spreadsheet					
Asset ID	Asset type	Location	Dwg No.	ADA compliant design	Constructed per design
XXXXXX	ADA Ramp	40th St SW Corner; South intersection E-W Crossing	C-XXX.XX	DM Cert Jan - 2021	IQF Cert April - 2022
XXXXXX	Sidewalk	Broadway Rd - Left Sta xx +xx to xx+xx	C-XXX.XX	DM Cert March - 2021	IQF Cert Nov - 2022
XXXXXX	Sidewalk	Broadway Rd - Right Sta xx +xx to xx+xx	C-XXX.XX	DM Cert March - 2021	IQF Cert Nov - 2022
XXXXXX	Push Button	Warner Rd SE Corner; East intersection N-S crossing	TS-XXX.XX	DM Cert Jan - 2021	IQF Cert March - 2021

TP Attachment 400-1 Pavement Design Summary and Materials Design Report

PHOENIX-CASA GRANDE HIGHWAY (I-10)
I-17 (SPLIT) TO SR202L (SANTAN)
010 MA 149 F0072 01C/010-C(220)T

PAVEMENT DESIGN SUMMARY REPORT # 19-33

ARIZONA DEPARTMENT OF TRANSPORTATION

FINAL

PROJECT NO.: 11607
DATE: MAY 2020

WSP
1230 WEST WASHINGTON STREET, SUITE 405
TEMPE, ARIZONA 85281

May 5, 2020

Arizona Department of Transportation
Pavement Design Section
Roadway Engineering Group
205 South 17th Avenue
Phoenix, Arizona 85007

Re: Pavement Design Summary **Report # 19-33**
Phoenix-Casa Grande Highway (I-10)
I-17 (Split) to SR 202L (Santan)
TRACS No. 010 MA 149 F0072 01C
Federal Project Number: 010-C(220)T

Our Pavement Design Summary is submitted herewith in support of the subject project. The following is a summary of the information considered in the pavement design for this project. We understand this information will be used by the selected Developer to construct the project pavements. The Materials Design Report for the project is submitted separately.

Please contact us if you have any questions concerning this report.

Respectfully submitted,
WSP USA

By:



EXPIRES 12/31/

Kevin L. Porter, PE
Senior Geotechnical Engineer

Reviewed By:

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cc: Addressee (PDF)

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A EXISTING PAVEMENT STRUCTURAL SECTIONS
B ADOT PMS HISTORY
C PAVEMENT STRUCTURAL SECTION CALCULATIONS

1 INTRODUCTION

1.1 GENERAL INFORMATION

Traffic demand is causing the I-10 corridor and adjacent local arterial street system to become increasingly congested during morning and evening peak travel periods. Future traffic volume predictions indicate the congestion will continue to worsen, causing further delays and increased travel times in the corridor. Improvements to the I-10 corridor are necessary to increase the freeway capacity and help alleviate increased levels of traffic on the local transportation system.

The purpose of this project is to enhance operational characteristics and mobility of regional and local traffic. The planned project combines proposed improvements from the ADOT Near-Term Improvement DCR and the MAG Spine Study. The geometric layout of the project will be provided to Developers in a Schematic Design.

The project is located within the ADOT Central District, in the cities of Phoenix, Tempe, and Chandler, and the Town of Guadalupe, in Maricopa County, Arizona. The project improvements along I-10 extends from the I-10/I-17 (Split) traffic interchange (milepost (MP149.5)) to the Loop 202 Santan Freeway (MP 160.9). The project also includes the segment of State Route (SR) 143 (Hohokam Expressway) from Broadway Road (MP 0.25) to just south of the Salt River (MP 1.3), and US 60 (Superstition Freeway) from MP 172.0 east to Hardy Drive (MP 173.0).

1.2 PROJECT SCOPE

The overall project will consist of widening and restriping I-10 within the project limits to add general purpose (GP) lanes, high-occupancy vehicle (HOV) lanes, and auxiliary (AUX) lanes; constructing collector-distributor (CD) roads; reconstructing the I-10 system interchange with SR 143 to include direct HOV access between SR 143 and I-10 to and from the east; and improving the I-10 system interchange with US 60.

This Pavement Design Summary (PDS) and the Materials Design Report (MDR, submitted separately) are part of the Technical Provisions for the project. The requirements provided herein are to be used by the selected Developer to construct various pavements for the project in the ADOT maintained improvement areas. However, additional information beyond that provided herein will be required to support final design of the pavement related items. This additional information includes geotechnical subgrade information, as well as the existing pavement thickness of various crossroad pavements located outside of ADOT maintenance limits. For pavements outside of ADOT maintenance limits, and for temporary or detour pavements, separate pavement report(s) in accordance with the local jurisdiction shall be prepared and submitted.

2 PROJECT DESCRIPTION

2.1 ROADWAY DESCRIPTION

The project includes improvements to mainline I-10, SR 143, and US 60 and associated traffic and system interchange improvements.

I-10 varies from an east-west to north-south trending freeway within the project limits. The roadway is generally comprised of 3 to 6 general purpose lanes in each direction of travel and an HOV lane. Auxiliary lanes are present in some locations. The mainline roadway is generally at or near existing site grades. There are several bridge crossings and 10 traffic or system interchanges within the project limits, including 32nd Street, 40th Street, 48th Street/SR143, Broadway Road, US60, Baseline Road, Guadalupe Road, Elliot Road, Warner Road, and Ray Road.

SR143 intersects I-10 near 48th Street and is a north-south trending roadway with 2 to 3 general purpose lanes in each direction. The roadway is generally at-grade or elevated within the project limits and has a service traffic interchange at University Drive.

US 60 is an east-west trending roadway and intersects I-10 north of Baseline Road. This roadway is generally depressed and approaches existing grade near the intersection with I-10. The roadway generally consists of 3 general purpose lanes and an HOV lane with various ramp/flyover/auxiliary lanes in the area.

There will also be limited improvements to various crossroads in the vicinity of the project and outside of ADOT maintenance limits. These are to be addressed by the Developer during final design.

2.2 PROJECT DESCRIPTION

The project will widen existing I-10 to the outside roughly between 24th Street and Elliot Road. The existing Salt River bridges will be widened to accommodate seven GP lanes and two HOV lanes to 32nd Street. The west end of the bridge will flare to accommodate future reconstruction of the I-10/I-17 system interchange. Between 32nd Street and the I-10 system interchange with US 60, I-10 will have a basic six GP lane and two HOV lane typical section, with AUX lanes added between interchanges and at CD roadway connections. South of Baseline Road, the existing lanes will be restriped to create 11-foot wide lanes. Limited outside widening in the eastbound direction south of Baseline, including widening of some of the ramps, will be included as part of this project, however, we understand this reach may be part of a future MAG project. Existing HOV buffers will be eliminated throughout the project length.

The SR 143, Broadway Road, and 48th Street interchanges will be reconstructed and connected to new CD roads. The eastbound CD road will begin as the direct connection from southbound SR 143 to eastbound I-10, with the addition of the Broadway Road eastbound on-ramp and extending to Baseline Road, providing access to US 60, I-10, and Baseline Road. The westbound CD road will run between Baseline Road and 40th Street, providing access to Broadway Road, SR 143, 48th Street north, University Drive, and 40th Street. A direct HOV connection between SR 143 and I-10 to and from the east will also be added.

The interchanges at 40th Street and US 60 will be modified. The 40th Street westbound off-ramp will be eliminated and access from I-10 provided via the westbound CD road. The existing 40th Street southbound loop on-ramp will be eliminated and the eastbound off-ramp relocated. The westbound I-10 to eastbound US 60 ramp will be widened, and the existing westbound US 60 to westbound I-10 ramp relocated to accommodate the westbound CD road and a new ramp providing access to the westbound CD road from westbound US 60.

In addition, much of mainline I-10 and US 60, as well as a few crossroads and ramps, will receive an AR-ACFC overlay but other portions of the project will not. The limits of AR-ACFC will extend to 50 feet beyond the gore, on the crossroad side of the gore. Existing AR-ACFC will be removed and replaced according to the limits noted in the Technical Provisions for the

project. For those portions of the project on I-10 mainline where the existing AR-ACFC will be removed and not replaced, conventional diamond grinding of the exposed concrete pavement surface shall be performed.

3 PAVEMENT HISTORY AND AVAILABLE DATA

3.1 EXISTING PAVEMENT SECTIONS

Available record drawings along the project alignment were reviewed to identify the existing pavement sections throughout the corridor. In general, and based on our review, Table 3-1 below presents approximate mainline pavement thicknesses for various reaches within the project limits.

The table presents the pavement thicknesses in general proximity to the planned mainline widening. Based on the record drawings reviewed, much of the I-10 mainline general purpose lanes have load transfer dowels, with non-dowelled inside and/or outside shoulders. In addition, different pavement sections than those noted below may be present in some locations as part of short sections of previous improvements. Further evaluation and/or exploration is required during final design to characterize the pavement sections present if they may affect future pavement performance. It is the Developer's responsibility to review record drawings and/or perform field work as necessary to verify actual in-place pavement sections.

It is noted that recent pavement cores from mainline pavements were not obtained to verify or confirm the noted thicknesses.

Table 3-1 Existing Pavement Sections

ROAD	SEGMENT[1]	EXISTING PCCP/BASE THICKNESS[2]
I-10	24th Street - 40th Street	10" PCCP/5" LCB
	40th Street - Southern Avenue	13.5" PCCP/4" ACB
	Southern Avenue – Baseline Road	12" PCCP/4" ACB
	Baseline Road -Ray Road	13" PCCP/3" ACB
SR143	I-10 - 10th Place	12.5" PCCP/4" AB
	10th Place – 0.25 miles north University Drive	9" CRCP/4"AB
	0.25 miles north University Drive – Salt River	11" PCCP/4" AB
US 60	I-10 – Hardy Drive	9" to 13" PCCP/Varies

Notes:
1 – Locations are approximate
2 – Lean concrete base (LCB), Asphalt concrete base (ACB), or aggregate base (AB)

Based on the record drawings, pavement thicknesses for the various ramps at service traffic interchanges within the project limits generally ranged from 8 to 11 inches of PCCP on 4 inches of either cement treated base (CTB) or aggregate base (AB). Some ramps also include asphaltic concrete (AC) portions with varying thicknesses of AC and AB.

Maps showing the various existing pavement sections believed to be present throughout the corridor are included in Appendix A. As noted above, variations to those sections and/or limits presented on the maps are possible and will need to be verified during final design of the project.

3.2 VISUAL OBSERVATIONS

A limited pavement condition survey consisting of visual observations of mainline I-10 and associated ramps was performed by WSP in August 2019. However, many of the roadways were covered with AR-ACFC and all potential distresses of the underlying PCCP pavement are not visible where this condition exists. The general descriptions summarizing the observed distresses and estimated quantities are presented in Table 3-2. It should be anticipated that additional areas of distress will be encountered once the friction course is removed.

The primary distresses observed during the survey consisted of longitudinal cracking of the PCCP pavement at various locations which has reflected through the overlaying AR-ACFC. Longitudinal cracking was frequently observed in existing pavement slabs that are wider than 12 feet. These locations were commonly within the HOV lane and at some ramp locations. Limited transverse cracking and spalls were observed in various locations. Although not specifically observed during the limited survey, it is also anticipated joint repairs will be needed in select locations once the AR-ACFC is removed. The quantities presented in Table 3-2 are only estimates based on the observations of the limited August survey and should be expected to vary.

Table 3-2 Pavement Distress Summary

Location	Direction	Longitudinal Cracks (feet)	Transverse Cracks (feet)	Spalls (#/square feet)
I-10 Mainline				
24th Street - 32nd Street	WB	2500	100	4/20
	EB	300	75	12/60
32nd Street - 40th Street	WB	600	50	5/25
	EB	1100	100	7/35
40th Street - 48th Street	WB	50	-	5/25
	EB	1150	-	2/10
48th Street - Broadway Rd	WB	-	-	1/5
	EB	200	-	-
Broadway Rd – Baseline	WB	400	-	18/100
	EB	150	-	6/30
Baseline Rd – Elliot Rd	WB	675	-	29/150
	EB	225	40	6/30

Location	Direction	Longitudinal Cracks (feet)	Transverse Cracks (feet)	Spalls (#/square feet)
Elliot Rd – Warner Rd	WB	160	-	6/30
	EB	-	-	11/60
Warner Rd – Ray Rd	WB	200	-	7/35
	EB	20	-	6/30
Ramps				
24th Street	-	1060	-	30/150
32nd Street	-	4750	-	37/200
40th Street	-	240	-	25/125
Baseline Rd	-	80	-	100/500
Elliot Rd	-	350	15	16/80

The ramps at Warner Road, which are composed of flexible pavement, show moderate to serve cracking on both the eastbound and westbound off-ramps.

3.3 TEST DATA

The following sections provide information regarding available test data for the project and includes Pavement Management System information, geotechnical data, and limited pavement core information.

3.3.1 PAVEMENT MANAGEMENT SYSTEM INFORMATION

ADOT Pavement Management System (PMS) data for I-10, SR 143 and US 60 are provided in Table 3-3. Both I-10 and SR 143 data is from an assessment performed in 2018 by Fugro and US 60 data is from an assessment performed by ADOT in 2015-16. A history of the projects constructed on I-10 and SR 143 that were available in the ADOT Pavement Management System database are provided in Appendix B. Field verification of these records with recent physical pavement cores has not been completed and thus the information may not be accurate. The Developer shall be responsible to verify actual conditions as they pertain to their design.

Table 3-3 Summary of PMS Data

ROADWAY	MILEPOST	ROUGHNESS (IRI) RANGE, INCH/MILE	AVERAGE IRI (INCH/MILE)	RATING
I-10 EB	149.5-150	43-93	65.5	Satisfactory
I-10 WB		53-81	66.8	

ROADWAY	MILEPOST	ROUGHNESS (IRI) RANGE, INCH/MILE	AVERAGE IRI (INCH/MILE)	RATING
I-10 EB I-10 WB	150-151	42-81 42-91	57.5 58.9	Satisfactory
I-10 EB I-10 WB	151-152	45-86 54-93	58.8 62.5	Satisfactory
I-10 EB I-10 WB	152-153	38-71 32-68	50.2 44.5	Satisfactory
I-10 EB I-10 WB	153-154	36-63 34-49	45.7 41.3	Satisfactory
I-10 EB I-10 WB	154-155	33-90 37-55	48.6 43.7	Satisfactory
I-10 EB I-10 WB	155-156	39-115 47-113	61.2 68.5	Satisfactory
I-10 EB I-10 WB	156-157	48-126 59-145	67.0 77.1	Satisfactory
I-10 EB I-10 WB	157-158	45-102 48-156	62.4 77.9	Satisfactory
I-10 EB I-10 WB	158-159	46-80 39-67	65.3 55.1	Satisfactory
I-10 EB I-10 WB	159-160	47-130 42-73	69.5 55.6	Satisfactory
I-10 EB I-10 WB	160-161	34-66 31-59	45.7 42.9	Satisfactory
SR143 NB SR143 SB	0.2-1	142-209 87-262	175.7 170.3	Objectionable

ROADWAY	MILEPOST	ROUGHNESS (IRI) RANGE, INCH/MILE	AVERAGE IRI (INCH/MILE)	RATING
SR143 NB SR143 SB	1-1.3	118-207 108-183	163.4 146.8	Tolerable
US 60 EB US 60 WB	172-173	49-98 41-86	65.1 56.3	Satisfactory

3.3.2 GEOTECHNICAL DATA

Limited geotechnical data was available within the project limits. Available geotechnical data obtained from geotechnical and pavement reports that were provided by ADOT and included in the Reference Information Documents (RIDs) were reviewed and used to estimate appropriate pavement design parameters. The design and construction R-values listed in various project reports are summarized in Table 3-4:

Table 3-4 Design and Construction R-Values

ROADWAY	PROJECT NO.	DESIGN R-VALUES	CONSTUCTION R-VALUES
I-10	010 MA 154 H727801C	20	20
I-10	010 MA 158 H575601C	26	26
I-10	010 MA 154 H014204C	42	42
I-10	010 MA 152 H014304C	25	25
I-10	010 MA 152 H219001C	25	25
I-10	010 MA 154 H208001C	25	25
I-10	010 MA 155 H238201C	26	26
I-10	010 MA 156 H238202C	30	30
I-10	010 MA 156 H388001C	24	24
I-10	010 MA 158 H575601C	26	26

ROADWAY	PROJECT NO.	DESIGN R-VALUES	CONSTUCTION R-VALUES
I-10	010 MA 160 H662701C	20	20
I-10	010 MA 154 H727801C	20	20
SR 143	143 MA 002 H752801C	25	25
SR 143	143 MA 2 H204401C	25	25
SR 143	143 MA 2 H204402C	25	25
SR 143	143 MA 2 H204403C	20	20
SR 143	143 MA 2 H204401C	40	40
SR 143	143 MA 0 H391201C	20	20
US 60	60 MA 172 H537001C	20	20
US 60	360 MA 000 H316401C	26	26
US 60	60 MA 172 H689801C	20	20

In accordance with the Technical Provisions, additional geotechnical information is required to be obtained by the Developer during final design. This includes borings or other subsurface investigations with appropriate laboratory testing to evaluate subgrade characteristics for conformance with the pavement design assumptions.

3.3.3 PAVEMENT CORES

Pavement cores were obtained by WSP in April 2020 at a few select locations near 48th Street and Broadway Road. The asphalt concrete thickness varied from 5 to 6 inches in thickness and was underlain by aggregate base materials ranging from 5 to 18 inches thick. Additional data from these cored locations are provided in the RIDs.

It should be expected the pavement core thickness will vary throughout the project limits and the Developer shall obtain additional pavement cores as needed for their design.

4 DESIGN CALCULATIONS

4.1 DESIGN PARAMETERS

The following rigid pavement design parameters were obtained from the 2017 ADOT Pavement Design Manual (PDM) and used to develop the minimum required pavement sections for the project. The calculations are provided in Appendix C. Additional design parameters related to traffic and subgrade conditions are provided in subsequent sections.

Table 4-1 Rigid Pavement Design Parameters

PARAMETER	SYMBOL	VALUE
Reliability	R	99%
Standard normal deviate	Z_R	-2.327
Combined standard of error	S_0	0.25
Modulus of rupture	S_c'	670 psi
Drainage coefficient*	C_d	1.0 to 1.07
Modulus of elasticity (concrete)	E_c	4,000,000 psi
Initial serviceability index	P_o	4.2
Terminal serviceability index	P_t	3.0
Load transfer coefficient	J	3.9 (non-dowelled) 2.8 (dowelled) 2.5 (CRCP)
Seasonal Variation Factor	SVF	1.0
*Asphalt concrete base (ACB) assumes "good" drainage (C_d=1.07); aggregate base (AB) assumes fair drainage (C_d=1.0)		

It should be noted that for rigid pavement design of cross roads, a reliability of 95% was used. Correspondingly, other parameters were also revised including serviceability and standard normal deviate in accordance with the PDM.

Flexible pavements are planned at 40th Street, 48th Street, Broadway Road, and Warner Road and Ray Road ramps. Accordingly, the following flexible design parameters were used:

- Reliability, R, of 95%;
- Serviceability index loss, ΔPSI, of 1.4; and,
- Standard of error, So, of 0.45.

4.2 TRAFFIC VOLUMES

Existing (2018), future build (2020 and 2040), and future no-build (2040) traffic volumes were provided by the Maricopa Association of Governments (MAG) from their travel demand model (TDM). These projections also included truck volumes for each scenario. The MAG TDM includes the study area planned roadway network, population, and employment forecast to estimate future traffic volumes. All 2020 and 2040 models provided assumed the SR 202L South Mountain Freeway was complete and open.

A growth rate was calculated between 2020 and 2040 traffic volumes to allow volume projections to be calculated for each year of pavement design life. Truck percentages were calculated from the data in the TDM to help determine the design Equivalent Single Axle Loads (ESALs) in general accordance with Appendix A of the PDM.

The 20-year ESAL's summarized in the Table 4-2 were utilized for design for the various roadway mainline segments.

Table 4-2 Mainline Pavement Design ESALs

Mainline Road	Segment	Design ESALs
I-10	24th Street – Southern Avenue	149,520,459
	Southern Avenue - Baseline Road	64,087,172
	Baseline Road – Ray Road	85,008,470
SR143	I-10 - Sky Harbor Blvd	34,065,551
US60	I-10 – Hardy Drive	45,989,697
CD Roads	40th Street – Baseline Road	24,256,064

For other project pavements included herein, the MAG model was used similarly as noted above to develop the design ESALs. These data are summarized on Table A (attached) for the various movements defined in the RFP and referenced herein.

4.3 SOIL SUBGRADE PARAMETERS

A design R-value of 20 was utilized for analysis of new pavement sections. Based on an R-value of 20 and a seasonal variation factor of 1.0 taken from Figure 2-1 and Table 2-4 in the PDM, a resilient modulus of 12,125 pounds per square inch (psi) was calculated and used for flexible pavement design.

Using the resilient modulus obtained above, and Figures 2-6 and 2-7, and Table 2-9 in the PDM, we utilized a design modulus of subgrade reaction, k, of 1000 pounds per cubic inch (pci) for design of rigid pavements supported on AC base with no loss of support, and a value of 625 pci for design of rigid pavements supported on aggregate base, as presented in Appendix C.

If the subgrade does not meet an R-value of 20, as noted in the subgrade acceptance chart provided in the MDR, subgrade improvement shall be performed. Subgrade improvement may consist of a 3-foot overexcavation and replacement with compacted suitable materials, or lime stabilization to a minimum depth of 12 inches, to meet the project subgrade requirements. Geogrid base stabilization will not be an acceptable form of subgrade improvement beneath rigid concrete pavement sections.

For locations outside of ADOT maintenance limits and where pavement sections are not provided herein, the Developer shall develop their own subgrade acceptance requirements based on their respective pavement designs and in conformance with the design and construction requirements of the local jurisdiction.

5 REQUIREMENTS

5.1 PAVEMENT SECTIONS

Based on the information provided above, pavement sections were developed for the project and are discussed in the sections below. The Developer shall use the pavement sections provided below. It is understood the Developer will likely revise the schematic alignments provided, and as such, the stations and lengths provided are expected to be revised by the Developer, but the minimum pavement sections required below shall be used. The stationing referenced for each pavement section is based on existing or proposed stationing, as noted on Table A, attached. Additional discussion on the development and selection of the minimum required pavement sections for the project is also provided below. The minimum required pavement sections are separated into mainline, system ramp connections, and service TI ramps and crossroad sections.

5.1.1 MAINLINE PAVEMENTS

Table 5-1 presents minimum required pavement sections for mainline pavements on I-10, SR 143, US 60 and the planned CD Roads.

Table 5-1 Required Mainline and CD Road Rigid Pavement Sections

ROAD	LOCATION[1]	STATION FROM/TO[1]	BASE THICKNESS/TYPE[2] (IN)	PCCP THICKNESS (IN)	TOTAL THICKNESS (IN)
I-10	24th Street – Southern Ave	7911+21/8158+16	3.0 ACB	14.5 (dowelled)[3]	17.5
	Southern Ave - Baseline Road	8158+16/8230+00	3.0 ACB	12.5 (dowelled)[3]	15.5
	Baseline Road – Ray Road	8230+00/8437+10	3.0 ACB	13.0	16.0
SR143	I-10 – Sky Harbour Blvd	a 34+74/a 38+00 a 64+67/b 85+16	3.0 ACB	13.5	16.5
		a 38+00/a 51+41	3.0 ACB	10.5[4]	13.5
US60	I-10 – Hardy Dr	113+38/147+68	3.0 ACB	14.0	17.0
CD Road	40th St - Baseline	17+32/167+75 WB 10+00/109+47 EB	3.0 ACB	12.5	15.5
Notes:					

1. Locations/Stations are approximate. Mainlines reference existing stationing except CD Roads, which uses proposed stationing. See Table 1 (attached).
2. Asphalt concrete base (ACB). AC Miscellaneous Structural may be used.
3. I-10 mainline pavements used as general purpose and auxiliary lanes shall include load transfer dowels within these limits.
4. New CRCP shall be constructed adjacent to existing CRCP. Reinforcement details are provided in the MDR.

As noted above, improvements to I-10 mainline south of Baseline Road may be affected by a future MAG project. As such, the required pavement section is to match the existing pavement type and thickness within this reach.

Also, there is existing continuously reinforced concrete pavement (CRCP) located along SR 143 near University Drive (MP 0.27 to 1.16). Widening adjacent to CRCP within this reach shall also consist of CRCP as provided in the table above. CRCP reinforcement requirements are provided in the MDR for this project. Longitudinal reinforcement is required to be 0.7% and shall consist of #6 bars at 6-inch spacing placed mid-depth of the slab. Transverse reinforcement is required to be #5 bars at 36-inch spacing. General CRCP details are provided in the MDR. Connection details, gap slabs, reinforcement lap splices, etc., shall be further developed and provided by the Developer as part of their design submittal for review and approval by ADOT.

For clarification, CD Road connections to other system connections shall use the CD Road mainline pavement section provided in the table above. However, connections from the CD Road to existing cross roads are considered ramps and discussed below.

5.1.2 SYSTEM RAMP CONNECTION PAVEMENTS

The required pavement sections for system ramp connections are defined by movement in the RFP and summarized on attached Table A. The MAG model was used to calculate design ESALs for the various movements. The stations and lengths provided are expected to be revised by the Developer, but the pavement sections required shall be used for the noted movements. A minimum pavement thickness of 12 inches of PCCP is required for all system connection pavements on this project to provide increased pavement life and flexibility for future improvements. Limits for AR-ACFC on new system ramps are provided in the Technical Provisions.

5.1.3 SERVICE INTERCHANGE RAMPS AND CROSS ROAD PAVEMENTS

Ramp and cross road pavements were designed using traffic data from the MAG model. Each pavement section for service TI ramps or cross road shall have the same pavement thickness for each leg of the TI in accordance with common ADOT practice, and as provided in the attached Table A.

Various pavement distresses throughout the project limits were noted during the limited pavement condition survey. Specifically, several ramps within the project limits exhibit moderate to severe distress. The 32nd Street off-ramps (Ramps B and C) shall be reconstructed up to the cross road. In addition, Warner Road off-ramps (Ramps B and D) shall receive a 2-inch mill and replace for the full width of each ramp which shall extend up to the cross road. These repairs shall be included in the contract base bid.

Recommendations for cross road pavement thicknesses are also provided. These pavement thicknesses shall be used within ADOT maintenance limits, with rigid pavement sections provided within ADOT access control. For pavement sections outside ADOT maintenance limits, the pavement section shall be designed in accordance with the local jurisdiction's requirements but shall not be less than the existing thickness and the Developer shall obtain approval from the local jurisdiction.

5.1.4 DETOUR PAVEMENTS

Developer shall develop a pavement design for detours and/or temporary pavements. Detours and temporary pavement sections shall not be less than ADOT minimums as provided in Table 2-10 of the PDM. The design ESALs to be used for detour pavement design shall use the 20-year design ESAL's provided herein, prorated for the anticipated service life of the specific detour. Recommendations, including calculations and material specifications, for detour and temporary pavement design shall be submitted to ADOT for review and approval. Developer shall be responsible to maintain detour and temporary pavements in a condition satisfactory to ADOT. Detour and temporary pavements may use ADOT Miscellaneous Structural-Special Mix (409).

5.2 PAVEMENT SURFACING

The existing AR-ACFC will be removed and replaced on various roadways with locations defined in the Technical Provisions and herein. New AR-ACFC placed on rigid pavement shall have a thickness of 1-inch and AR-ACFC placed on flexible pavement shall have a thickness of ½-inch. No AR-ACFC is required on SR 143, CD roads, or new system ramps, unless noted in the Technical Provisions. Limits for AR-ACFC are provided in the Technical Provisions.

Flexible pavement sections at 40th Street, 48th Street, Broadway Road, and Warner Road and Ray Road ramps, shall receive ½-inch AR-ACFC.

For portions of the project where AR-ACFC is being removed but not replaced, namely on I-10 west of 40th Street, the surface exposed after milling of the AR-ACFC shall receive conventional diamond grinding to achieve the desired finished surface in accordance with the project specifications provided in the Technical Provisions and MDR for the project.

5.3 PAVEMENT REPAIRS

As noted above, various distresses, including longitudinal and transverse cracks and scattered spalls were observed within the project limits. In addition, longitudinal cracks were observed on some ramps and within the existing HOV lanes, predominantly in the westbound direction between 24th Street to 32nd Street and Baseline Road to Elliot Road, where pavement slabs are wider (approximately 16-feet wide). When the AR-ACFC is removed, the pavement is to be inspected by the Engineer for distresses to be mitigated, where necessary. If the cracks exceed ½-inch in width or if faulting across the crack has occurred, partial or full slab replacement may be necessary. Alternatively, cross-stitching may be considered as a remedial measure to provide load transfer across cracks that are tight. For portions of the wider slabs that have not cracked, a saw-cut mid-slab to a depth of 1/3 of the slab thickness (T/3) may be considered to provide future crack control.

Given the uncertainty of quantities, we understand these distresses will be considered for repair under the "Engineer Directed Maintenance" portion of the agreement. When the friction course is removed, adequate time shall be included in the Developer's schedule for observation, evaluation, and repair prior to replacing the friction course. These repairs shall be scheduled and performed under traffic control set up for other planned improvements.

5.4 PAVEMENT DETAILS

When widening against the existing pavement, the Developer shall make every effort to locate longitudinal construction joints to coincide with lane lines or the center of a travel lane. When a longitudinal construction joint is located on a lane line or at the center of a lane, and the widening is 12 feet or more in width, the Developer shall use ADOT standard epoxy-coated smooth dowel bars along the joint (#5 x 24-inch long at 30-inch centers). When a longitudinal construction joint is located on a lane line or at the center of a lane, and the widening is less than 12 feet in width, the Developer shall use ADOT standard epoxy-coated deformed bars along the joint (#5 x 24-inch long at 30-inch centers). When a longitudinal construction joint is not located on a lane line or at the center of a lane, #8 x 18-inch long epoxy-coated smooth dowel bars shall be placed 18-inch on centers for load transfer across the joint. The #8 bars shall be located 12 inches from any transverse joint.

When placing #8 dowel bars for the longitudinal construction joint, the bars shall be placed perpendicular to the pavement center line and pavement surface within a tolerance of ± 3/8-inch for the full dowel length. Other requirements for dowel bars are as provided in the stored specifications and standard specifications.

New shoulders and curb and gutter shall be in accordance with ADOT standards. Construction details for PCCP and repair of PCCP slabs are provided in the MDR.

New joints shall be sealed in accordance with ADOT standards.

The Developer shall use the requirements provided herein to develop their paving plan submittals and shall include all necessary pavement details.

REFERENCES

— Arizona Department of Transportation (2017, September 29), Pavement Design Manual.
— Arizona Department of Transportation (2008), Standard Specifications for Road and Bridge Construction.
— Federal Highway Administration (August, 2016), Continuously Reinforced Concrete Pavement Manual, Guidelines for Design, Construction, Maintenance, and Rehabilitation.

Table A

DESIGN ESALS AND RECOMMENDED PAVEMENT SECTIONS FOR DEFINED MOVEMENTS, RAMPS AND CROSSROAD PAVEMENTS							
New Rigid Pavement Sections - Mainline & CD Road							
Location	Stationing		ESALs	AC Base (in.)	CRCP (in.)	PCCP (in.)	Total Thickness (in.)[5]
	From	To					
I-10	7911+21[2]	8158+16[2]	149,520,459	3.0	-	14.5[1]	17.5
	8158+16[2]	8230+00[2]	64,087,172	3.0	-	12.5[1]	15.5
	8230+00[2]	8437+10[2]	85,008,470	3.0	-	13.0	16.0
SR 143	a 38+00[2]	a 51+41[2]	34,065,551	3.0	10.5	-	13.5
	a 34+74[2]	a 38+00[2]		3.0	-	13.5	16.5
	a 64+67[2]	b 85+16[2]					
US 60 (US 60 Ramp S-E_2 Stationing)	113+38[2]	147+68[2]	45,989,697	3.0	-	14.0	17.0
WB CD	17+32	167+75	24,256,064	3.0	-	12.5	15.5
EB CD	10+00	109+47					
New Rigid Pavement Sections - Defined Movements, System Ramps, Ramps, Crossroads							
Location	Stationing		ESALs	Class 2 AB (in.)	AC Base (in.)	PCCP (in.)	Total Thickness (in.)[5]
	From	To					
SR 143 SI							
Ramp SW	16+66	27+83	24,256,064	-	3.0	12.5	15.5
WB C-D to SR 143 NB	41+61	65+51					
SR 143 SB to EB C-D	42+88	68+29					
DHOV WB (DHOV - SR143 Stationing)	25+34	53+34	11,854,209	-	3.0	12.0[3]	15.0
DHOV EB (DHOV - SR143 Stationing)	26+07	53+34					
US 60 SI							
US 60 Ramp NE	24+84	28+94	10,928,689	-	3.0	12.0[3]	15.0
Existing US 60 Ramp NE	3+98[2]	14+84[2]					
Baseline Road Ramp D	15+63	20+65	10,440,282	-	3.0	12.0[3]	15.0
EB C-D to Baseline Road (C-D)	16+30	47+57	24,256,064	-	3.0	12.5	15.5
EB C-D to Baseline Road (Ramp)	47+57	53+36	10,357,388	-	3.0	12.0[3]	15.0
EB C-D to US 60 Ramp SE	14+10	17+28	4,749,706	-	3.0	12.0[3]	15.0
Existing US 60 Ramp SE	88+91[2]	94+15[2]	35,533,161	-	3.0	13.5	16.5
I-10 WB to WB C-D	12+75	29+64	24,256,064	-	3.0	12.5	15.5
US 60 WB to WB C-D	15+24	35+13	6,943,426	-	3.0	12.0[3]	15.0
US 60 Ramp WN	194+37	214+54	40,221,286	-	3.0	14.0	17.0
Existing US 60 Ramp WN	114+54[2]	118+53[2]	40,221,286	-	3.0	14.0	17.0
Priest Drive							
Existing Priest Drive Ramp D	8+58[2]	10+83[2]	12,055,654	4.0	-	12.0	16.0
48th Street							
48th Street Ramp B	13+01	19+41	20,372,655	4.0	-	13.0	17.0
48th Street Loop Ramp	14+00	25+40					
Broadway Road							
Broadway Road Ramp A	13+83	30+29	24,359,534	4.0	-	13.5	17.5
Broadway Road Ramp B	16+25	42+46					
Broadway Road Ramp C	10+56	18+42					
Broadway Road Ramp D	10+39	20+78					
University Drive							
WB C-D to University Drive Ramp C	11+31	29+19	12,217,394	4.0	-	12.0	16.0
University Drive Ramp C	10+00	17+25					
University Drive Ramp D	7+79	16+35					
32nd Street							
32nd Street Ramp A	3+92	14+09	29,436,305	4.0	-	14.0	18.0
32nd Street Ramp B	4+86	14+77					
32nd Street Ramp C	+76	11+62					
32nd Street Ramp D	3+87	11+40					
40th Street							
40th Street Ramp A	14+71	21+95	17,856,308	4.0	-	13.0	17.0
40th Street Ramp B	17+67	28+42					
40th Street Ramp C	13+00	26+13					
40th Street Ramp D	11+31	19+86					

Table A

DESIGN ESALS AND RECOMMENDED PAVEMENT SECTIONS FOR DEFINED MOVEMENTS, RAMPS AND CROSSROAD PAVEMENTS							
New Rigid Pavement Sections - Defined Movements, System Ramps, Ramps, Crossroads							
Location	Stationing From	Stationing To	ESALs	Class 2 AB (in.)	AC Base (in.)	PCCP (in.)	Total Thickness (in.)[5]
Elliot Road							
Existing Elliot Road Ramp C	9+95[2]	12+28[2]	27,618,495	4.0	-	14.0	18.0
Existing Elliot Road Ramp D	5+36[2]	10+80[2]					
Ray Road							
Existing Ray Road Ramp A	5+31[2]	7+80[2]	10,467,024	4.0	-	12.0	16.0
Existing Ray Road Ramp D	10+44[2]	10+67[2]					
Broadway Road							
Broadway Road[4]	4+76	36+16	24,309,446	4.0	-	12.5	16.5
48th Street							
48th Street SB	17+21	55+17	19,485,914	4.0	-	12.0	16.0
48th Street NB	15+52	52+28					
40th Street							
Existing 40th Street[4]	16+00[2]	24+05[2]	24,904,455	4.0	-	12.5	16.5
Baseline Road							
Existing Baseline Road Ramp B	6+22[2]	14+06[2]	8,477,535	4.0	-	12.0[3]	16.0
I-10							
DPS Turnaround	8069+25	8075+75	-	4.0	-	10.0	14.0
New Flexible Pavement Sections							
Location	Stationing From	Stationing To	ESALs	Class 2 AB (in.)	AC Base (in.)	AC (3/4") (End Prod.) (in.)	Total Thickness (in.)[5]
Broadway Road							
Broadway Road[4]	4+76	36+16	18,390,162	12.0	-	8.0	20.0
48th Street							
48th Street SB (Ex SR143 Stationing)	0+58[2]	6+05[2]	14,741,147	11.0	-	8.0	19.0
48th Street NB (Ex SR143 Stationing)	0+58[2]	6+05[2]					
40th Street							
Existing 40th Street[4] (North of I-10)	14+14[2]	16+00[2]	18,840,288	12.0	-	8.0	20.0
Existing 40th Street[4] (South of I-10)	27+05[2]	27+99[2]					
Warner Road							
Warner Rd Ramp A	2+00[2]	11+11[2]	6,631,456	10.0	-	7.0	17.0
Warner Rd Ramp B	0+39[2]	7+80[2]					
Warner Rd Ramp C	6+48[2]	15+15[2]					
Ray Road							
Existing Ray Rd Ramp D	4+77[2]	10+44[2]	10,467,024	10.0	-	8.0	18.0
Rehabilitation Flexible Pavement Sections							
Location	Stationing From	Stationing To				Mill (in.)	Replace AC (3/4") (End Prod.) (in.)[5]
Existing Warner Road Ramp B	0+39[2]	9+60[2]				2.0	1.5
Existing Warner Road Ramp D	6+88[2]	15+71[2]				2.0	1.5

[1] Includes load transfer dowels

[2] Based on existing stationing

[3] Minimum PCCP thickness = 12.0"

[4] Within ADOT access control PCCP shall be used and outside ADOT access control AC shall be used

[5] Limits of AR-ACFC not shown/included. See Technical Provisions for locations.

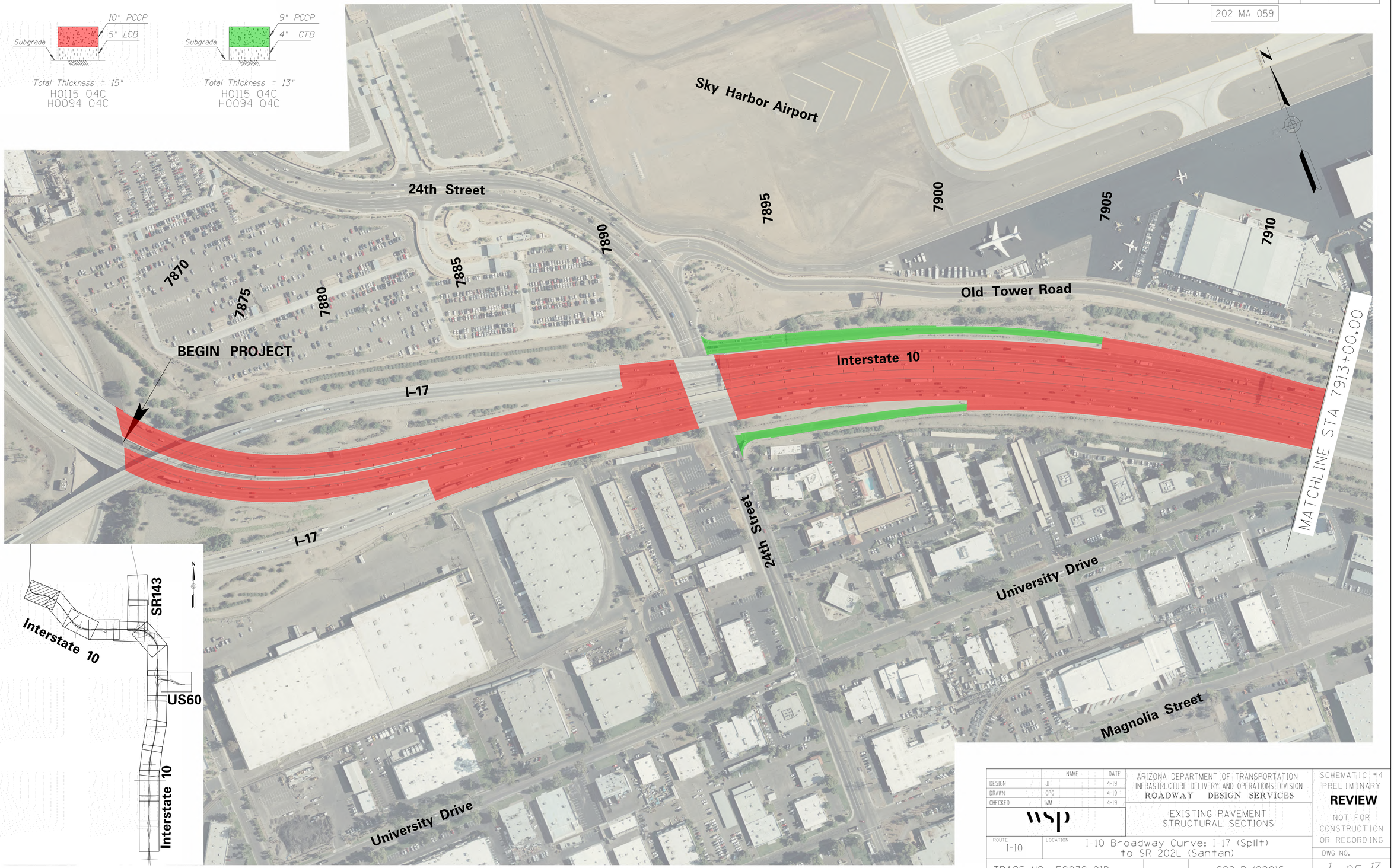
APPENDIX A

EXISTING PAVEMENT STRUCTURAL SECTIONS

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

Total Thickness = 15"
H0115 04C
H0094 04C

Total Thickness = 13"
H0115 04C
H0094 04C



	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
DWG NO.

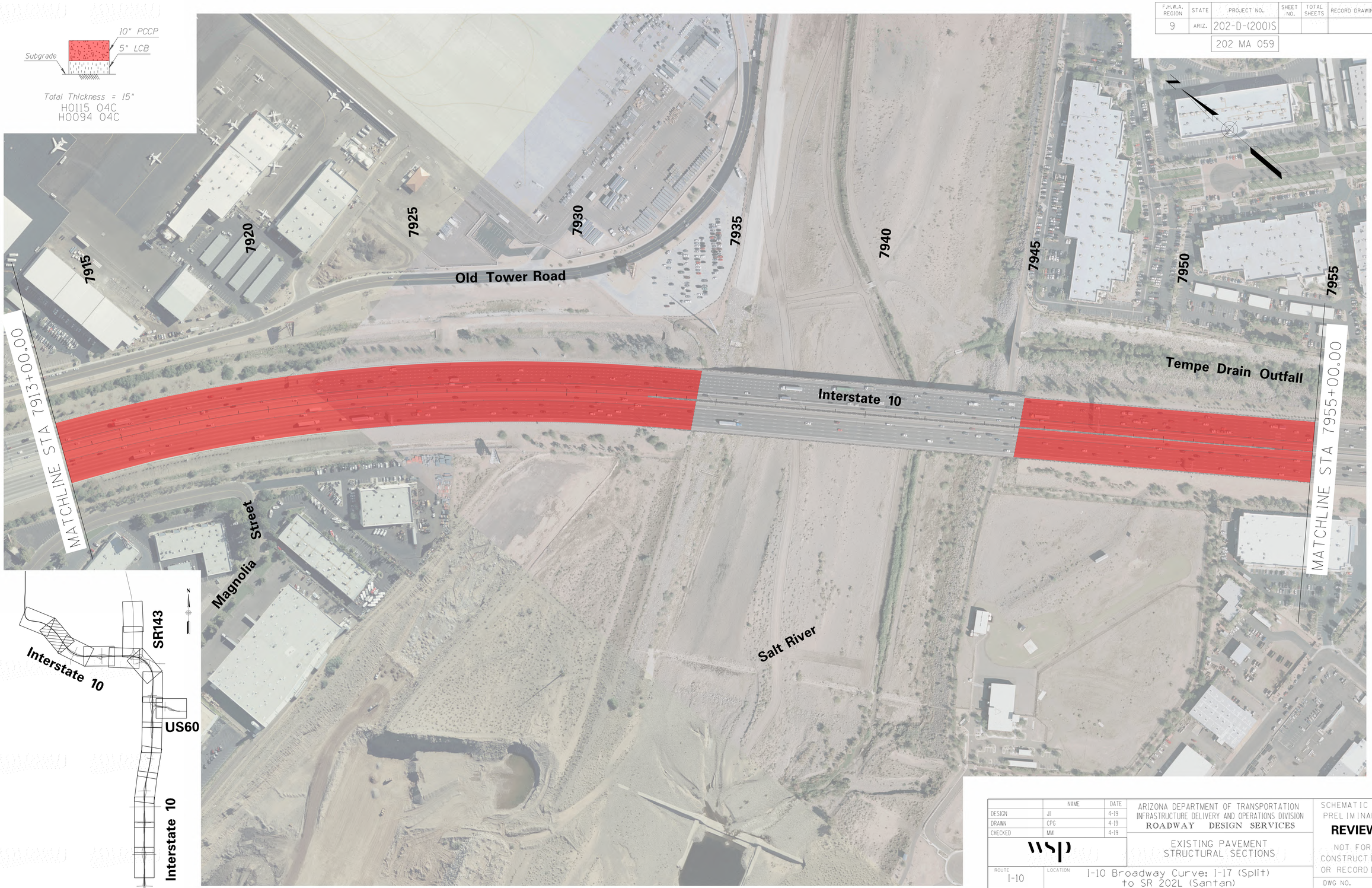
TRACS NO. F0072 01D | 202-D-(200)S | 1 OF 17

DATE | LOCATION | REVISIONS | FINISHED PLANS | SURVEY NO.

Mon 04 Nov 2019, 12:12:28 \\prdpwics01\ics_workingdir\7608\340308_14\Pavement_sheet_01.dgn

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

Total Thickness = 15"
H0115 04C
H0094 04C



	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

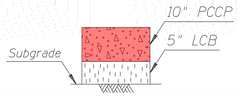
SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
DWG NO.

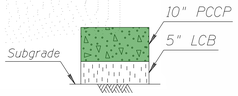
TRACS NO. F0072 01D | 202-D-(200)S | 2 OF 17

DATE- | LOCATION- | REVISIONS- | FINISHED PLANS- | SURVEY NO.

Mon 04 Nov 2019, 12:12:30 \\prdpwics01\ics_workingdir\7608\340308_15\Pavement_sheet_02.dgn



Total Thickness = 15"
H0115 04C
H0094 04C



Total Thickness = 15"
H0115 04C
H0094 04C

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

Elwood Street

Elwood Street

32nd Street

Tempe Drain

Tempe Drain Outfall

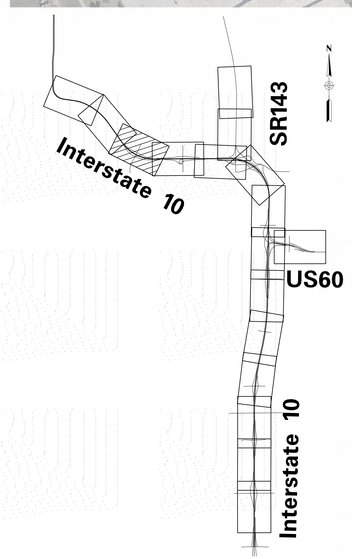
MATCHLINE STA 7955+00.00

MATCHLINE STA 7997+00.00

36th Street

7955
7960
7965
7970
7975
7980
7985
7990
7995

Interstate 10



	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)

DWG NO.

TRACS NO. F0072 01D | 202-D-(200)S | 3 OF 17

DATE | LOCATION | REVISIONS | FINISHED PLANS | SURVEY NO.

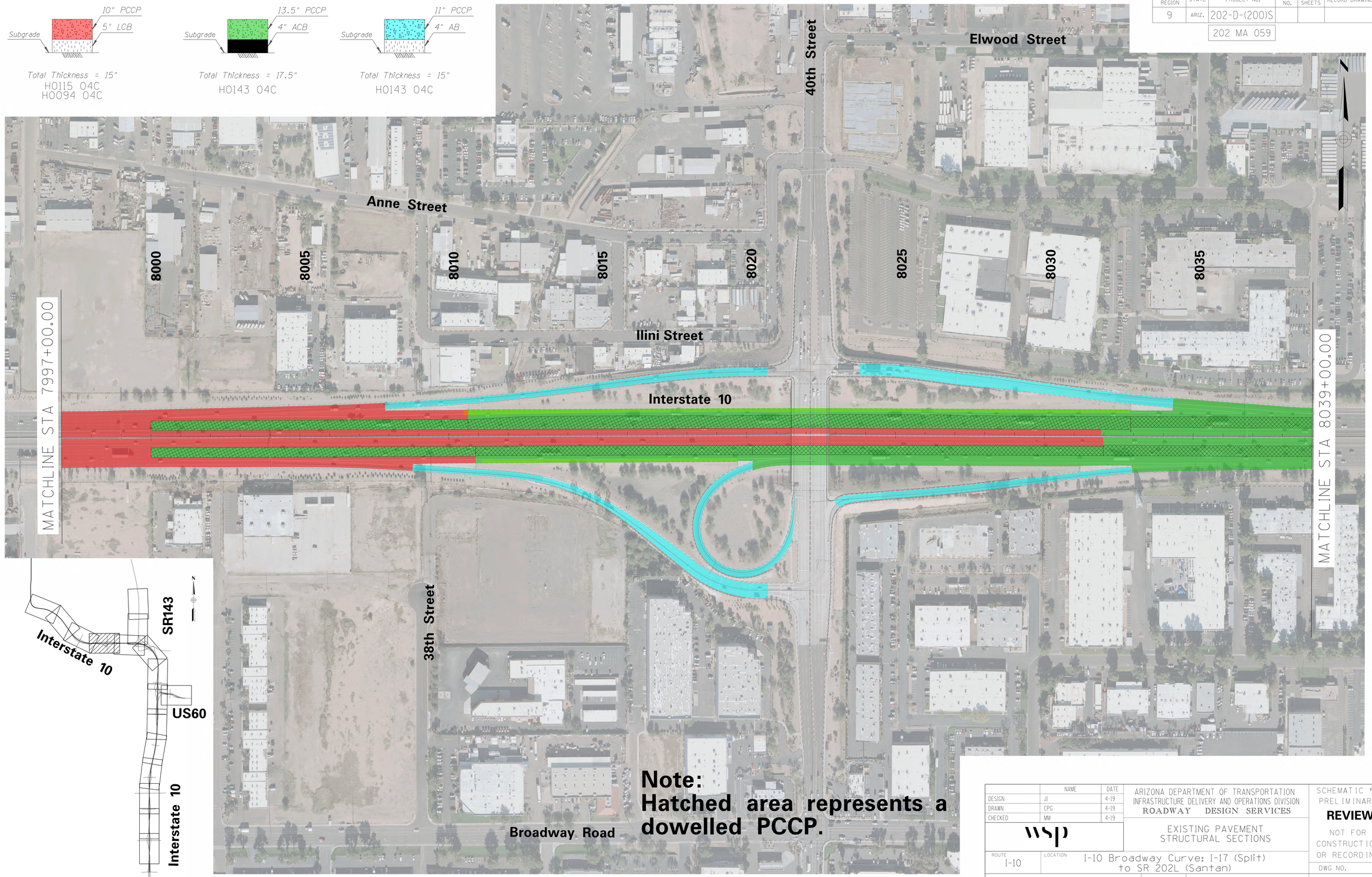
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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

Total Thickness = 15"
H0115 04C
H0094 04C

Total Thickness = 17.5"
H0143 04C

Total Thickness = 15"
H0143 04C



	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)

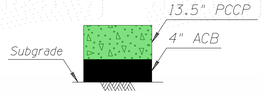
TRACS NO. F0072 01D | 202-D-(200)S

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

DWG NO.
4 OF 17

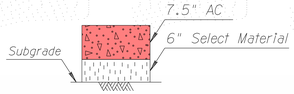
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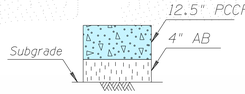
Total Thickness = 17.5"

H0143 04C



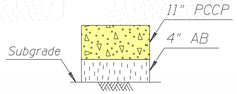
Total Thickness = 13.5"

M600-3-503



Total Thickness = 16.5"

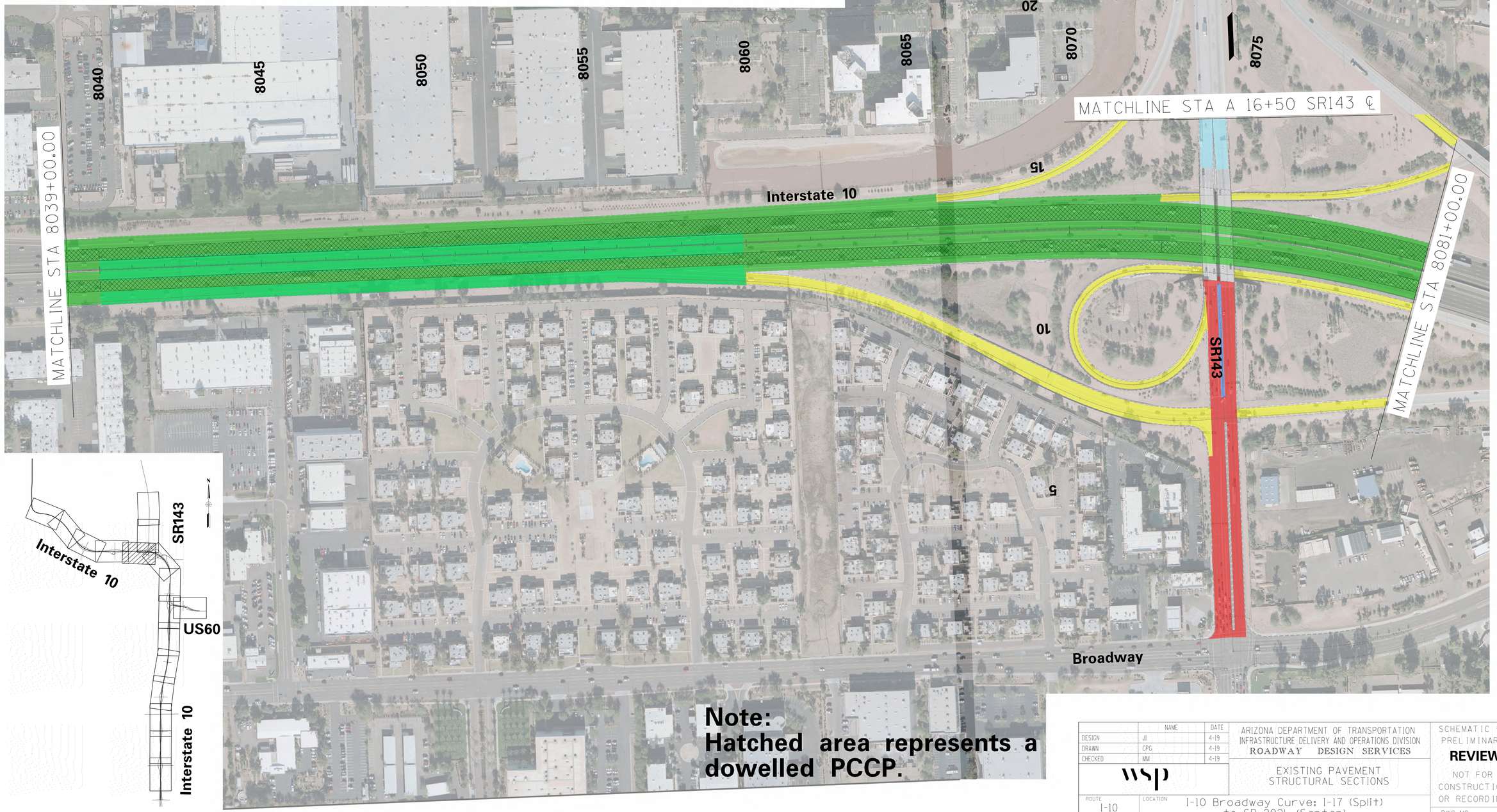
H3912 01C



Total Thickness = 15"

H0143 04C

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			



Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPC	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

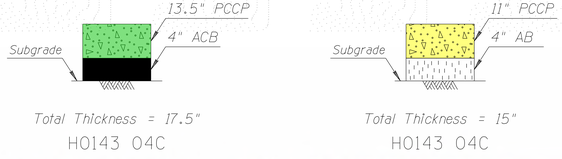
SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
DWG NO.

TRACS NO. F0072 01D | 202-D-(200)S | 5 OF 17

DATE: | LOCATION: | REVISIONS: | FINISHED PLANS: | SURVEY NO.

Mon 04 Nov 2019, 12:12:34 \\prdpwics01\ics_workingdir\7608\340308_18\Pavement_sheet_05.dgn



Total Thickness = 17.5"

H0143 04C

Total Thickness = 15"

H0143 04C

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

52nd Street

Frontage Road

8095

8100

8105

8110

8115

8120

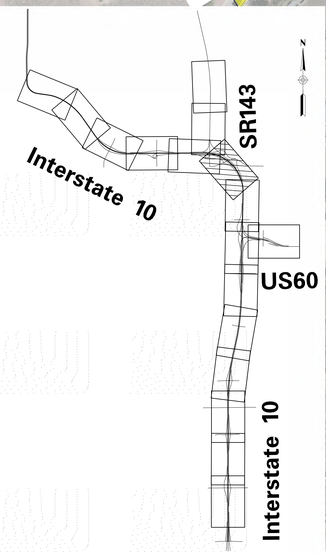
8090

8085

Interstate 10

MATCHLINE STA 8081+00.00

MATCHLINE STA 8123+00.00



Broadway Road

Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

ROUTE: I-10

LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)

TRACS NO. F0072 01D

202-D-(200)S

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

DWG NO.

6 OF 17

DATE: | LOCATION: | REVISIONS: | FINISHED PLANS: | SURVEY NO.: | DATE:

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Total Thickness = 17.5"
H0143 04C

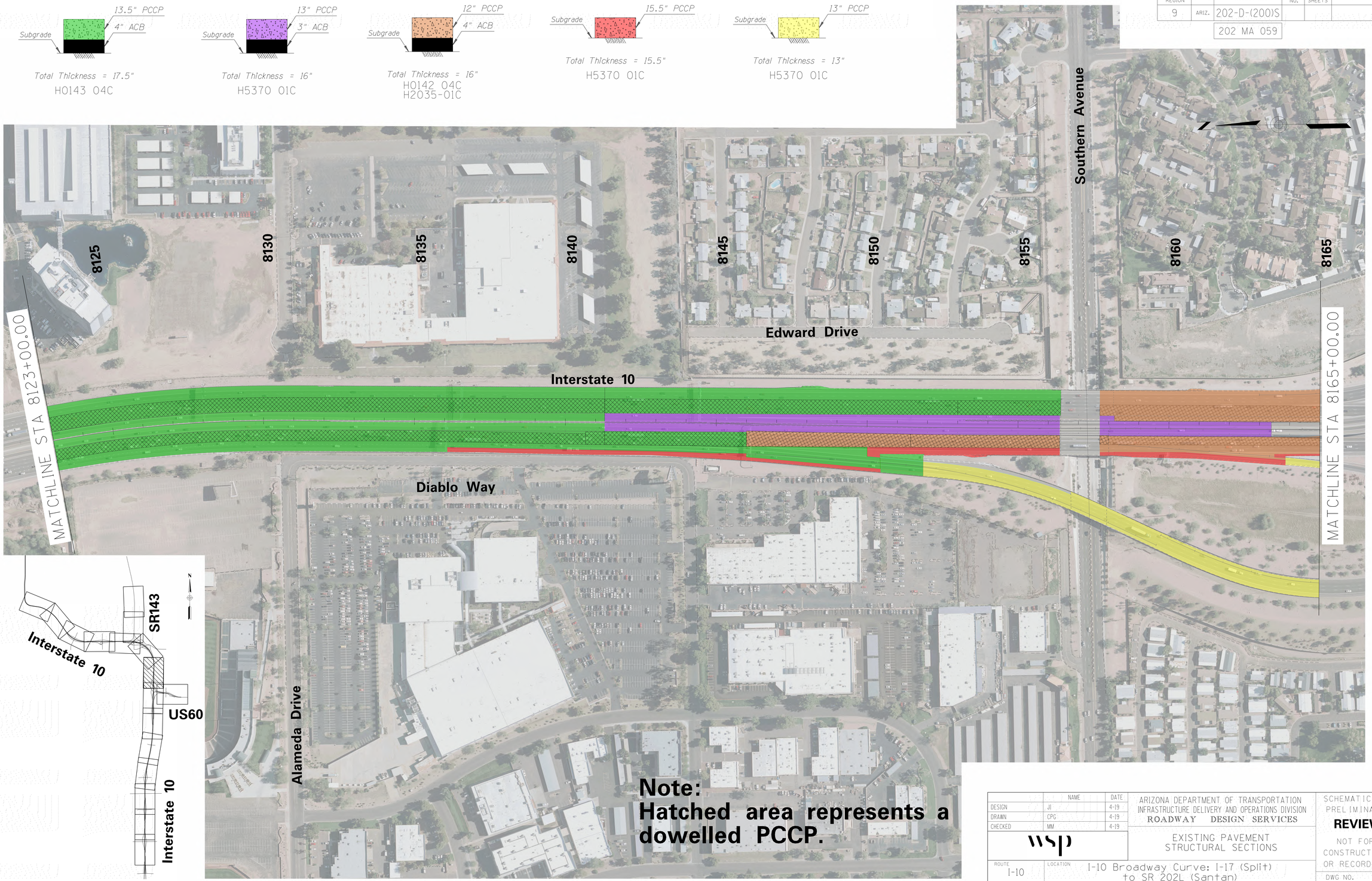
Total Thickness = 16"
H5370 01C

Total Thickness = 16"
H0142 04C
H2035-01C

Total Thickness = 15.5"
H5370 01C

Total Thickness = 13"
H5370 01C

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			



Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

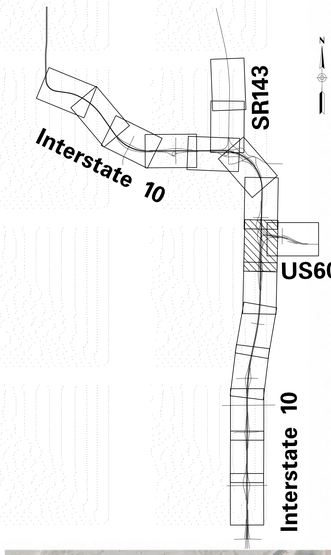
SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

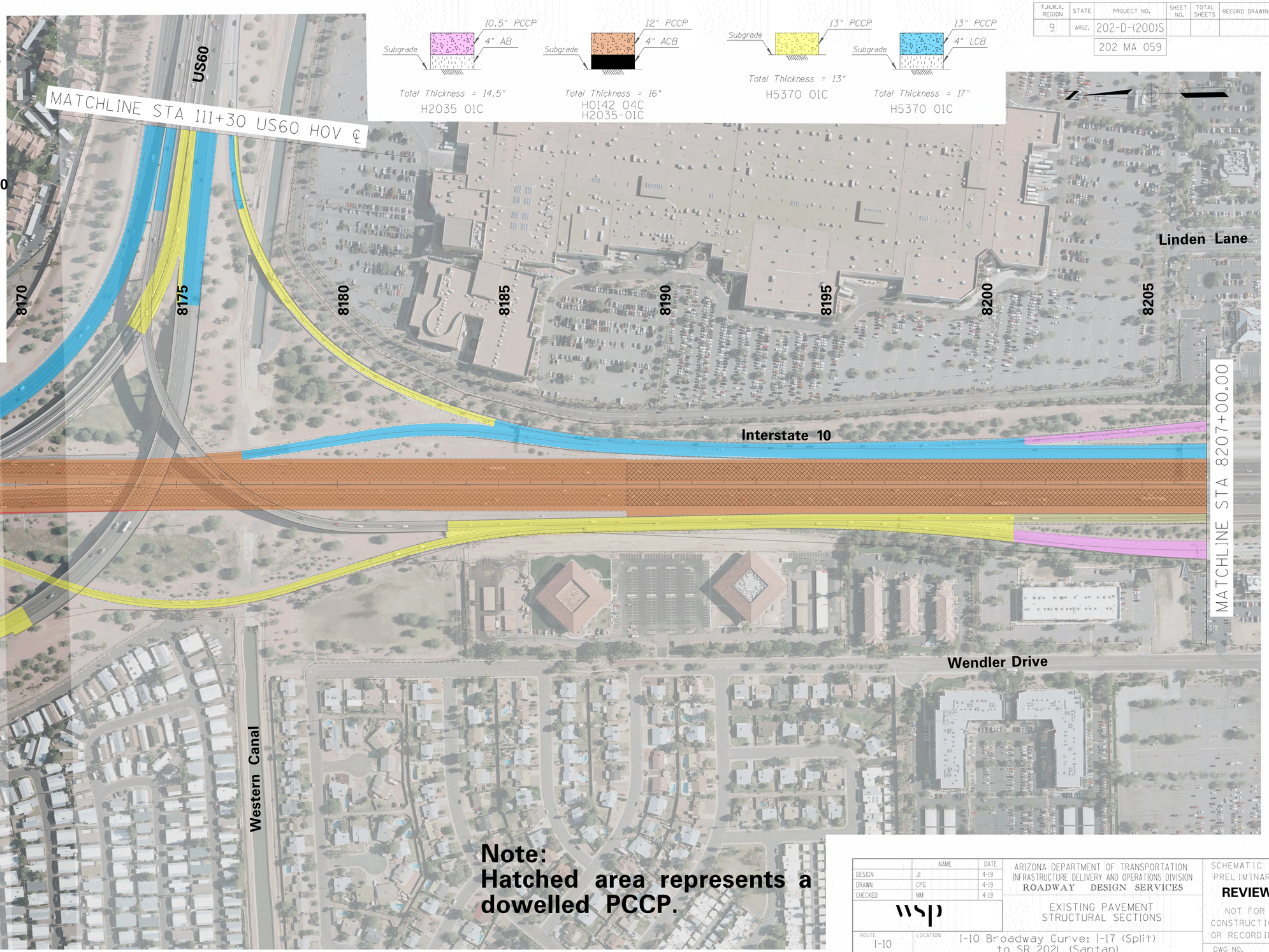
ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	

TRACS NO. F0072 01D | 202-D-(200)S | 7 OF 17

SURVEY NO. | FINISHED PLANS | REVISIONS | LOCATION | DATE

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

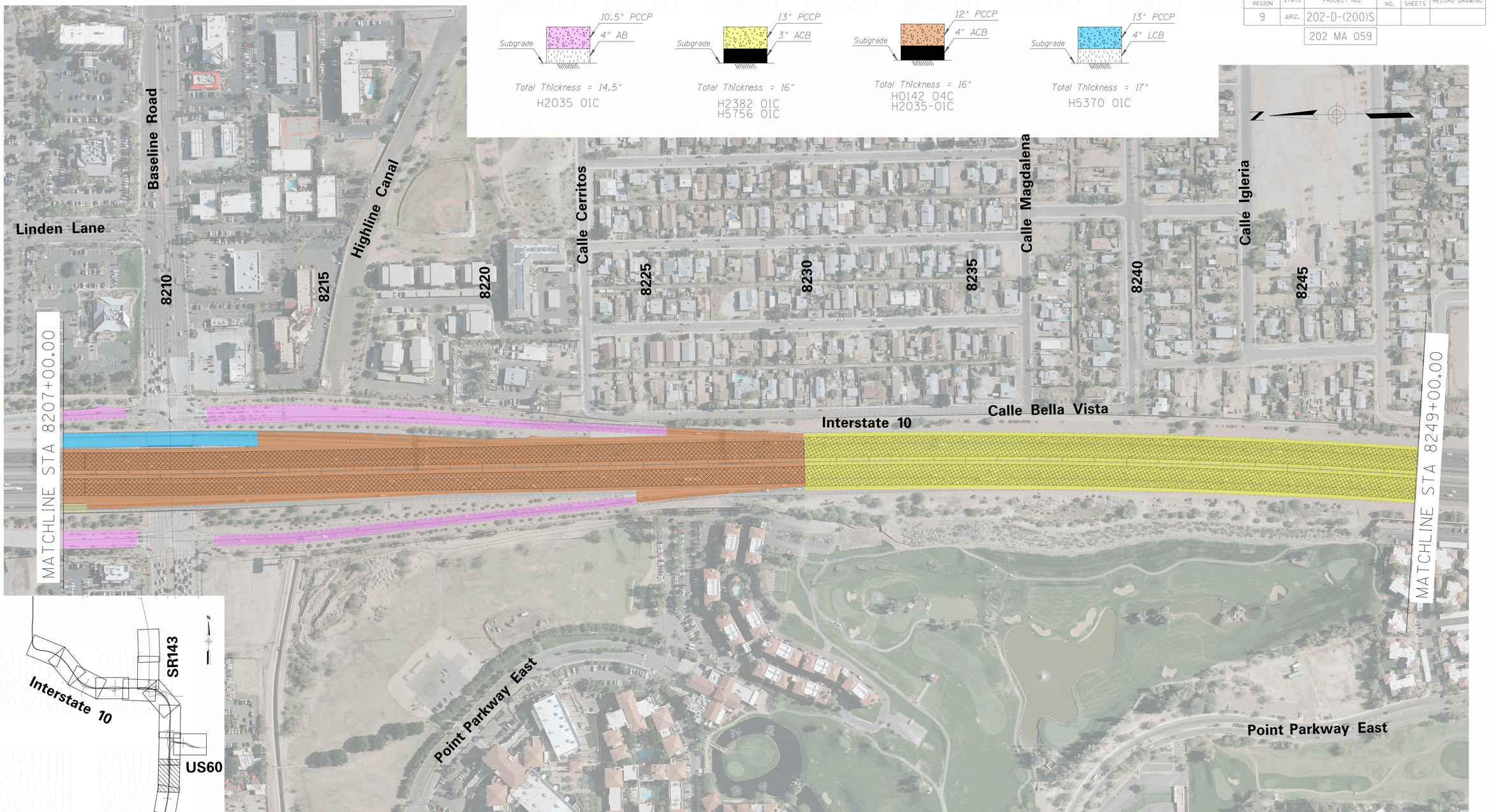
ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	8 OF 17

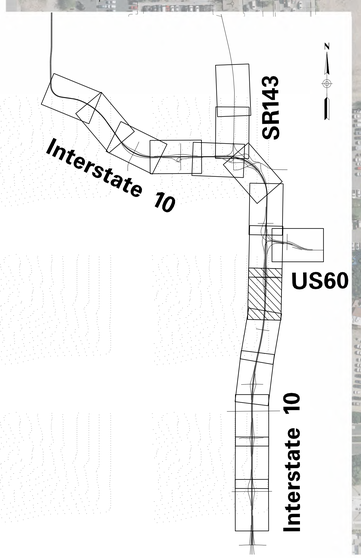
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DATE: | LOCATION: | REVISIONS: | FINISHED PLANS: | SURVEY NO.

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			





Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D	202-D-(200)S	9 OF 17

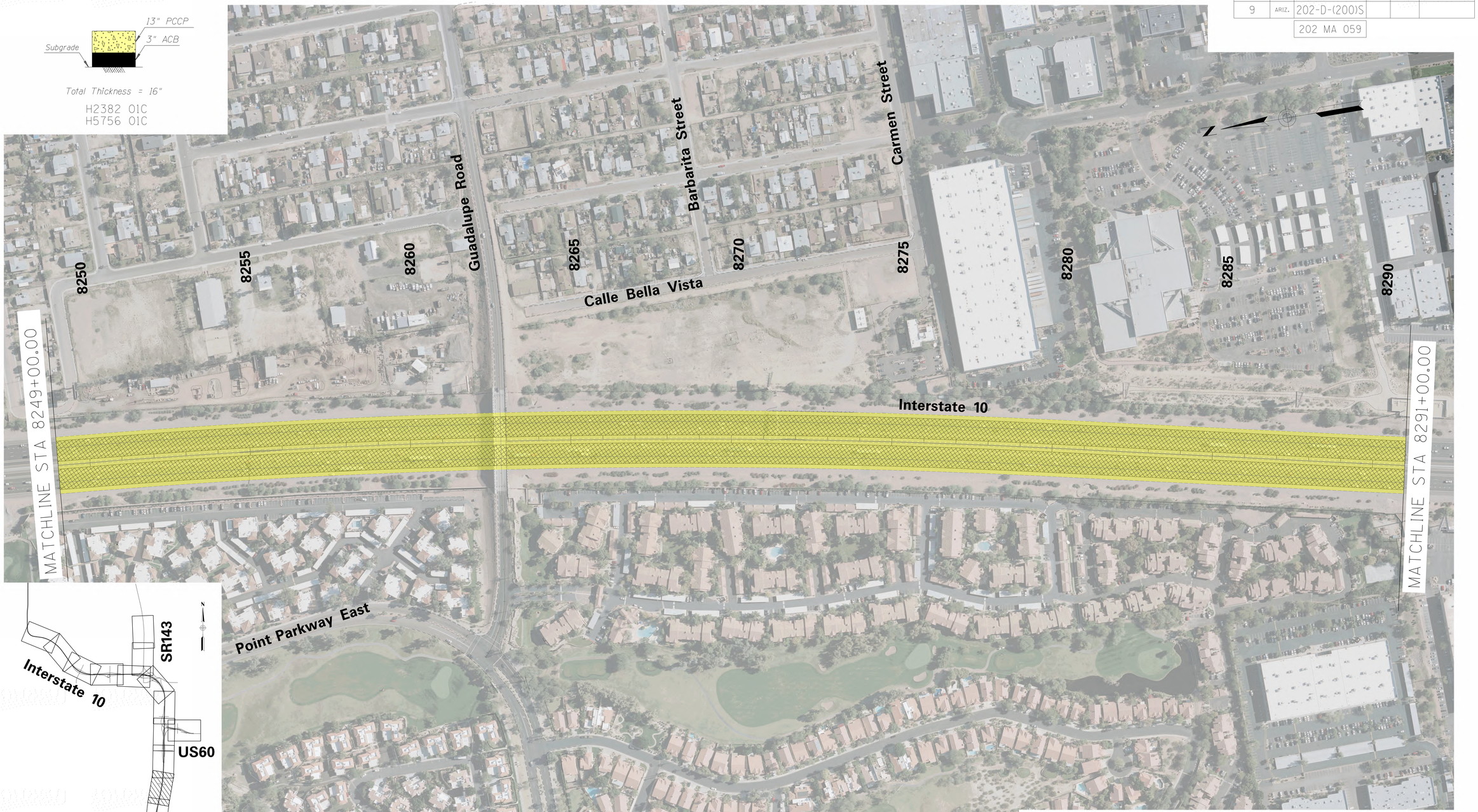
SURVEY NO. | FINISHED PLANS | REVISIONS | LOCATION | DATE

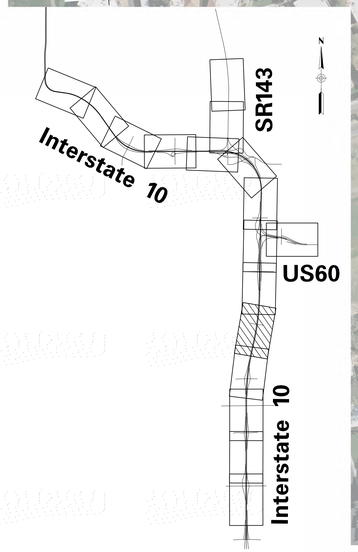
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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

Total Thickness = 16"

H2382 01C
H5756 01C





Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	10 OF 17

TRACS NO. F0072 01D | 202-D-(200)S

DATE | REVISIONS | FINISHED PLANS | LOCATION | SURVEY NO.

Mon 04 Nov 2019, 12:14:29 \\prdpwics01\ics_workingdir\7608\340308_23\Pavement_sheet_10.dgn

Total Thickness = 16"

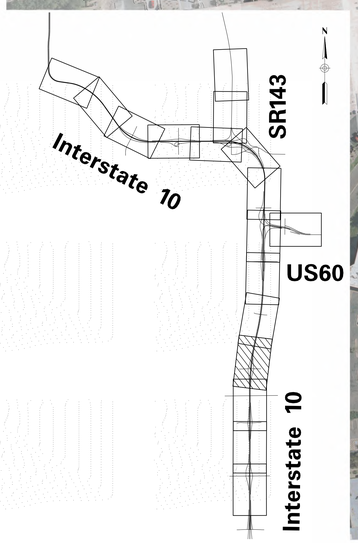
H2382 01C
H5756 01C

Total Thickness = 16"

H2382 01C
IR-10-3 (192)

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			





Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
DWG NO.

TRACS NO. F0072 01D | 202-D-(200)S | 11 OF 17

SURVEY NO. | FINISHED PLANS | REVISIONS | LOCATION | DATE

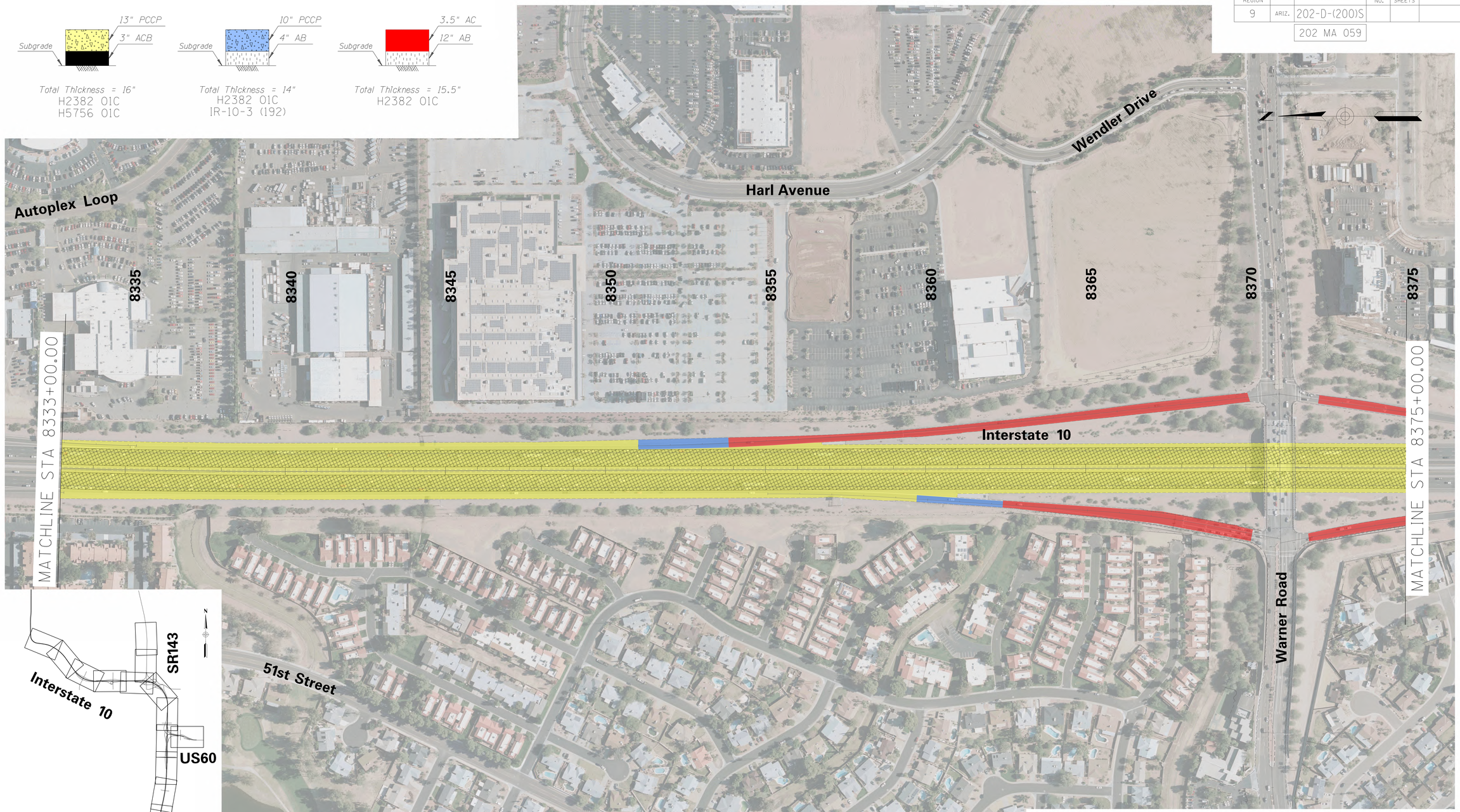
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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

Total Thickness = 16"
H2382 01C
H5756 01C

Total Thickness = 14"
H2382 01C
IR-10-3 (192)

Total Thickness = 15.5"
H2382 01C



Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT
STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	

TRACS NO.			
F0072 01D		202-D-(200)S	12 OF 17

DATE: | LOCATION: | REVISIONS: | FINISHED PLANS: | SURVEY NO.

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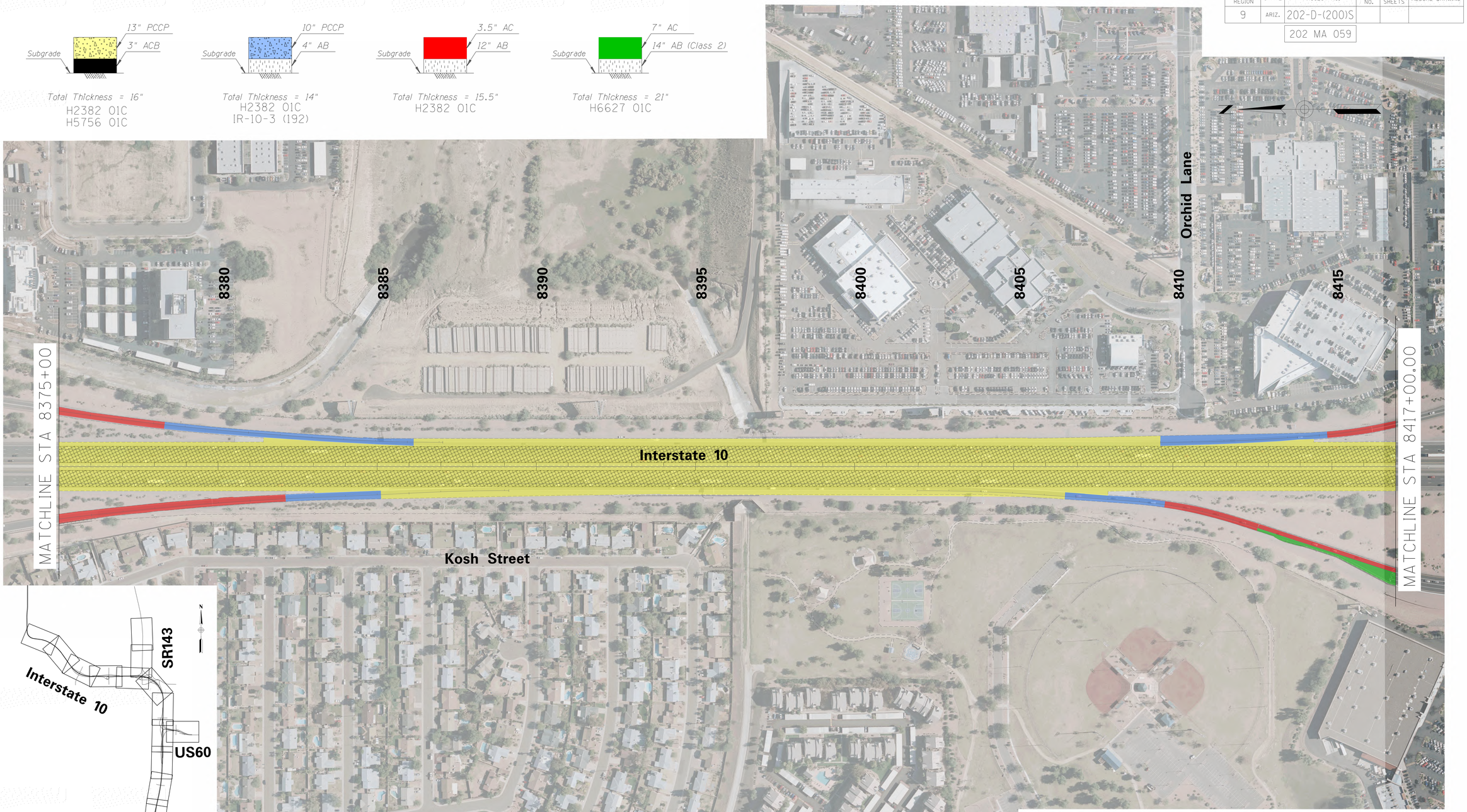
F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			

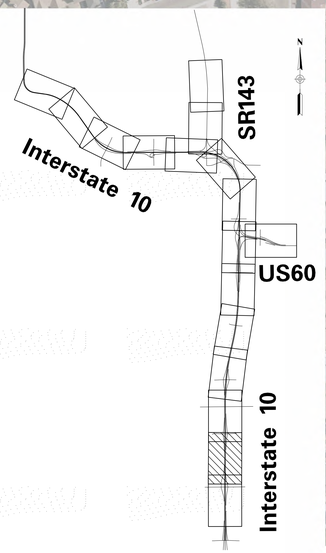
Total Thickness = 16"
H2382 01C
H5756 01C

Total Thickness = 14"
H2382 01C
IR-10-3 (192)

Total Thickness = 15.5"
H2382 01C

Total Thickness = 21"
H6627 01C





Note:
Hatched area represents a dowelled PCCP.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

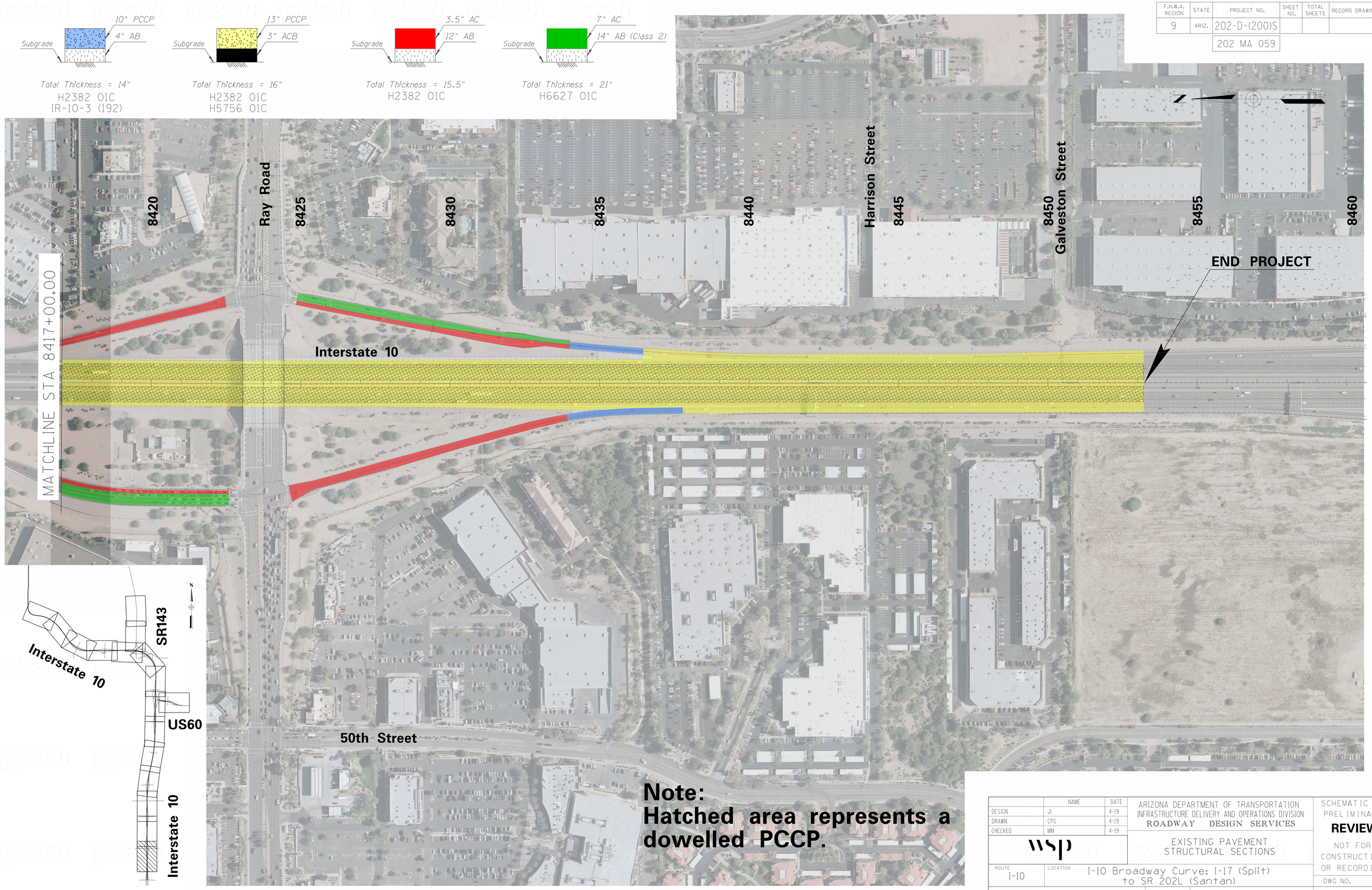
ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
DWG NO.

TRACS NO. F0072 01D | 202-D-(200)S | 13 OF 17

Mon 04 Nov 2019, 12:14:42 \\prdpwics01\ics_workingdir\7608\340308_26\Pavement_sheet_13.dgn

DATE | REVISIONS | LOCATION | FINISHED PLANS | SURVEY NO.

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			



	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

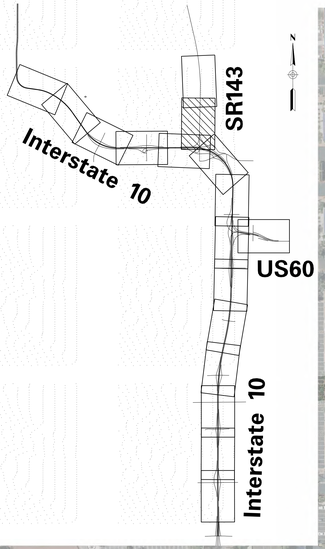
EXISTING PAVEMENT STRUCTURAL SECTIONS

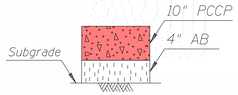
SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D	202-D-(200)S	14 OF 17

DATE: | LOCATION: | REVISIONS: | FINISHED PLANS: | SURVEY NO.

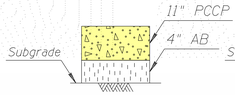
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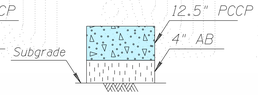
Total Thickness = 14"

H3912 01C



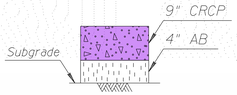
Total Thickness = 15"

H0143 04C



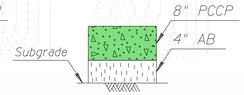
Total Thickness = 16.5"

H3912 01C



Total Thickness = 13"

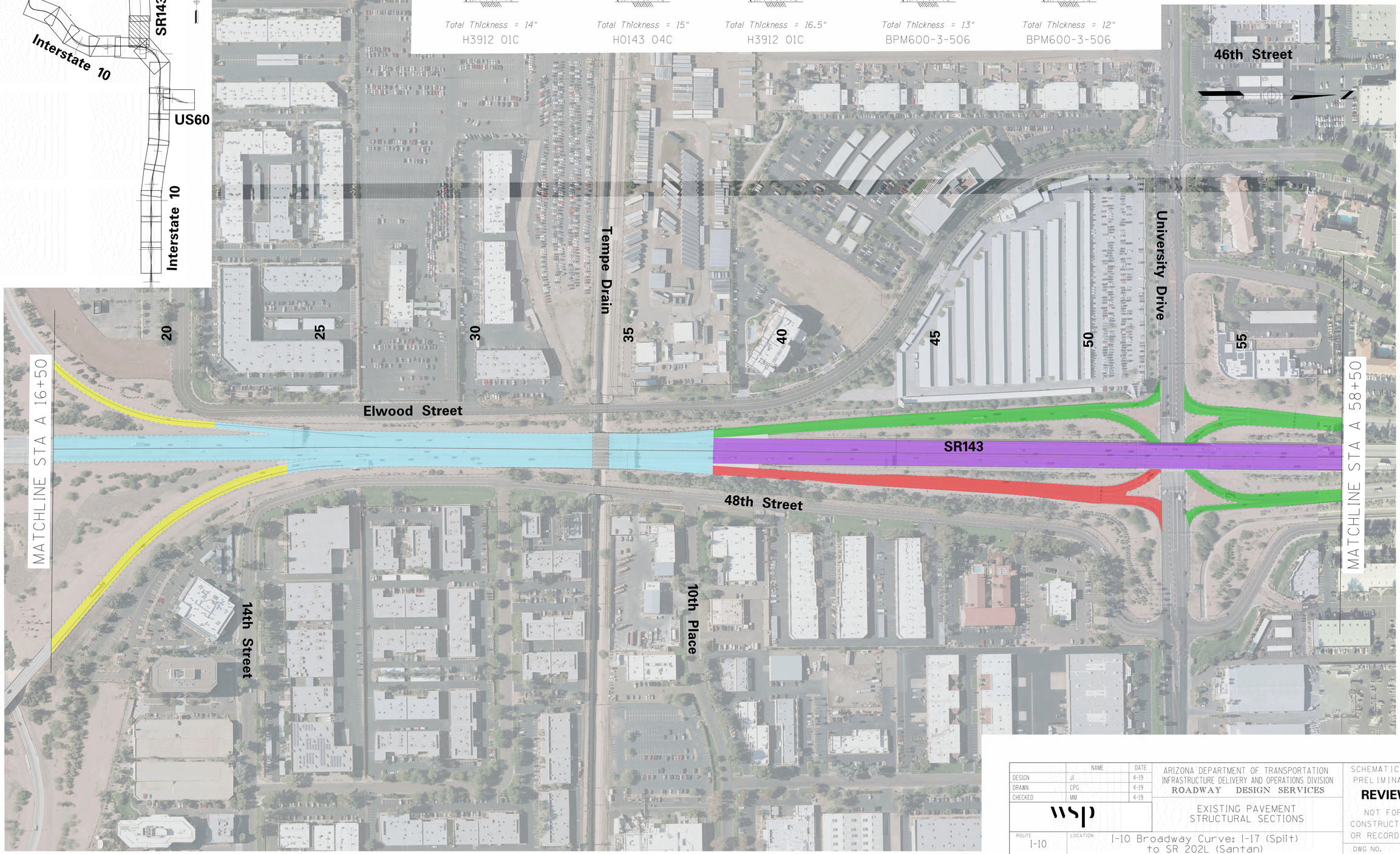
BPM600-3-506



Total Thickness = 12"

BPM600-3-506

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			



	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

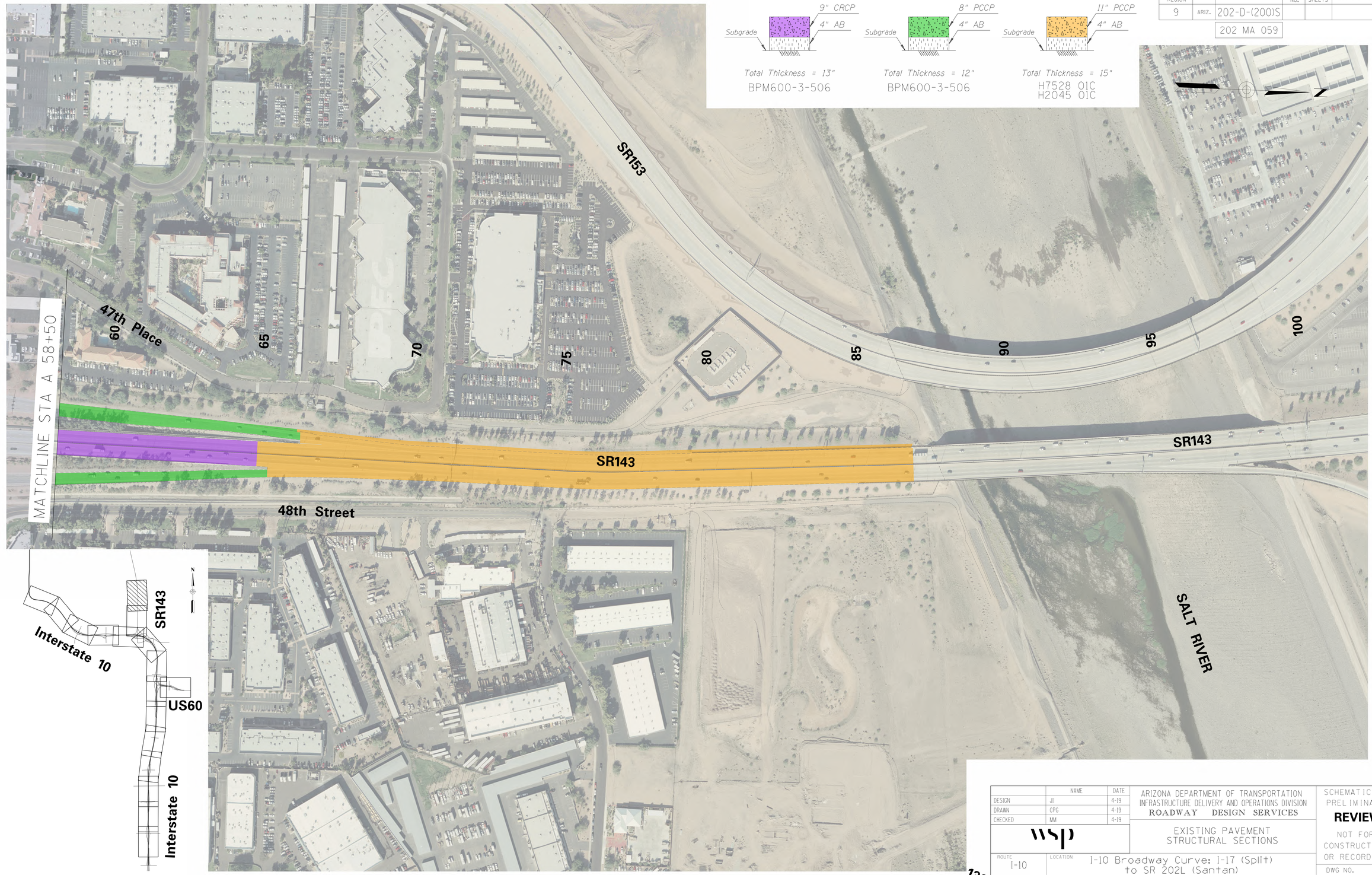
ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	

TRACS NO. F0072 01D | 202-D-(200)S | 15 OF 17

SURVEY NO. | FINISHED PLANS | REVISIONS | LOCATION | DATE | SURVEY NO.

Mon 04 Nov 2019, 13:39:43 \\prdpwics02\ics_workingdir\5120\340308_30\Pavement_sheet_15.dgn

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			



	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT
STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE: I-10
LOCATION: I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
DWG NO.

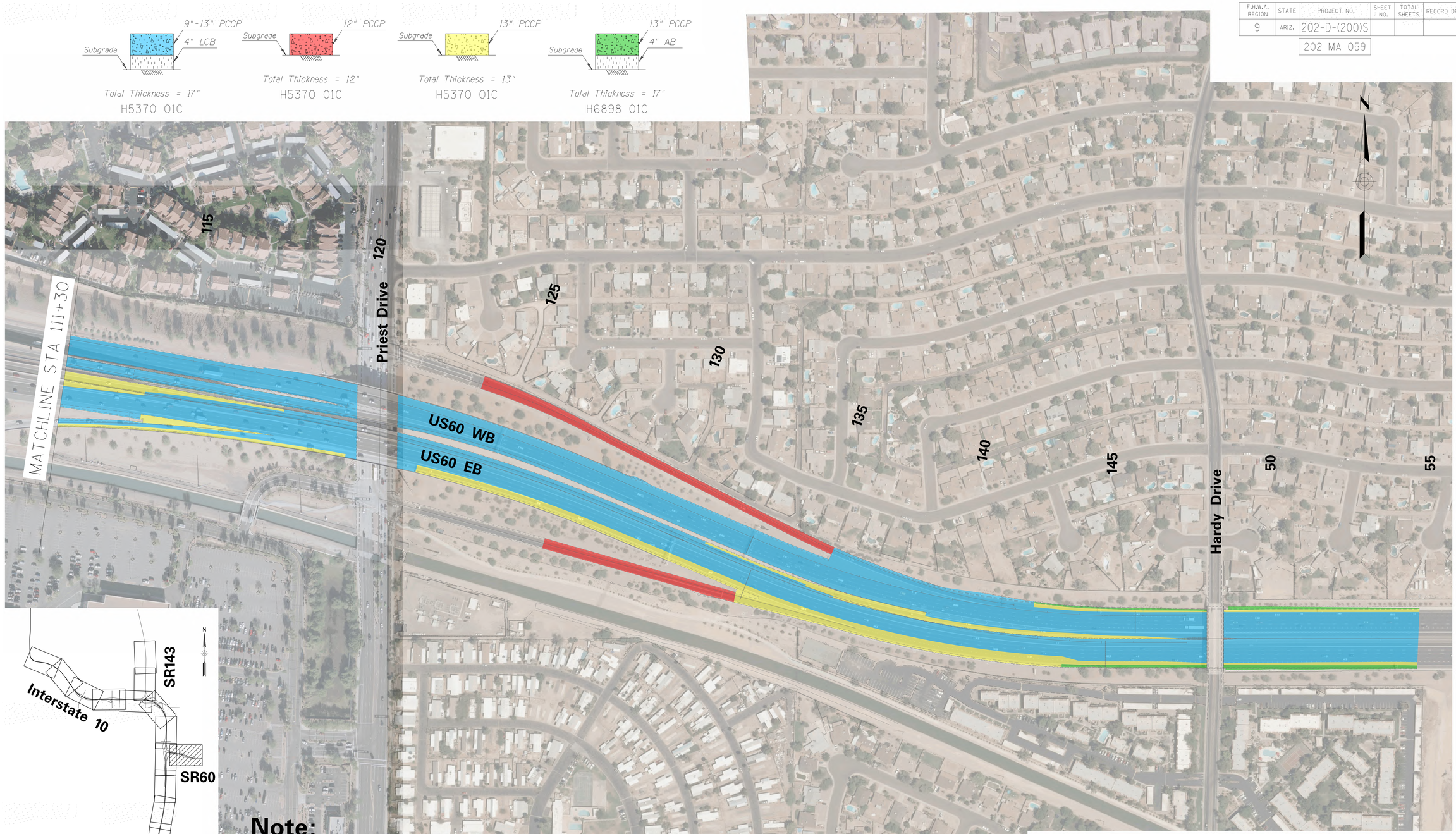
TRACS NO. F0072 01D | 202-D-(200)S | 16 OF 17

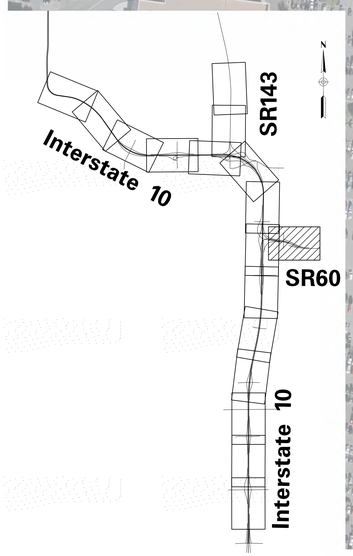
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SURVEY NO. | DATE | LOCATION | REVISIONS | FINISHED PLANS | SURVEY NO.

Mon 04 Nov 2019, 12:14:36 \\prdpwics01\ics_workingdir\7608\340308_29\Pavement_sheet_16.dgn

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	202-D-(200)S			
		202 MA 059			





Note:
West of Hardy Drive, the stations are based off the SE Ramp centerline.
East of Hardy Drive the stations are based off US 60 Median centerline.

	NAME	DATE
DESIGN	JI	4-19
DRAWN	CPG	4-19
CHECKED	MM	4-19

wsp

ARIZONA DEPARTMENT OF TRANSPORTATION
INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
ROADWAY DESIGN SERVICES

EXISTING PAVEMENT STRUCTURAL SECTIONS

SCHEMATIC #4
PRELIMINARY
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

ROUTE	LOCATION	DWG NO.
I-10	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		202-D-(200)S 17 OF 17

SURVEY NO. | FINISHED PLANS | REVISIONS | LOCATION | DATE | SURVEY NO.

Mon 04 Nov 2019, 12:16:51 \\prdpwics01\ics_workingdir\7608\340308_31\Pavement_sheet_17.dgn

APPENDIX B

ADOT PMS HISTORY

Pavement History Lift Descriptions

Lift Code	Lift Description
AB	Aggregate Base
AC	Asphaltic Concrete
AR	AC with Asphaltic Rubber (AR - AC)
AS	ACSC Asphaltic Concrete Surface Course
AT	Asphaltic Concrete (TR+)
BB	Bituminous Treated Base
BM	Base Material AB, SM
BO	Borrow Material
BR	Broom Seal Or Scrub Seal
BS	Bituminous Treated Surface
C1	Chip Seal, Plane, Coated Or Pre-Coated (PG 64-28 TR+) [0.3]
CB	Cement Treated Base
CF	Const Fabric - Separation Geotextile Fabric 0.0"
CK	Crack Seal (Rubberized)
CL	Lean Concrete Base
CM	Compacted Millings
CP	Poly Chip Seal Coat [0.3]
CR	Cold Recycled Overlay, Cold In-Place Recycle (CIR)
CS	Cement Treated Subgrade
DC	Double Chip Seal (2 Emulsified Asphalt Application) [0.6]
DP	Double Application Polymer Seal Coat (Chip Seal and Fog Coat) [0.3]
FB	Fly Ash Base
FC	ACFC Asphaltic Concrete Friction Course
FF	Filter Fabric
FG	Fabric Grid Composite Interlayer (0.0)
FL	Flush Coat Or Fog Seal Or Fog Coat [0.0]
FR	ACFC With Asphaltic Rubber (AR-ACFC) [0.5 to 1.0]
FS	Fly Ash Subgrade
FT	ACFC With Terminal Blend (TR+) (AR-ACFC) [0.5 to 1.0]
GG	Geogrid Base Reinforcement [0.0]
GM	Geomembrane
GR	Grind
GT	Geotextile
GV	Groove
HS	Heater Scarification
KS	Crack & Seat PCCP
LB	Lime Treated Base
LC	Leveling Course
LM	Leveling Course Millling
LS	Lime Subgrade
MB	Bituminous Membrane
MC	Mix And Compacted Existing Materials
MS	Micro Seal / Micro-Surface (Type III)
OA	Open Graded Base Material
OB	Open Graded Bituminous Treated Base
OC	Open Graded Asphaltic Concrete
OE	Obliterate Existing AC
PB	Permeable Bituminous Treated Base (PBTB)
PC	Portland Cement Concrete [PLAIN]
PD	Portland Cement Concrete [DOWELLED]
PF	(P_ACFC) Polymermodified ACFC
PM	(PEM) Permeable European Mixture Friction Course
PP	Portland Cement Concrete, Pre-Stress
PR	Portland Cement Concrete, Continuous Re-Inforced
PS	Plant Mix Seal Coat
RA	Rejuvenating Agent
RC	Recycled AC - Asphalt Removed, Rejuvenated, Replaced

Pavement History Lift Descriptions

Lift Code	Lift Description
RE	Remove Existing Material
RF	Rock Fill
RG	Remove Geotech Fabric Or Material
RM	Rubberized Membrane (Interlayer or Seal Coat)
RO	Recycled AC Overlay (HOT ONLY)
SA	(SMA) Stone Matrix Asphalt
SB	Aggergate Subbase (Similar To Select Material)
SC	Seal Coat - Cover Material With Emulsified Asphalt[0.3]
SI	AR- Stress Absorbing Membrane Interlayer [0.3]
SK	Skid Abrade
SM	Select Material
SR	Slurry Seal [0.3]
SS	Subgrade Seal
TA	Texture Abrade
TC	Tack Coat
TR	Tire Rubber Modified Slurry Seal
TW	Ultra Thin White Topping
WM	Warm Mix Asphalt (Foaming or Chemical)
XX	Invalid Selection

I-10 Pavement History

Prefix	Route No	Suffix	Dir	Beg MP	End MP	Lane	Lift 1	Thickness 1	Lift 2	Thickness 2	Lift 3	Thickness 3	Lift 4	Thickness 4	Project Number	Month	Year	Tracs Number
I	10		W	160.25	160.57	2	RE	30	AC	30	FR	5			NH 10-3-(322)	9	1997	H238201C
I	10		W	160.25	160.57	3	RE	30	AC	30	FR	5			NH 10-3-(322)	9	1997	H238201C
I	10		E	150.88	151.16	1	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		W	150.88	151.16	1	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		E	152.28	154.35	1	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		E	152.28	154.35	2	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		E	152.28	154.35	3	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		E	152.28	154.35	4	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		E	152.28	154.35	5	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		W	152.28	154.35	1	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		W	152.28	154.35	2	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		W	152.28	154.35	3	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		W	152.28	154.35	4	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		W	152.28	154.35	5	AB	40	PC	135					ACI-10-3-309	11	1992	H219001C
I	10		E	152.43	154.57	1	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		E	152.43	154.57	2	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		E	152.43	154.57	3	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		E	152.43	154.57	4	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		E	152.43	154.57	5	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		W	152.43	154.57	1	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		W	152.43	154.57	2	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		W	152.43	154.57	3	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		W	152.43	154.57	4	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		W	152.43	154.57	5	AB	40	PP	135					ACIR-10-3(315)	11	1992	H203601C
I	10		E	160.08	161.81	1	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		E	160.08	161.81	2	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		E	160.08	160.88	3	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		E	160.08	160.59	4	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		E	160.08	160.59	5	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		W	160.3	162.03	1	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		W	160.3	162.03	2	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		W	160.3	162.03	3	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		W	160.3	160.75	4	AB	40	PP	130					STP -600-7(1)B	12	2003	H508801C
I	10		E	147.99	155.44	1	FR	10							010-C-NFA	8	2007	H695601C
I	10		W	148.01	155.44	1	FR	10							010-C-NFA	8	2007	H695601C
I	10		E	147.99	155.44	2	FR	10							010-C-NFA	8	2007	H695601C
I	10		E	147.99	155.44	3	FR	10							010-C-NFA	8	2007	H695601C
I	10		E	147.99	155.44	4	FR	10							010-C-NFA	8	2007	H695601C
I	10		W	148.01	155.44	2	FR	10							010-C-NFA	8	2007	H695601C
I	10		W	148.01	155.44	3	FR	10							010-C-NFA	8	2007	H695601C
I	10		W	148.01	155.44	4	FR	10							010-C-NFA	8	2007	H695601C
I	10		E	151.29	154.91	5	FR	10							010-C-NFA	8	2007	H695601C

I-10 Pavement History

Prefix	Route No	Suffix	Dir	Beg MP	End MP	Lane	Lift 1	Thickness 1	Lift 2	Thickness 2	Lift 3	Thickness 3	Lift 4	Thickness 4	Project Number	Month	Year	Tracs Number
I	10		E	149.74	151.29	6	FR	10							010-C-NFA	8	2007	H695601C
I	10		W	151.31	155.2	6	FR	10							010-C-NFA	8	2007	H695601C
I	10		W	149.85	151.31	7	FR	10							010-C-NFA	8	2007	H695601C
I	10		W	160.85	161.16	1	AC	40	PC	140	FR	10			STP -202-C(202)N	10	2011	H745701C
I	10		W	160.85	161.16	2	AC	40	PC	140	FR	10			STP -202-C(202)N	10	2011	H745701C
I	10		E	160.85	161.16	1	AC	40	PC	140	FR	10			STP -202-C(202)N	10	2011	H745701C
I	10		E	160.85	161.16	2	AC	40	PC	140	FR	10			STP -202-C(202)N	10	2011	H745701C
I	10		W	161.16	161.37	1	FR	10							STP -202-C(202)N	10	2011	H745701C
I	10		W	150.88	151.16	6	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		E	150.01	150.38	2	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		E	150.01	150.38	3	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		E	150.01	150.38	4	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		E	150.01	150.38	5	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		W	150.01	150.38	1	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		W	150.01	150.38	2	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		W	150.01	150.38	3	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		W	150.01	150.38	4	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		W	150.01	150.38	5	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
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I	10		W	160.55	161.19	1	SM	15	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		W	161.19	163.07	1	SM	12	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		E	160.55	161.19	2	SM	15	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		E	160.55	168.68	2	SM	150	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		E	161.19	163.07	2	SM	12	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		W	160.55	161.19	2	SM	15	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		W	161.19	163.07	2	SM	12	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
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I	10		E	159.78	159.95	4	FR	10							NON-NFA	10	2008	H708201C
I	10		W	159.78	160.08	1	FR	10							NON-NFA	10	2008	H708201C
I	10		E	159.78	159.95	1	FR	10							NON-NFA	10	2008	H708201C
I	10		E	159.78	159.95	2	FR	10							NON-NFA	10	2008	H708201C
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I	10		E	159.95	160.09	5	FR	10							NON-NFA	10	2008	H708201C
I	10		E	161.99	162.12	3	FR	10							NON-NFA	10	2008	H708201C
I	10		W	159.78	160.08	2	FR	10							NON-NFA	10	2008	H708201C
I	10		W	159.78	160.08	3	FR	10							NON-NFA	10	2008	H708201C
I	10		W	159.78	160.08	4	FR	10							NON-NFA	10	2008	H708201C
I	10		W	159.78	160.08	5	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.08	160.63	6	FR	10							NON-NFA	10	2008	H708201C
I	10		W	161.83	162.08	4	FR	10							NON-NFA	10	2008	H708201C

I-10 Pavement History

Prefix	Route No	Suffix	Dir	Beg MP	End MP	Lane	Lift 1	Thickness 1	Lift 2	Thickness 2	Lift 3	Thickness 3	Lift 4	Thickness 4	Project Number	Month	Year	Tracs Number
I	10		W	160.08	160.63	2	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.08	160.63	3	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.08	160.63	4	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.08	160.63	5	FR	10							NON-NFA	10	2008	H708201C
I	10		W	161.83	162.08	2	FR	10							NON-NFA	10	2008	H708201C
I	10		W	161.83	162.08	3	FR	10							NON-NFA	10	2008	H708201C
I	10		E	161.99	162.12	1	FR	10							NON-NFA	10	2008	H708201C
I	10		E	161.99	162.12	5	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.09	160.59	1	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.09	160.59	2	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.09	160.59	3	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.09	160.59	4	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.09	160.59	5	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.09	160.59	6	FR	10							NON-NFA	10	2008	H708201C
I	10		W	161.83	162.08	1	FR	10							NON-NFA	10	2008	H708201C
I	10		E	161.99	162.12	2	FR	10							NON-NFA	10	2008	H708201C
I	10		E	159.95	160.09	1	FR	10							NON-NFA	10	2008	H708201C
I	10		E	159.95	160.09	3	FR	10							NON-NFA	10	2008	H708201C
I	10		E	159.95	160.09	2	FR	10							NON-NFA	10	2008	H708201C
I	10		E	159.95	160.09	4	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.28	167.09	1	RE	35	AC	55	FR	5			IM 10- 3-272	10	1997	H356201C
I	10		E	150.01	150.38	1	CL	0	PD	100					I-10-3(204)	9	1988	H011504C
I	10		W	151.68	152.44	2	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		W	151.68	152.44	3	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		W	151.68	152.44	4	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		E	151.68	152.44	2	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		E	151.68	152.44	3	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		E	151.68	152.44	4	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		W	151.88	152.44	5	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		E	151.89	152.44	5	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		E	152.27	152.44	6	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		W	152.44	152.72	1	AB	40	AC	50					IR 10-3-(312)	10	2001	H014304C
I	10		E	152.44	154.36	1	AB	40	AC	50					IR 10-3-(312)	10	2001	H014304C
I	10		W	152.28	152.44	1	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		E	152.28	152.44	1	AC	40	PD	135					IR 10-3-(312)	10	2001	H014304C
I	10		E	154.29	156.43	1	RA	0	AC	40	PC	120			NH-10-3(310)	1	1996	H014204C
I	10		W	154.29	156.43	1	RA	0	AC	40	PC	120			NH-10-3(310)	1	1996	H014204C
I	10		W	148.8	152.1		SM	50	AB	40	PC	90			I 10- 3- 52	11	1965	PMS01271
I	10		W	155.62	160.55		SM	150	AB	40	AC	35	FC	5	I 10- 3- 56	4	1967	PMS01274
I	10		W	155.64	160.55		FL	0							I 10- 3-925	11	1973	PMS01281
I	10		W	155.7	160.6	2	RE	20	AC	15	FC	5			IR 10- 3-178	7	1984	PMS01584
I	10		W	155.67	160.55		HS	0	AC	20	FC	5			FI 10- 3-135	3	1980	PMS01088

I-10 Pavement History

Prefix	Route No	Suffix	Dir	Beg MP	End MP	Lane	Lift 1	Thickness 1	Lift 2	Thickness 2	Lift 3	Thickness 3	Lift 4	Thickness 4	Project Number	Month	Year	Tracs Number
I	10		W	161	167		RC	35	AC	15	FC	5			IR 10- 3-148	9	1983	PMS01582
I	10		W	161	168		SM	150	AB	40	AC	35	FC	5	I 10- 3-913	11	1969	PMS01279
I	10		E	148.8	152.1		SM	50	AB	40	PC	90			I 10- 3- 52	11	1965	PMS01271
I	10		E	152.9	153.89	1	AB	80	AC	80					ACIR 10- 3-198	11	1989	H265001C
I	10		E	155.62	160.55		SM	150	AB	40	AC	35	FC	5	I 10- 3- 56	4	1967	PMS01274
I	10		E	155.67	160.55		HS	0	AC	20	FC	5			FI 10- 3-135	3	1980	PMS01088
I	10		E	159.62	160.6		RE	20	AC	15	FC	5			IR 10- 3-178	7	1984	PMS01584
I	10		E	160.55	163.83	1	RM	3	AC	20	FC	5			IR 10- 3-142	3	1983	PMS01581
I	10		E	160.55	163.83	2	RC	45	AC	20	FC	5			IR 10- 3-142	3	1983	PMS01581
I	10		E	160.28	167.09	1	RE	35	AC	55	FR	5			IM 10- 3-272	10	1997	H356201C
I	10		E	160.28	167.09	2	RE	50	AC	65	FR	5			IM 10- 3-272	10	1997	H356201C
I	10		W	160.28	167.09	2	RE	50	AC	70	FR	5			IM 10- 3-272	10	1997	H356201C
I	10		E	156.02	160.25	1	AC	30	PC	130					NH 10-3-(322)	9	1997	H238201C
I	10		E	156.02	160.25	2	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		E	156.02	160.25	3	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		E	156.02	160.25	4	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		E	156.02	157.35	5	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		E	160.25	160.59	1	AB	120	AC	40	FR	5			NH 10-3-(322)	9	1997	H238201C
I	10		E	160.25	160.59	2	RE	30	AC	30	FR	5			NH 10-3-(322)	9	1997	H238201C
I	10		E	160.25	160.59	3	RE	30	AC	30	FR	5			NH 10-3-(322)	9	1997	H238201C
I	10		W	156.02	160.25	1	AC	30	PC	130					NH 10-3-(322)	9	1997	H238201C
I	10		W	156.02	160.25	2	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		W	156.02	160.25	3	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		W	156.02	160.25	4	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		W	156.02	157.35	5	RE	160	AC	30	PC	130			NH 10-3-(322)	9	1997	H238201C
I	10		W	160.25	160.57	1	AB	120	AC	40	FR	5			NH 10-3-(322)	9	1997	H238201C
I	10		W	161.16	161.37	2	FR	10							STP -202-C(202)N	10	2011	H745701C
I	10		E	161.16	161.37	1	FR	10							STP -202-C(202)N	10	2011	H745701C
I	10		E	161.16	161.37	2	FR	10							STP -202-C(202)N	10	2011	H745701C
I	10		E	155.44	159.69	1	FR	10							NH-900-A(072)A	5	2005	H637103C
I	10		W	155.44	159.69	1	FR	10							NH-900-A(072)A	5	2005	H637103C
I	10		E	155.44	159.69	2	FR	10							NH-900-A(072)A	5	2005	H637103C
I	10		E	155.44	159.69	3	FR	10							NH-900-A(072)A	5	2005	H637103C
I	10		W	155.44	159.69	2	FR	10							NH-900-A(072)A	5	2005	H637103C
I	10		W	155.44	159.69	3	FR	10							NH-900-A(072)A	5	2005	H637103C
I	10		W	155.44	159.69	4	FR	10							NH-900-A(072)A	5	2005	H637103C
I	10		E	156.04	160.7	1	RE	10	AC	10					I-10-3-520	1	1995	H396601C
I	10		E	156.04	160.7	2	RE	10	AC	10					I-10-3-520	1	1995	H396601C
I	10		W	156.04	160.7	1	RE	10	AC	10					I-10-3-520	1	1995	H396601C
I	10		W	156.04	160.7	2	RE	10	AC	10					I-10-3-520	1	1995	H396601C
I	10		E	154.6	156.02	1	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		W	154.6	156.02	1	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C

I-10 Pavement History

Prefix	Route No	Suffix	Dir	Beg MP	End MP	Lane	Lift 1	Thickness 1	Lift 2	Thickness 2	Lift 3	Thickness 3	Lift 4	Thickness 4	Project Number	Month	Year	Tracs Number
I	10		E	154.6	156.02	2	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		E	154.6	156.02	3	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		E	154.6	156.02	4	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		E	156.19	156.02	5	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		W	154.6	156.02	2	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		W	154.6	156.02	3	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		W	154.6	156.02	4	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		W	154.83	155.14	5	AC	40	PD	120					NH- 10-3(317)	5	1997	H203501C
I	10		E	152.1	154.61	1	SM	50	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	154.82	155.62	1	SM	100	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		W	153.98	155	1	SM	50	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	152.1	154.61	2	SM	50	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	152.1	154.61	3	SM	50	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	152.1	154.61	4	SM	50	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	154.82	155.62	2	SM	100	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	154.82	155.62	3	SM	100	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	154.82	155.62	4	SM	100	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	154.82	155.62	5	SM	100	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		W	153.98	155	2	SM	50	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		W	153.98	155	3	SM	50	AB	40	PC	90			I 10- 3- 54	8	1968	PMS01272
I	10		E	160.55	161.19	2	SM	15	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		E	161.19	163.07	2	SM	12	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		W	160.55	161.19	2	SM	15	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		W	161.19	163.07	2	SM	12	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		E	160.55	168.68	2	SM	150	AB	40	AC	35	FC	5	I 10- 3- 69	8	1968	PMS01278
I	10		E	150.88	151.16	2	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		W	150.88	151.16	2	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		E	150.88	151.16	3	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		W	150.88	151.16	3	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		E	150.88	151.16	4	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		W	150.88	151.16	4	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		E	150.88	151.16	5	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		W	150.88	151.16	5	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		E	150.88	151.16	6	CL	50	PC	100					IR-10-3-(206)	6	1987	H009404C
I	10		E	160.59	161.99	1	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.59	161.99	2	FR	10							NON-NFA	10	2008	H708201C
I	10		E	160.59	161.99	3	FR	10							NON-NFA	10	2008	H708201C
I	10		E	161.99	162.12	4	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.08	160.63	1	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.63	160.74	1	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.63	160.74	2	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.63	160.74	3	FR	10							NON-NFA	10	2008	H708201C

I-10 Pavement History

Prefix	Route No	Suffix	Dir	Beg MP	End MP	Lane	Lift 1	Thickness 1	Lift 2	Thickness 2	Lift 3	Thickness 3	Lift 4	Thickness 4	Project Number	Month	Year	Tracs Number
I	10		W	160.63	160.74	4	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.74	161.83	1	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.74	161.83	2	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.74	161.83	3	FR	10							NON-NFA	10	2008	H708201C
I	10		W	160.55	167.1	1	AC	15	FC	5					IR-10-3-(148)	10	1983	H123101C
I	10		W	160.55	167.1	2	AC	50	FC	5					IR-10-3-(148)	10	1983	H123101C
I	10		E	156.12	157.36	3	RE	5	FR	5					IR- 10-3-515	8	1992	H238202C
I	10		W	155.98	157.22	3	RE	5	FR	5					IR- 10-3-515	8	1992	H238202C

SR 143 Pavement History

Prefix	Route No	Suffix	Dir	Beg MP	End MP	Lane	Lift 1	Thickness 1	Lift 2	Thickness 2	Lift 3	Thickness 3	Lift 4	Project Number	Month	Year	Tracs Number
S	143		N	0.27	1.16	1	RE	100	AB	40	PC	90		BPM600- 3-506	6	1985	PMS00103
S	143		N	0.75	1.97	1	AB	50	AC	45	FC	5		BPM600- 3-505	7	1983	PMS00102
S	143		N	0.89	1.83	1	AB	40	PC	110				RAM600- 3-511	2	1992	PMS01971
S	143		N	1.83	2.48	1	AB	40	PC	110				RAM600- 3-514	1	1992	PMS01972
S	143		S	0.27	1.16	1	RE	140	AB	40	PC	90		BPM600- 3-506	6	1985	PMS00103
S	143		S	0.89	1.93	1	SM	60	AC	75	FC	5		ER600- 3- 3	12	1980	PMS00155
S	143		S	0.89	1.83	1	AB	40	PC	110				RAM600- 3-511	2	1992	PMS01971
S	143		S	1.83	2.48	1	AB	40	PC	110				RAM600- 3-514	1	1992	PMS01972
S	143		S	1.97	2.74	1	SM	60	AC	75	FC	5		TQM600- 3- 1	8	1980	PMS02556
S	143		N	0.01	0.21	1	RE	20	AC	20				600-3(5)P	4	1999	H391201C
S	143		S	0.01	0.21	1	RE	20	AC	20				600-3(5)P	4	1999	H391201C
S	143		N	0.21	0.72	1	AB	40	PC	125				600-3(5)P	4	1999	H391201C
S	143		S	0.21	0.72	1	AB	40	PC	125				600-3(5)P	4	1999	H391201C
S	143		N	0.21	0.72	2	AB	40	PC	125				600-3(5)P	4	1999	H391201C
S	143		S	0.21	0.72	2	AB	40	PC	125				600-3(5)P	4	1999	H391201C
S	143		N	0.53	0.72	3	AB	40	PC	125				600-3(5)P	4	1999	H391201C
S	143		S	0.46	0.68	3	AB	40	PC	125				600-3(5)P	4	1999	H391201C
S	143		N	0.01	0.21	2	RE	20	AC	20				600-3(5)P	4	1999	H391201C
S	143		N	0.01	0.21	3	RE	20	AC	20				600-3(5)P	4	1999	H391201C
S	143		S	0.01	0.21	2	RE	20	AC	20				600-3(5)P	4	1999	H391201C
S	143		S	0.01	0.11	3	RE	20	AC	20				600-3(5)P	4	1999	H391201C
S	143		S	0.75	1.97	1	AB	50	AC	45	FC	5		BPM600- 3-505	7	1983	PMS00102
S	143		N	0.89	1.93	1	SM	60	AC	75	FC	5		ER600- 3- 3	12	1980	PMS00155
S	143		S	1.97	2.74	1	SM	60	AC	75	FC	5		TQM600- 3- 1	8	1980	PMS02556

APPENDIX C

PAVEMENT STRUCTURAL SECTION CALCULATIONS

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	I-10 from 24th St - US 60
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	149,520,459	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	2.8	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**14.10**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	I-10 - US 60 to Baseline Rd
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	64,087,172	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	2.8	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**12.26**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	SR143 - I-10 to Sky Harbor Blvd
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	34,065,551	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**13.21**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	SR143 - I-10 to Sky Harbor Blvd (CRCP)
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	34,065,551	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	2.5	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**10.30**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	US60 - I-10 to Hardy Dr
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	45,989,697	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**13.88**

Pavement Design - 20 Year Design Life
AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Routes:	**Collector Distributor Routes:** WB CD EB CD SR143 Ramp SW WB CD to SR143 NB SR 143 SB to EB CD EB CD to Baseline Rd (CD) I-10 WB to WB CD
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/2/2019
Engineer:	T. Hull

Design Inputs

W18 =	24,256,064	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**12.49**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	SR 143 - DHOV EB/WB
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/2/2019
Engineer:	T. Hull

Design Inputs

W18 =	11,854,209	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**11.05**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	US 60 Ramp NE Existing US 60 Ramp NE
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	10,928,689	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**10.89**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	Baseline Rd Ramp B
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	11/22/2019
Engineer:	KLP

Design Inputs

W18 =	8,477,535	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**10.83**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	Baseline Rd Ramp D
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	10,440,282	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**10.80**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	EB C-D to Baseline Road (Ramp)
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	10,357,388	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**10.79**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	EB C-D to US 60 Ramp SE
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	4,749,706	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**9.34**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	Existing US 60 Ramp SE
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	35,533,161	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**13.30**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	US 60 WB to WB C-D
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	6,943,426	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**10.04**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	US 60 Ramp WN
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	9/30/2019
Engineer:	T. Hull

Design Inputs

W18 =	40,221,286	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	1000	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.07	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**13.58**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	Priest Dr Ramps
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	12,055,654	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**11.91**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	48th St Ramps
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	20,372,655	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**12.97**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	Broadway Rd Ramps
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	24,359,534	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**13.34**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	University Dr Ramps
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	12,217,394	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**11.94**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	32nd St Ramps
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	29,436,305	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**13.75**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	40th St Ramps
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	17,856,308	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**12.70**

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	Elliot Rd Ramps
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	27,618,495	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**13.61**

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name: I-10 GEC From I-17 to SR202L
Route: Broadway Rd
Location: Phoenix, Arizona
Owner/Agency: ADOT
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	5.15		**Subgrade Resilient Modulus**	12,125.00	**psi**
Total Flexible ESALs	18,390,162		**Initial Serviceability**	4.20	
Reliability	95.00	**percent**	**Terminal Serviceability**	2.80	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.44	1.00	8.00	3.52
Graded Stone Base	0.14	1.00	12.00	1.68
			ΣSN	5.20

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	Broadway Road
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	24,309,446	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	95	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	2.8	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**12.22**

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name: I-10 GEC From I-17 to SR202L
Route: 48th Street
Location: Phoenix, Arizona
Owner/Agency: ADOT
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	4.99		**Subgrade Resilient Modulus**	12,125.00	**psi**
Total Flexible ESALs	14,741,147		**Initial Serviceability**	4.20	
Reliability	95.00	**percent**	**Terminal Serviceability**	2.80	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.44	1.00	8.00	3.52
Graded Stone Base	0.14	1.00	11.00	1.54
			ΣSN	5.06

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	48th Street
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	19,485,914	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	95	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	2.8	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**11.79**

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name: I-10 GEC From I-17 to SR202L
Route: 40th Street
Location: Phoenix, Arizona
Owner/Agency: ADOT
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	5.17		**Subgrade Resilient Modulus**	12,125.00	**psi**
Total Flexible ESALs	18,840,288		**Initial Serviceability**	4.20	
Reliability	95.00	**percent**	**Terminal Serviceability**	2.80	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.44	1.00	8.00	3.52
Graded Stone Base	0.14	1.00	12.00	1.68
			ΣSN	5.20

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	40th Street
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	10/17/2019
Engineer:	T. Hull

Design Inputs

W18 =	24,904,455	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	95	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	2.8	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**12.27**

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name: ADOT's I-10 GEC
Route: Ray Road Ramps
Location: Arizona
Owner/Agency: Arizona DOT
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	4.73		**Subgrade Resilient Modulus**	12,125.00	**psi**
Total Flexible ESALs	10,467,024		**Initial Serviceability**	4.20	
Reliability	95.00	**percent**	**Terminal Serviceability**	2.80	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.44	1.00	8.00	3.52
Crushed Stone Base	0.14	1.00	10.00	1.40
			Σ SN	4.92

Pavement Design - 20 Year Design Life

AASHTO RIGID PAVEMENT DESIGN

Project Name:	I-10 GEC From I-17 to SR202L
Route:	I-10 Ray Road
Location:	Phoenix, Arizona
Owner / Agency:	ADOT
Date:	11/19/2019
Engineer:	S. Singhar

Design Inputs

W18 =	10,467,024	ESALs	*ESALs Applications Over Design Period*
PCC MR =	670	psi	*Concrete Modulus of Rupture*
E =	4,000,000	psi	*Concrete Elastic Modulus*
k-value =	625	psi/in	*Modulus of Subgrade Reaction*
R =	99	%	*Reliability*
So =	0.25	[-]	*Standard Deviation*
J =	3.9	[-]	*Load Transfer Coefficient*
Cd =	1.00	[-]	*Drainage Coefficient*
Pi =	4.2	[-]	*Initial Serviceability*
Pt =	3.0	[-]	*Terminal Serviceability*

DESIGN THICKNESS D, inches, =	**11.64**

PHOENIX-CASA GRANDE HIGHWAY (I-10)
I-17 (SPLIT) TO SR202L (SANTAN)
010 MA 149 F0072 01C/010-C(220)T

MATERIALS DESIGN REPORT
REPORT # 19-33

ARIZONA DEPARTMENT OF TRANSPORTATION

FINAL

PROJECT NO.: 11607
DATE: JUNE 2020

WSP
1230 WEST WASHINGTON STREET, SUITE 405
TEMPE, ARIZONA 85281

June 24, 2020

Arizona Department of Transportation
Pavement Design Section
Roadway Engineering Group
205 South 17th Avenue
Phoenix, Arizona 85007

Re: Materials Design Report — Report # 19-33
Phoenix-Casa Grande Highway (I-10)
I-17 (Split) to SR 202L (Santan)
TRACS No. 010 MA 149 F0072 01C
Federal Project Number: 010-C(220)T

Our Materials Design Report is submitted herewith in support of the subject project. The following is based on the information and recommendations provided in the Pavement Design Summary for this project, submitted separately. We understand this information will be used by the selected Developer to construct the project pavements.

Please contact us if you have any questions concerning this report.

Respectfully submitted,
WSP USA

By:



Kevin L. Porter, PE
Senior Geotechnical Engineer

Reviewed By:

David E. Peterson, PG
Senior Geologist

cc: Addressee (PDF)

June 24, 2020

MATERIALS DESIGN REPORT

Report Type: FINAL **Report No.: 19-33**

Highway Name: I-10

Project Name: I-10; I-17 Split to SR 202L

Project Number: 010 MA 149 F0072 01C/010-C(220)T

Project Scope: Widening, New Construction

Mile Post Limits: MP 149.5 to MP 160.9

Prepared by:

WSP USA

1230 West Washington Street, Suite 405

Tempe, Arizona 85281

SECTION I - PAVEMENT STRUCTURE

ITEM 1 - Structural Thickness (in inches)

New Rigid Pavement Sections - Mainline & CD Road						
Location	Stationing		AC Base	CRCP	PCCP	Total Thickness[5]
	From	To				
I-10	7911+21[2]	8158+16[2]	3.0	-	14.5[1]	17.5
	8158+16[2]	8230+00[2]	3.0	-	12.5[1]	15.5
	8230+00[2]	8437+10[2]	3.0	-	13.0	16.0
SR 143	a 38+00[2]	a 51+41[2]	3.0	10.5	-	13.5
	a 34+74[2]	a 38+00[2]	3.0	-	13.5	16.5
	a 64+67[2]	b 85+16[2]				
US 60 (US 60 Ramp S-E_2 Stationing)	113+38[2]	147+68[2]	3.0	-	14.0	17.0
WB CD	17+32	167+75	3.0	-	12.5	15.5
EB CD	10+00	109+47				
New Rigid Pavement Sections - Defined Movements, System Ramps, Ramps, Crossroads						
Location	Stationing		Class 2 AB	AC Base	PCCP	Total Thickness[5]
	From	To				
SR 143 SI						
Ramp SW	16+66	27+83	-	3.0	12.5	15.5
WB C-D to SR 143 NB	41+61	65+51				
SR 143 SB to EB C-D	42+88	68+29				
DHOV WB (DHOV - SR143 Stationing)	25+34	53+34	-	3.0	12.0[3]	15.0
DHOV EB (DHOV - SR143 Stationing)	26+07	53+34				
US 60 SI						
US 60 Ramp NE	24+84	28+94	-	3.0	12.0[3]	15.0
Existing US 60 Ramp NE	3+98[2]	14+84[2]				
Baseline Road Ramp D	15+63	20+65	-	3.0	12.0[3]	15.0
EB C-D to Baseline Road (C-D)	16+30	47+57	-	3.0	12.5	15.5
EB C-D to Baseline Road (Ramp)	47+57	53+36	-	3.0	12.0[3]	15.0
EB C-D to US 60 Ramp SE	14+10	17+28	-	3.0	12.0[3]	15.0
Existing US 60 Ramp SE	88+91[2]	94+15[2]	-	3.0	13.5	16.5
I-10 WB to WB C-D	12+75	29+64	-	3.0	12.5	15.5
US 60 WB to WB C-D	15+24	35+13	-	3.0	12.0[3]	15.0
US 60 Ramp WN	194+37	214+54	-	3.0	14.0	17.0
Existing US 60 Ramp WN	114+54[2]	118+53[2]	-	3.0	14.0	17.0
Priest Drive						
Existing Priest Drive Ramp D	8+58[2]	10+83[2]	4.0	-	12.0	16.0
48th Street						
48th Street Ramp B	13+01	19+41	4.0	-	13.0	17.0
48th Street Loop Ramp	14+00	25+40				
Broadway Road						
Broadway Road Ramp A	13+83	30+29	4.0	-	13.5	17.5
Broadway Road Ramp B	16+25	42+46				
Broadway Road Ramp C	10+56	18+42				
Broadway Road Ramp D	10+39	20+78				
University Drive						
WB C-D to University Drive Ramp C	11+31	29+19	4.0	-	12.0	16.0
University Drive Ramp C	10+00	17+25				
University Drive Ramp D	7+79	16+35				
32nd Street						
32nd Street Ramp A	3+92	14+09	4.0	-	14.0	18.0
32nd Street Ramp B	4+86	14+77				
32nd Street Ramp C	+76	11+62				
32nd Street Ramp D	3+87	11+40				

SECTION I - PAVEMENT STRUCTURE

ITEM 1 - Structural Thickness (in inches)

New Rigid Pavement Sections - Defined Movements, Ramps, Crossroads						
Location	Stationing		Class 2 AB	AC Base	PCCP	Total Thickness[5]
	From	To				
40th Street						
40th Street Ramp A	14+71	21+95	4.0	-	13.0	17.0
40th Street Ramp B	17+67	28+42				
40th Street Ramp C	13+00	26+13				
40th Street Ramp D	11+31	19+86				
Elliot Road						
Existing Elliot Road Ramp C	9+95[2]	12+28[2]	4.0	-	14.0	18.0
Existing Elliot Road Ramp D	5+36[2]	10+80[2]				
Ray Road						
Existing Ray Road Ramp A	5+31[2]	7+80[2]	4.0	-	12.0	16.0
Existing Ray Road Ramp D	10+44[2]	10+67[2]				
Broadway Road						
Broadway Road[4]	4+76	36+16	4.0	-	12.5	16.5
48th Street						
48th Street SB	17+21	55+17	4.0	-	12.0	16.0
48th Street NB	15+52	52+28				
40th Street						
Existing 40th Street[4]	16+00[2]	24+05[2]	4.0	-	12.5	16.5
Baseline Road						
Existing Baseline Road Ramp B	6+22[2]	14+06[2]	4.0	-	12.0[3]	16.0
I-10						
DPS Turnaround	8069+25	8075+75	4.0	-	10.0	14.0

New Flexible Pavement Sections - Crossroads						
Location	Stationing		Class 2 AB	AC Base	AC (3/4") (End Prod.)	Total Thickness[5]
	From	To				
Broadway Road						
Broadway Road[4]	4+76	36+16	12.0	-	8.0	20.0
48th Street						
48th Street SB (Ex SR143 Stationing)	0+58[2]	6+05[2]	11.0	-	8.0	19.0
48th Street NB (Ex SR143 Stationing)	0+58[2]	6+05[2]				
40th Street						
Existing 40th Street[4] (North of I-10)	14+14[2]	16+00[2]	12.0	-	8.0	20.0
Existing 40th Street[4] (South of I-10)	27+05[2]	27+99[2]				
Warner Road						
Warner Rd Ramp A	2+00[2]	11+11[2]	10.0	-	7.0	17.0
Warner Rd Ramp B	0+39[2]	7+80[2]				
Warner Rd Ramp C	6+48[2]	15+15[2]				
Ray Road						
Existing Ray Rd Ramp D	4+77[2]	10+44[2]	10.0	-	8.0	18.0

Rehabilitation Flexible Pavement Sections				
Location	Stationing		Mill	Replace AC (3/4") (End Prod.)[5]
	From			
Existing Warner Road Ramp B	0+39[2]	9+60[2]	2.0	1.5
Existing Warner Road Ramp D	6+88[2]	15+71[2]	2.0	1.5

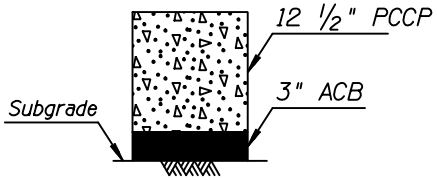
[1] Includes load transfer dowels

[2] Based on existing stationing

[3] Minimum PCCP thickness = 12.0"

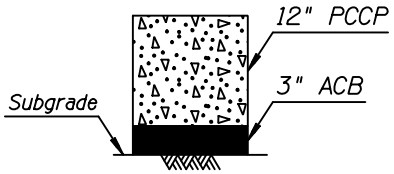
[4] Within ADOT access control PCCP shall be used and outside ADOT access control AC shall be used

[5] Limits of AR-ACFC not shown/included. See Technical Provisions for locations.



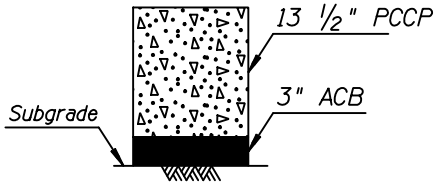
Total Thickness = 15 ½"

SECTION NO. 1



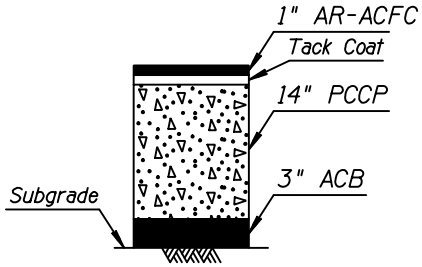
Total Thickness = 15"

SECTION NO. 2



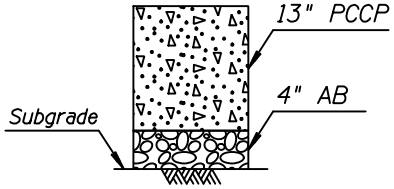
Total Thickness = 16 ½"

SECTION NO. 3



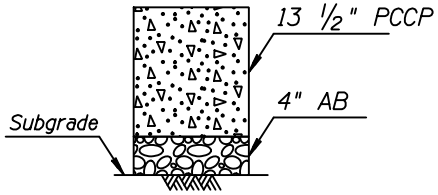
Total Thickness = 18"

SECTION NO. 4



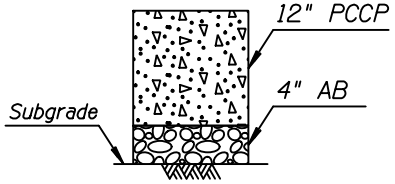
Total Thickness = 17"

SECTION NO. 5



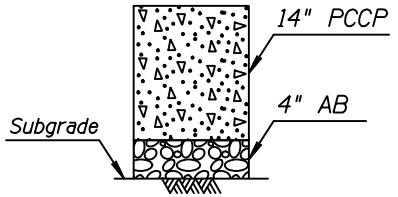
Total Thickness = 17 ½"

SECTION NO. 6



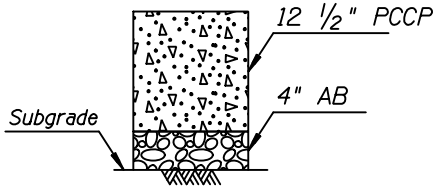
Total Thickness = 16"

SECTION NO. 7



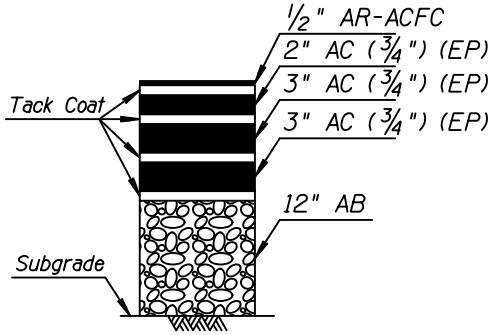
Total Thickness = 18"

SECTION NO. 8



Total Thickness = 16 ½"

SECTION NO. 9

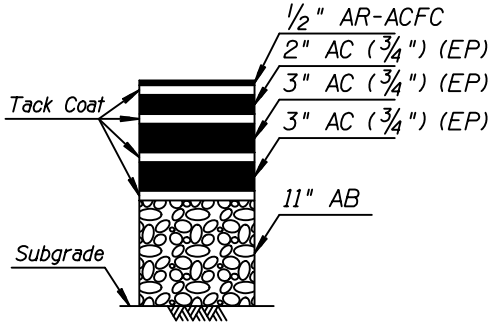


Total Thickness = 20 ½"

SECTION NO. 10

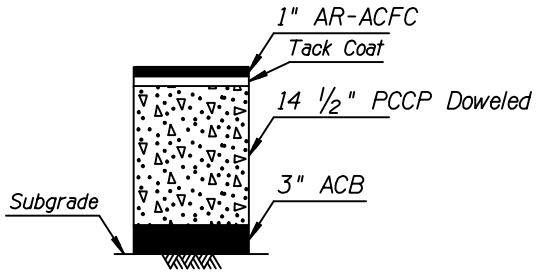
See attached Table 1 for stations

wsp	PAVEMENT STRUCTURAL SECTIONS SHEET 1	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



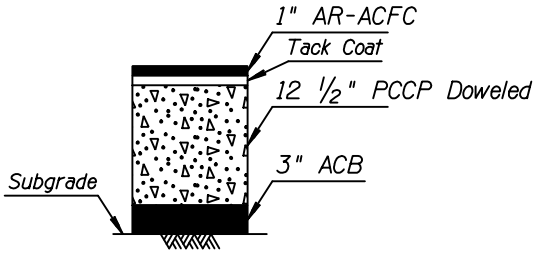
Total Thickness = 19 1/2"

SECTION NO. 11



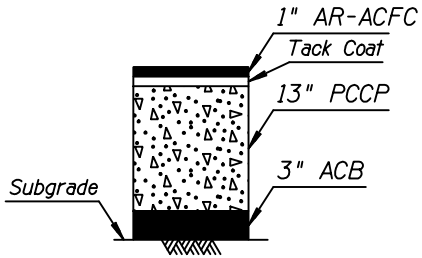
Total Thickness = 18 1/2"

SECTION NO. 12



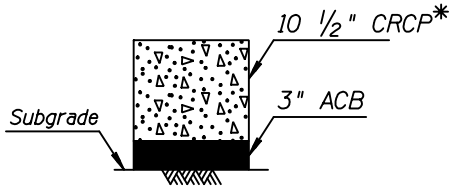
Total Thickness = 16 1/2"

SECTION NO. 13



Total Thickness = 17"

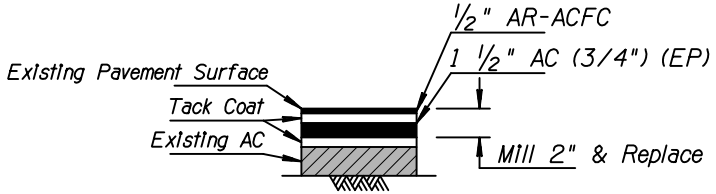
SECTION NO. 14



Total Thickness = 13 1/2"

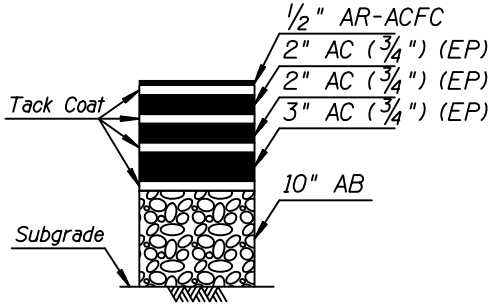
*See CRCP Details for reinforcing

SECTION NO. 15



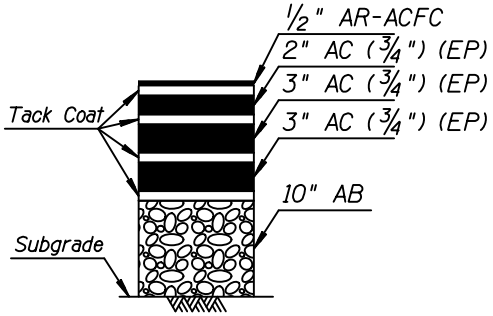
Total Thickness = 2"

SECTION NO. 16



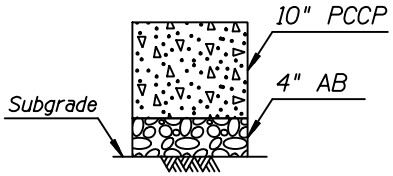
Total Thickness = 17 1/2"

SECTION NO. 17



Total Thickness = 18 1/2"

SECTION NO. 18

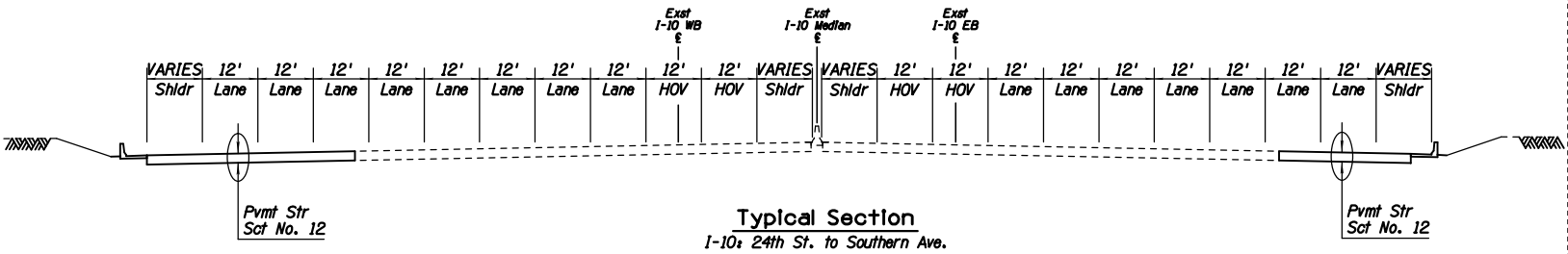


Total Thickness = 14"

SECTION NO. 19

See attached Table 1 for stations

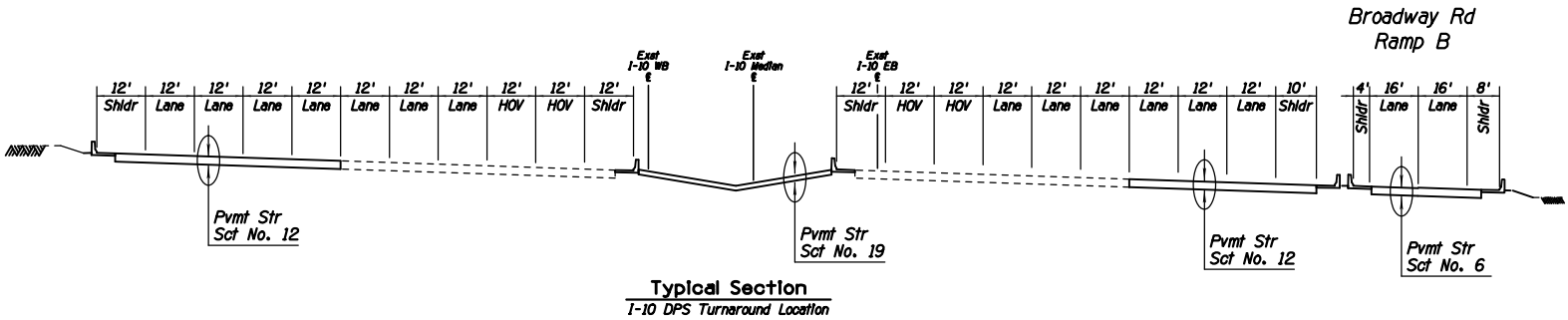
WSP	PAVEMENT STRUCTURAL SECTIONS SHEET 2	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

I-10: 24th St. to Southern Ave.

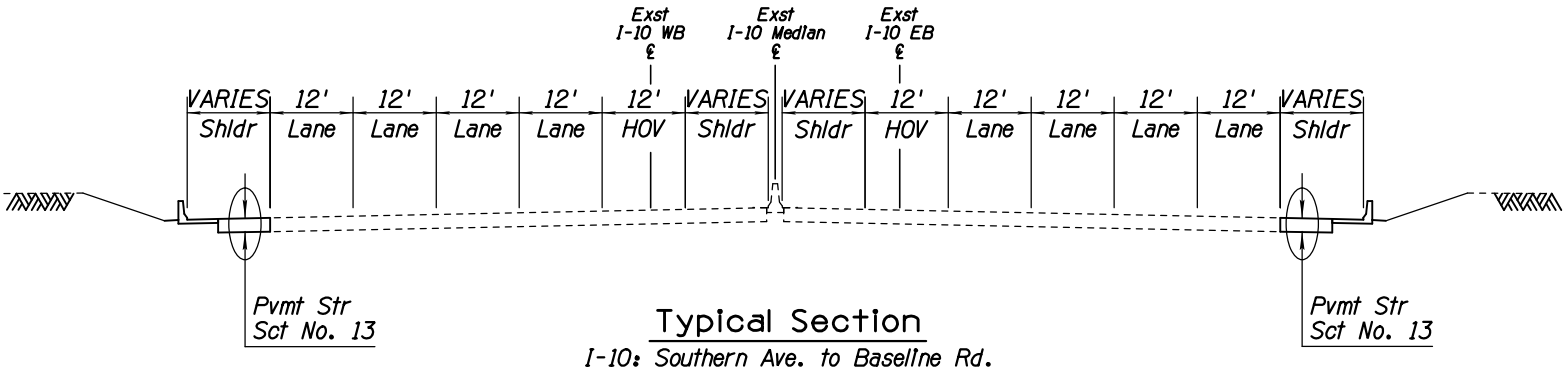
wsp	TYPICAL SECTIONS SHEET 1	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

I-10 DPS Turnaround Location

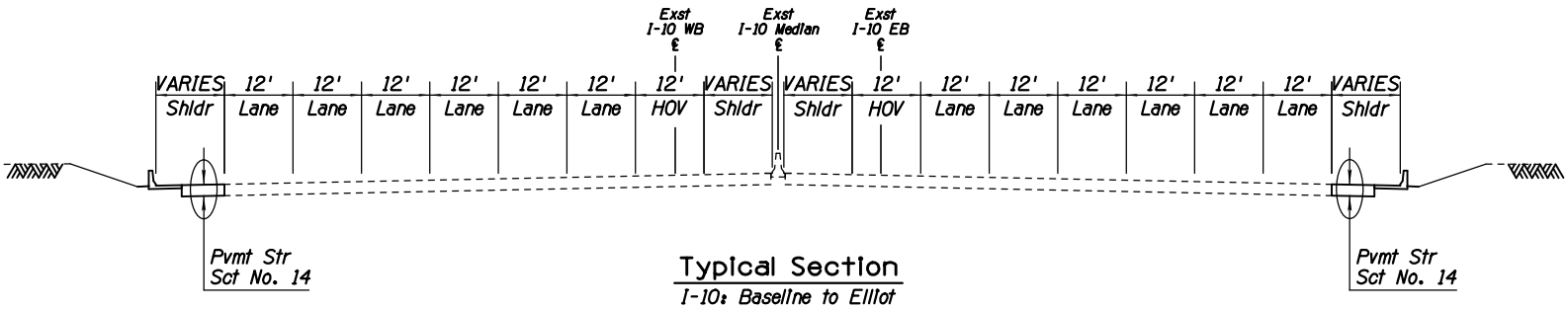
WSP	TYPICAL SECTIONS SHEET 2	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

I-10: Southern Ave. to Baseline Rd.

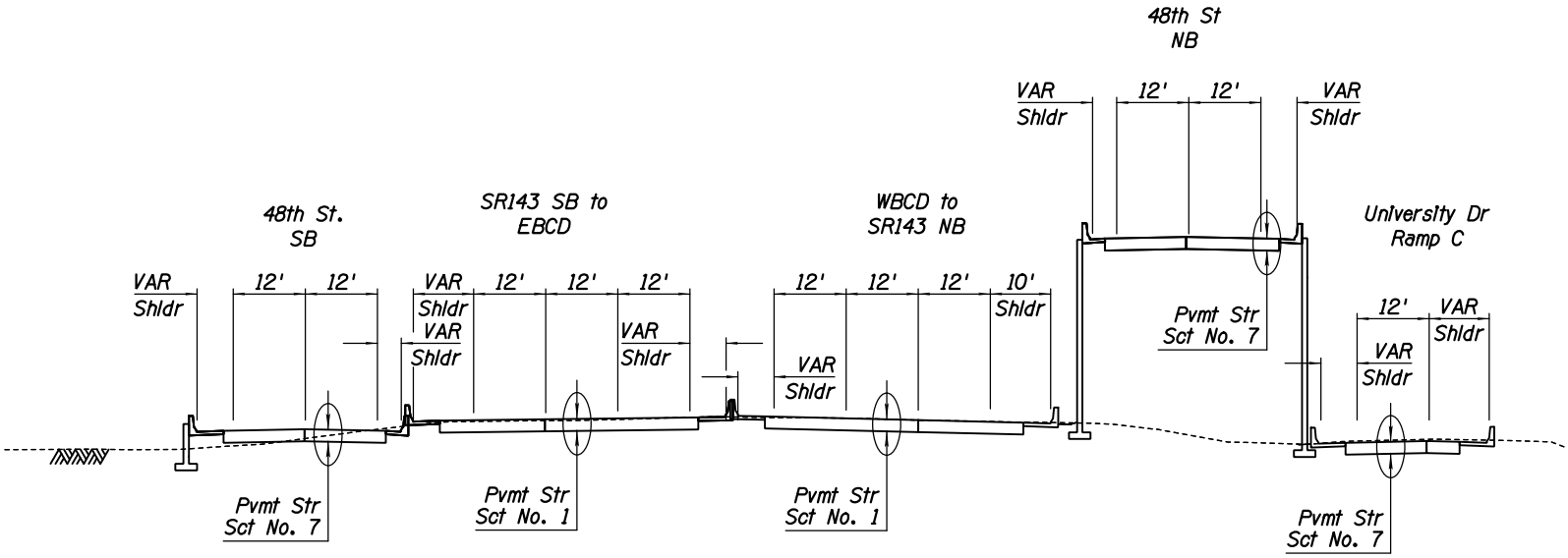
wsp	TYPICAL SECTIONS SHEET 3	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

I-10: Baseline to Elliot

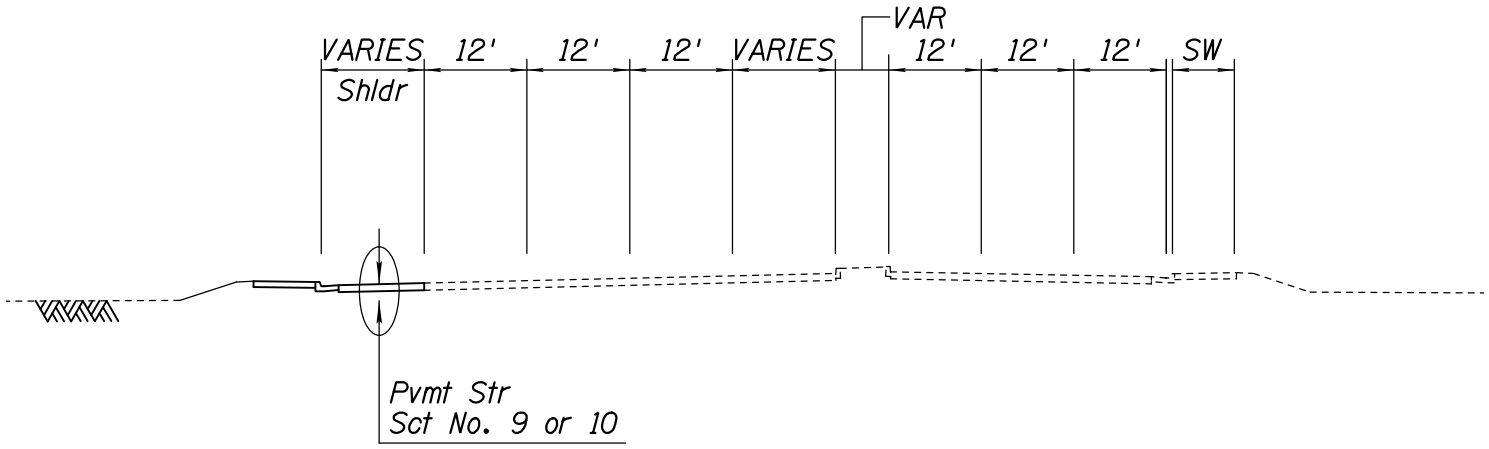
WSP	TYPICAL SECTIONS SHEET 4	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

SR 143: I-10 Interchange to University Dr.
48th St. SB
48th St. NB

wsp		TYPICAL SECTIONS SHEET 5
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T

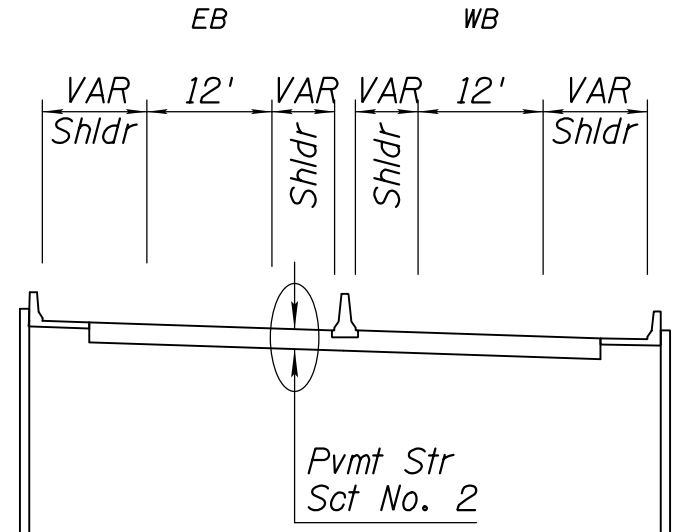


Typical Section

40th St.

*Use PCCP within ADOT access control limits

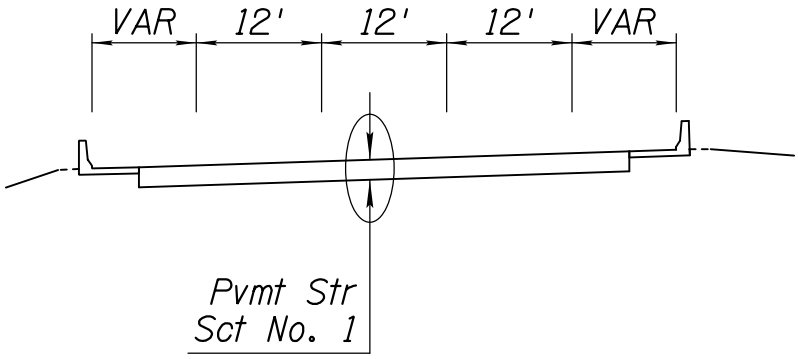
wsp		TYPICAL SECTIONS SHEET 6
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

DH0V-SR143

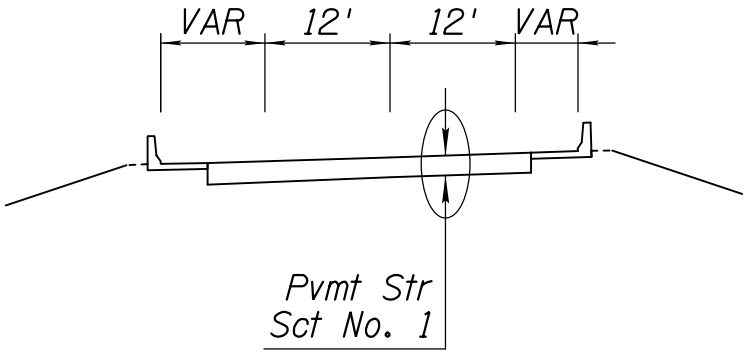
wsp		TYPICAL SECTIONS SHEET 7
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

WB C-D
EB C-D

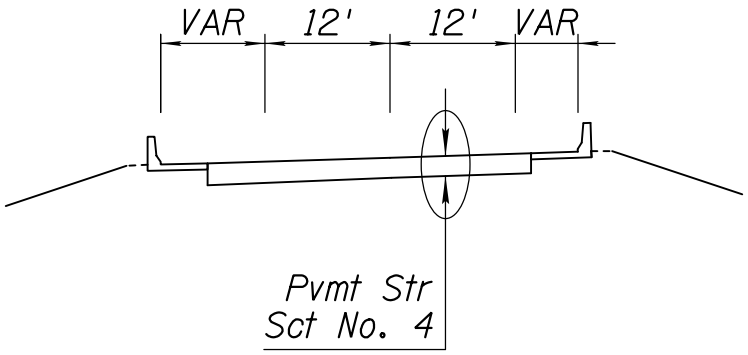
WSP	TYPICAL SECTIONS SHEET 8	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

WB C-D to SR 143 NB
SR 143 SB to EB C-D
EB C-D to Baseline Road (C-D)
I-10 WB to WB C-D

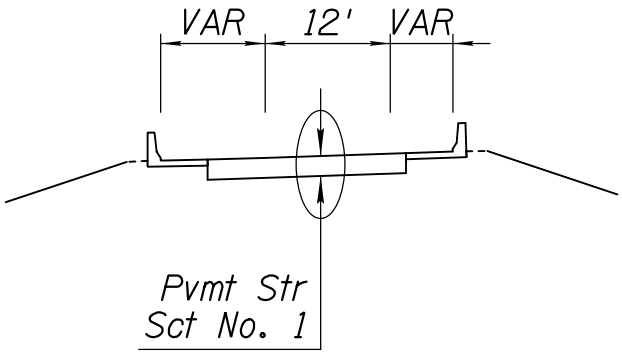
wsp		TYPICAL SECTIONS SHEET 9
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

US 60 Ramp WN

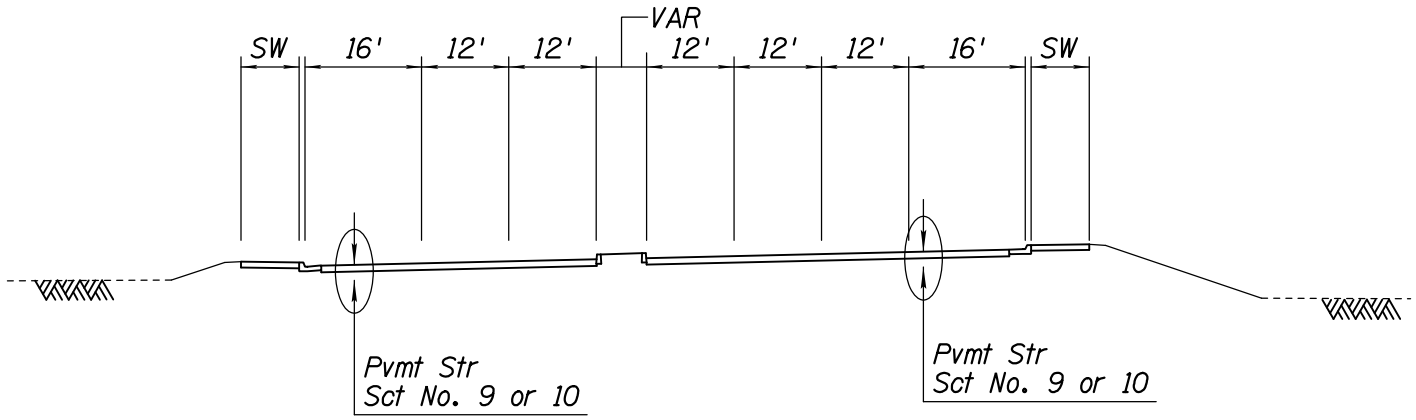
wsp		TYPICAL SECTIONS SHEET 10
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

Ramp SW

wsp		TYPICAL SECTIONS SHEET 11
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T

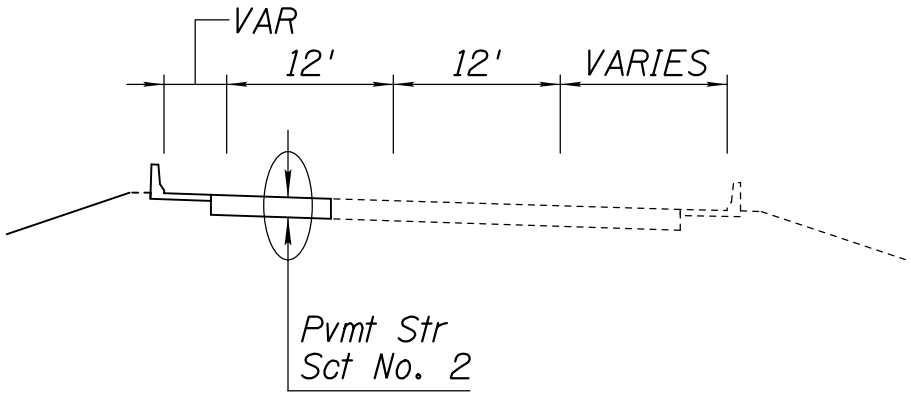


Typical Section

Broadway Rd.

**Use PCCP within ADOT access control limits*

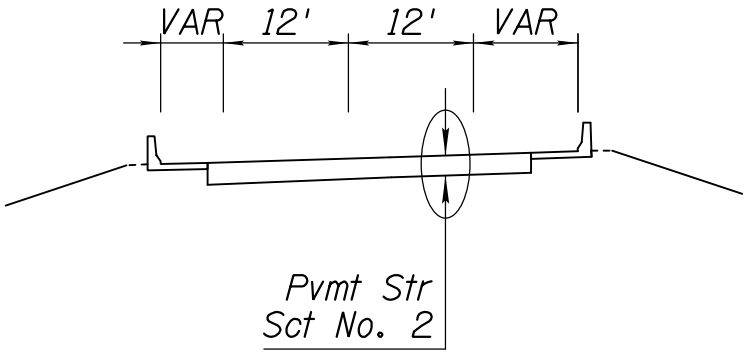
wsp		TYPICAL SECTIONS SHEET 12
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

EX US 60 Ramp NE

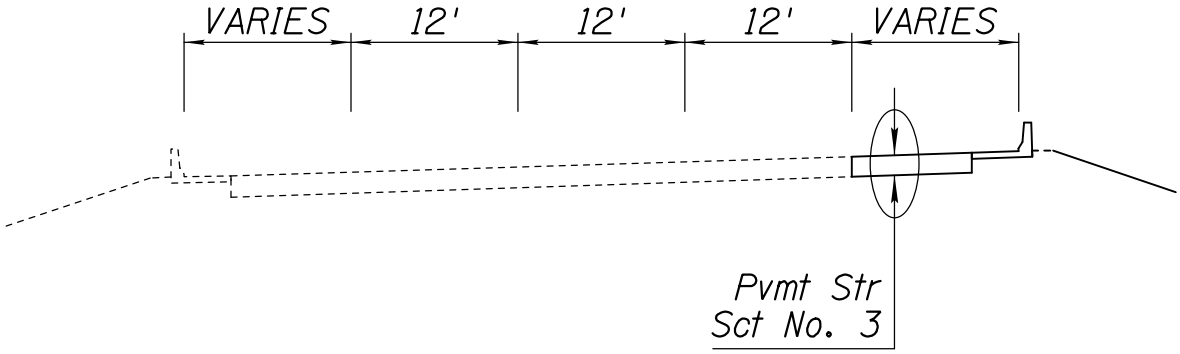
wsp	TYPICAL SECTIONS SHEET 13	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

US 60 Ramp NE
EB C-D to Baseline Rd. (Ramp)
EB C-D to US 60 Ramp SE
US 60 WB to WB C-D

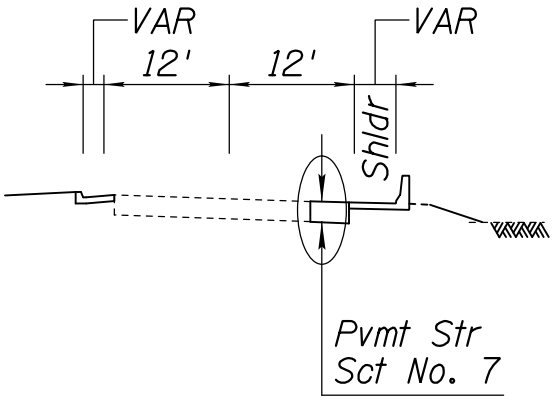
wsp		TYPICAL SECTIONS SHEET 14
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

EX US 60 Ramp SE

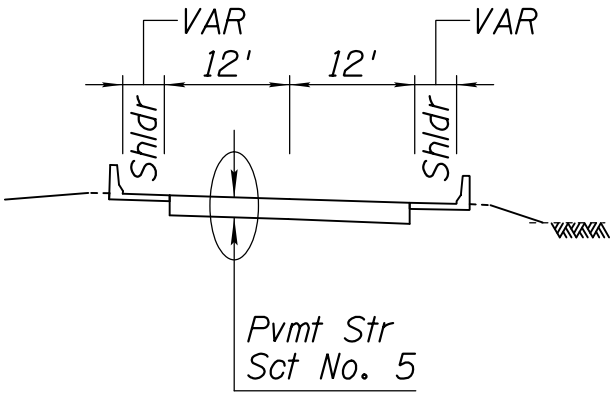
wsp		TYPICAL SECTIONS SHEET 15
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

Priest Dr. Ramps

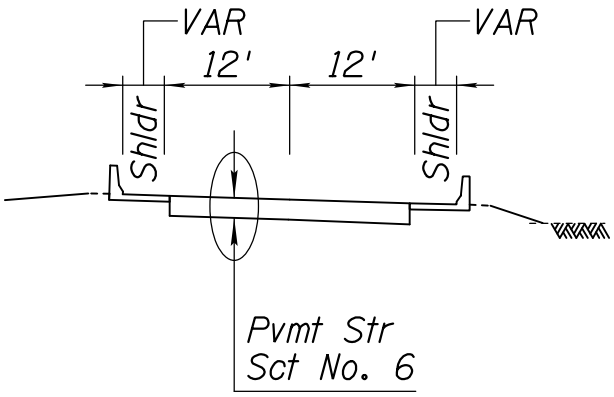
wsp		TYPICAL SECTIONS SHEET 16
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

40th St. Ramps (A,B,C,D)
48th St. Ramp B
48th St. Loop Ramp

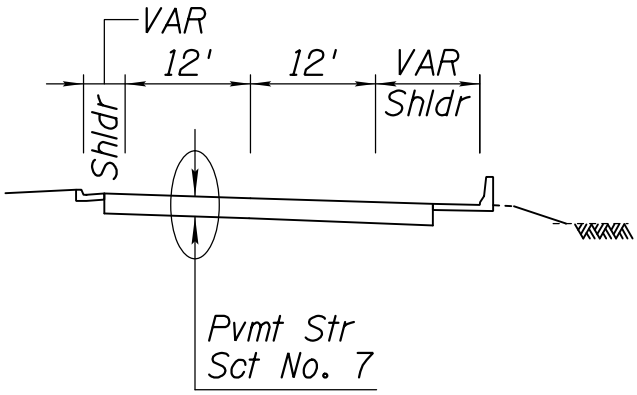
wsp		TYPICAL SECTIONS SHEET 17
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

Broadway Rd. Ramps (A,B,C,D)

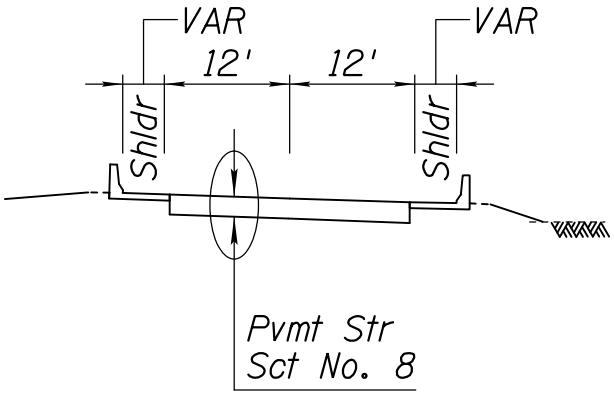
wsp		TYPICAL SECTIONS SHEET 18
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

University Dr. Ramps (C,D)

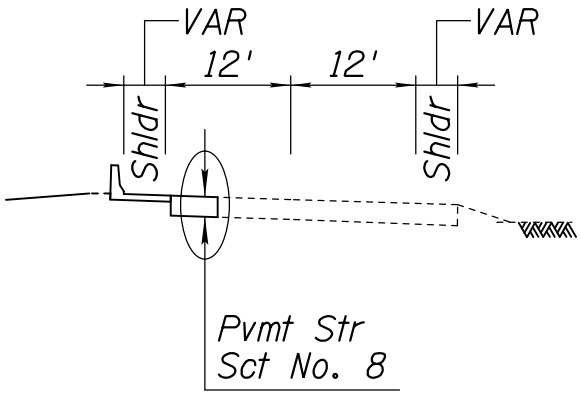
wsp		TYPICAL SECTIONS SHEET 19
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

32nd St. Ramps (A,B,C,D)

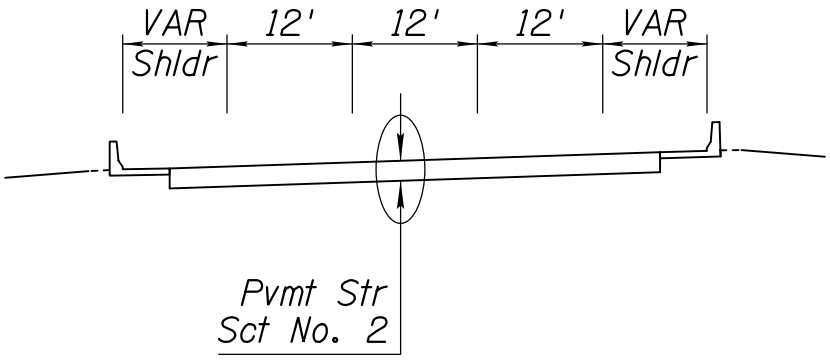
wsp		TYPICAL SECTIONS SHEET 20
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

Elliot Rd. Ramps (C,D)

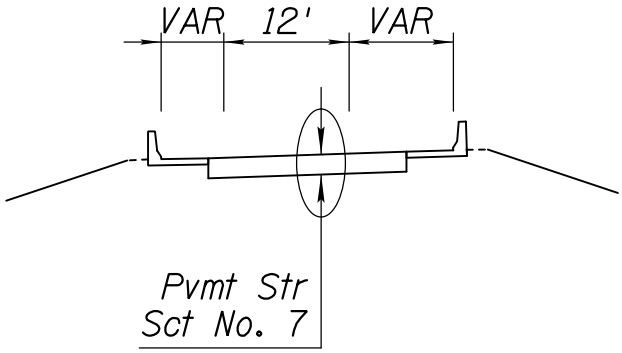
wsp		TYPICAL SECTIONS SHEET 21
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

Baseline Rd. Ramp D

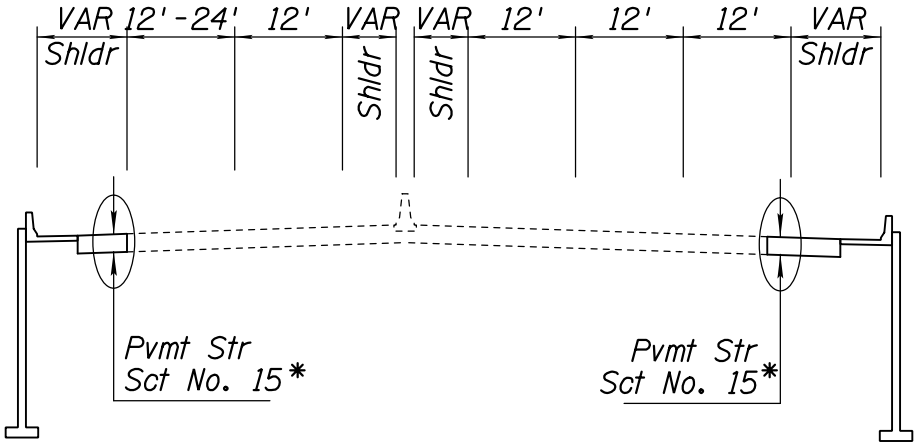
wsp		TYPICAL SECTIONS SHEET 22
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

WB C-D to University Dr. Ramp C

wsp		TYPICAL SECTIONS SHEET 23
ROUTE I-10	LOCATION	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
TRACS NO. F0072 01D		010-C(220)T

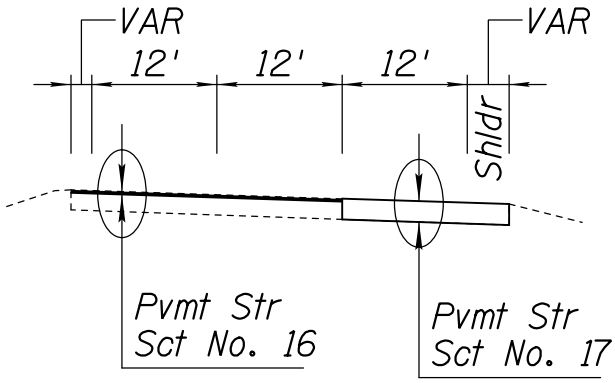


Typical Section

SR143 Widening

**Outside Limits of CRCP use PSS#3*

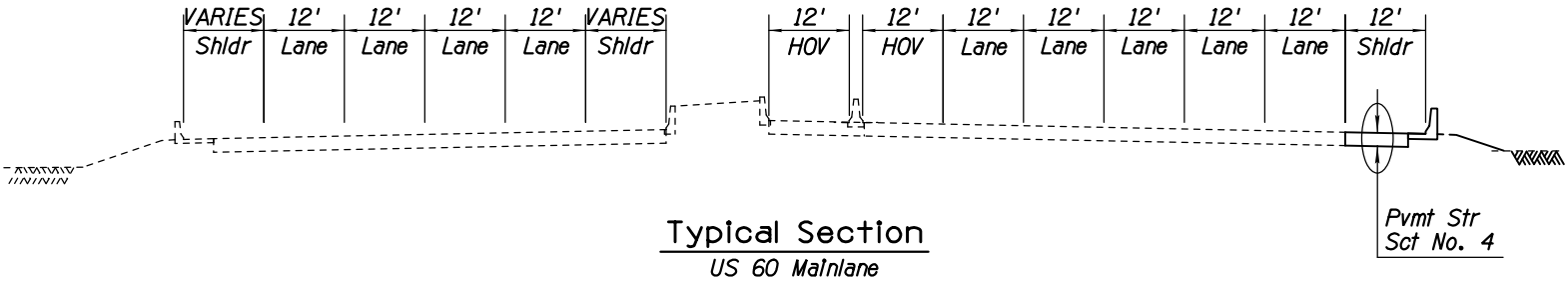
wsp		TYPICAL SECTIONS SHEET 24
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

Warner Rd. Ramps (B,D)

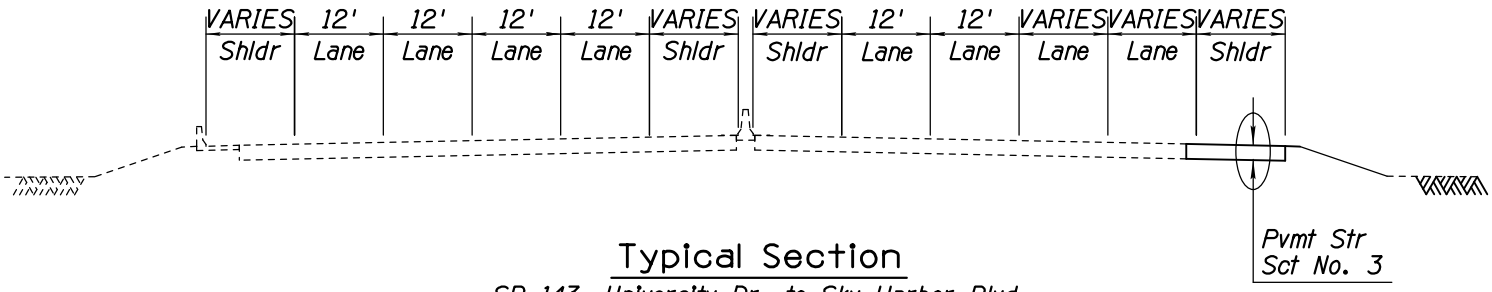
wsp		TYPICAL SECTIONS SHEET 25
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

US 60 Mainlane

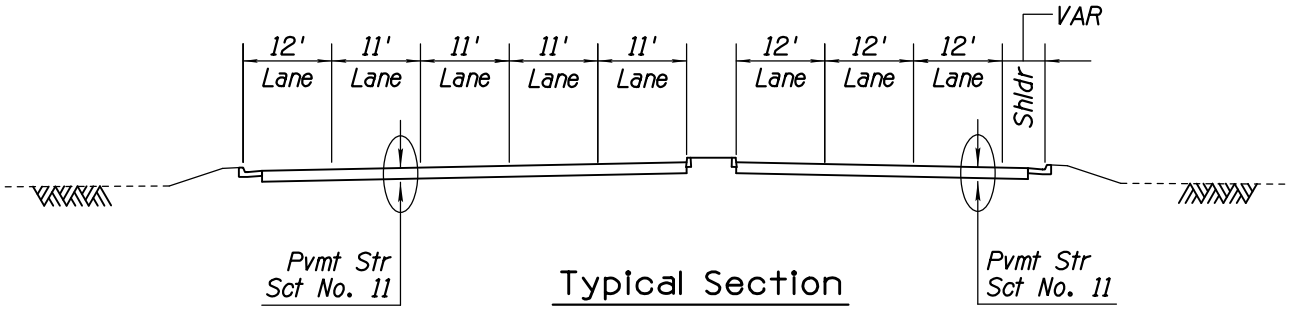
wsp	TYPICAL SECTIONS SHEET 27	
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

SR 143: University Dr. to Sky Harbor Blvd.

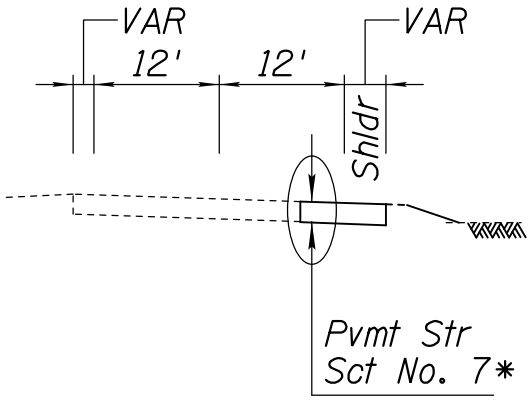
wsp		TYPICAL SECTIONS SHEET 26
ROUTE I-10	LOCATION	I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)
TRACS NO. F0072 01D		010-C(220)T



Typical Section

48th St. SB
48th St. NB

wsp		TYPICAL SECTIONS SHEET 28
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T



Typical Section

Ray Rd. Ramps (A,D)

**Outside Limits of PCCP use PSS#18*

wsp		TYPICAL SECTIONS SHEET 29
ROUTE I-10	LOCATION I-10 Broadway Curve: I-17 (Split) to SR 202L (Santan)	
TRACS NO. F0072 01D		010-C(220)T

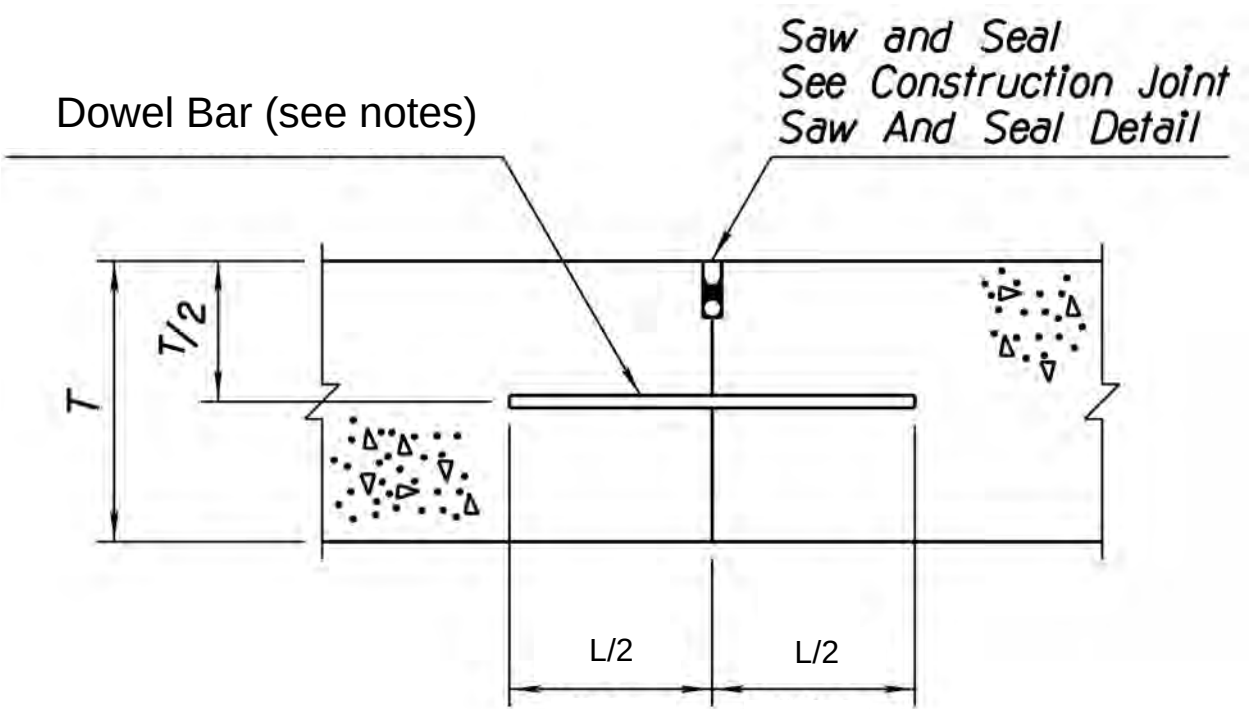
PCCP DETAILS

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



Notes:

1. When a longitudinal construction joint is located on a lane line or at the center of a lane, and the widening is 12 feet or more in width, use ADOT standard epoxy-coated smooth dowel bars along the joint (#5 x 24-inch long at 30-inch centers).
2. When a longitudinal construction joint is located on a lane line or at the center of a lane, and the widening is less than 12 feet in width, use ADOT standard epoxy-coated deformed bars along the joint (#5 x 24-inch long at 30-inch centers).
3. When a longitudinal construction joint is not located on a lane line or at the center of a lane, use #8 x 18-inch long epoxy-coated smooth dowel bars placed 18-inch on centers. The #8 bars shall be located 12 inches from any transverse joint. Bars shall be placed perpendicular to the pavement centerline within a tolerance of ± 3/8-inch for the full dowel length.

Note: T = PCCP Thickness
L = Dowel Bar Length

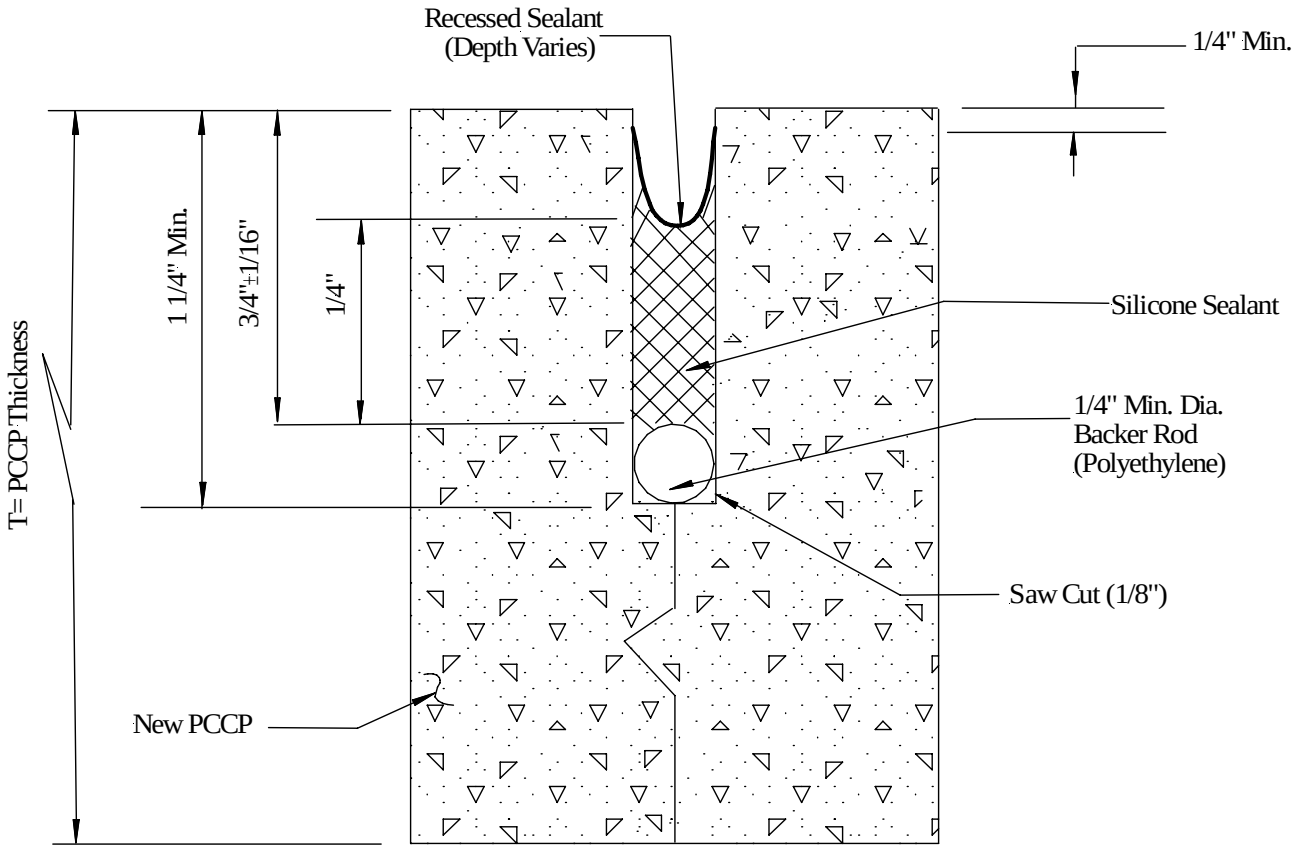
LONGITUDINAL CONSTRUCTION JOINT BETWEEN EXISTING PCCP AND NEW PCCP

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



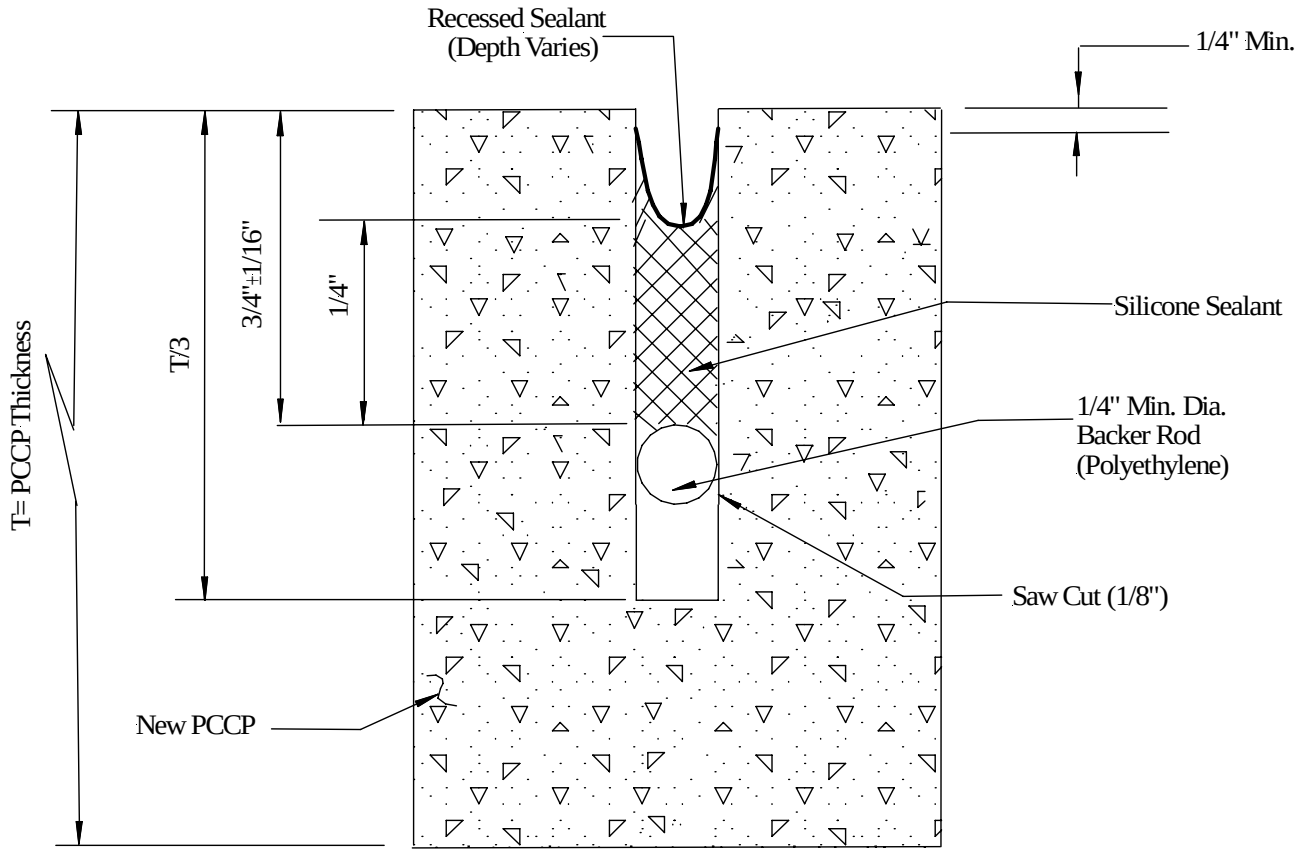
CONSTRUCTION JOINT DETAIL (STD C-07.01)

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



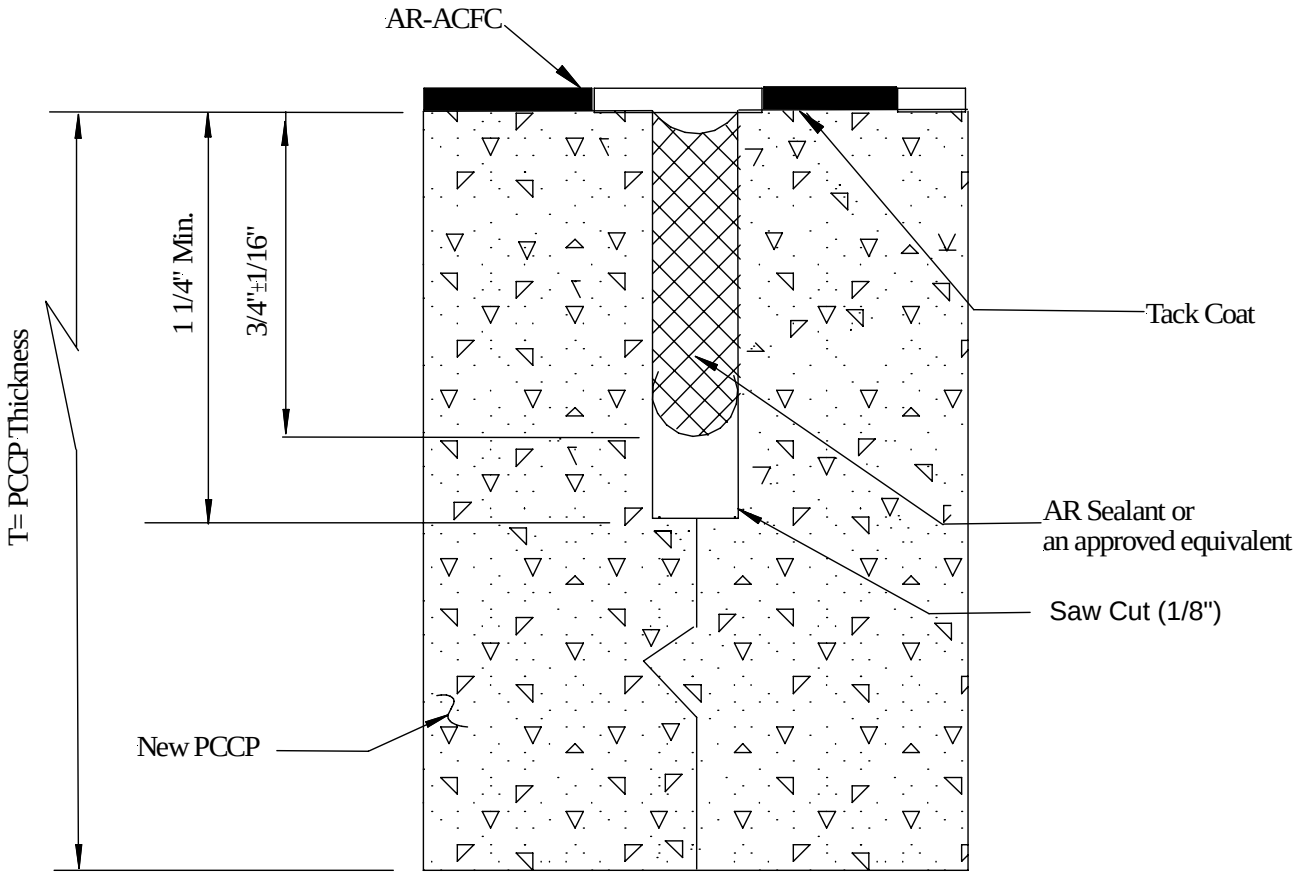
WEAKENED JOINT DETAIL (STD C-07.01)

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



CONSTRUCTION JOINT DETAIL

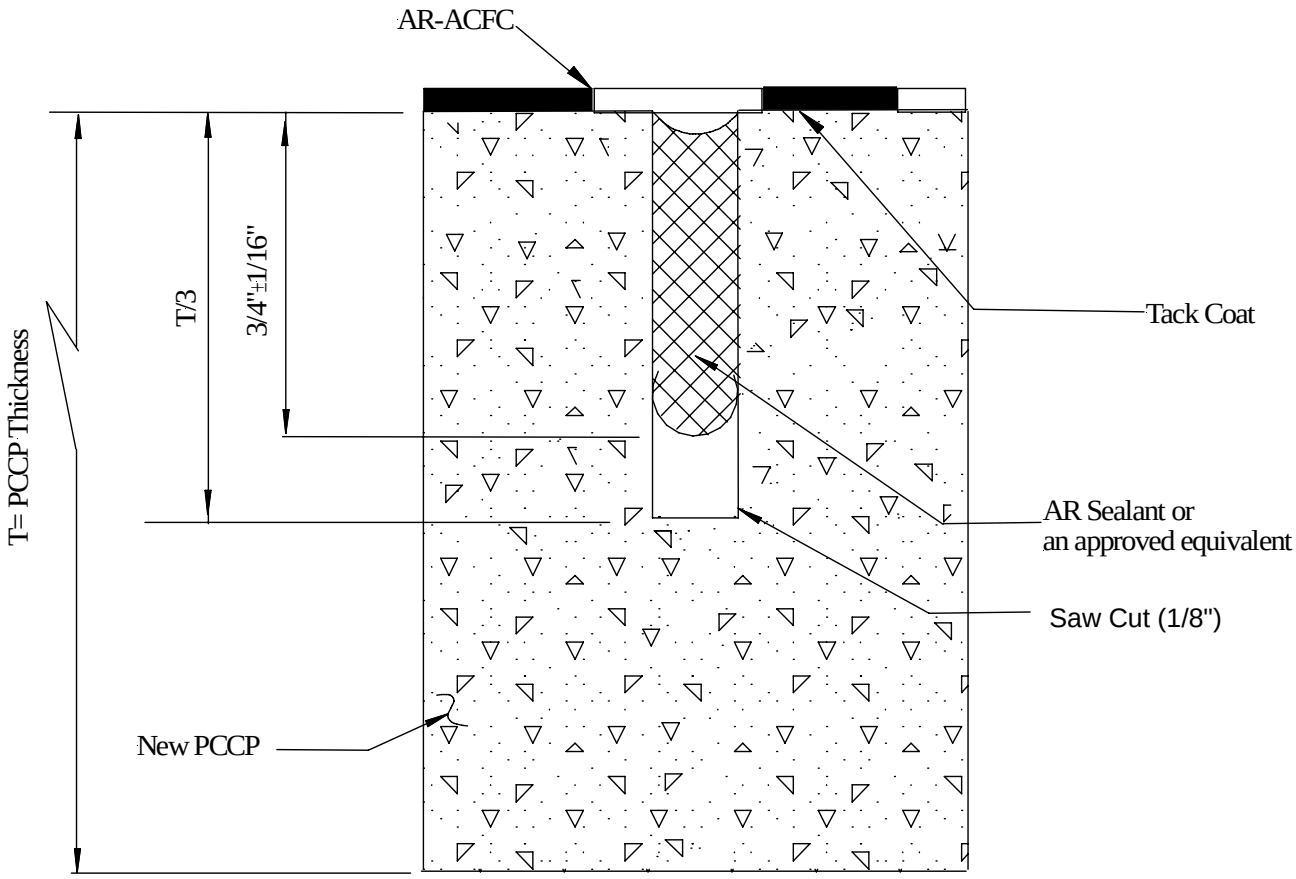
(NEW PCCP COVERED WITH AR-ACFC)

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



WEAKENED JOINT DETAIL

(NEW PCCP COVERED WITH AR-ACFC)

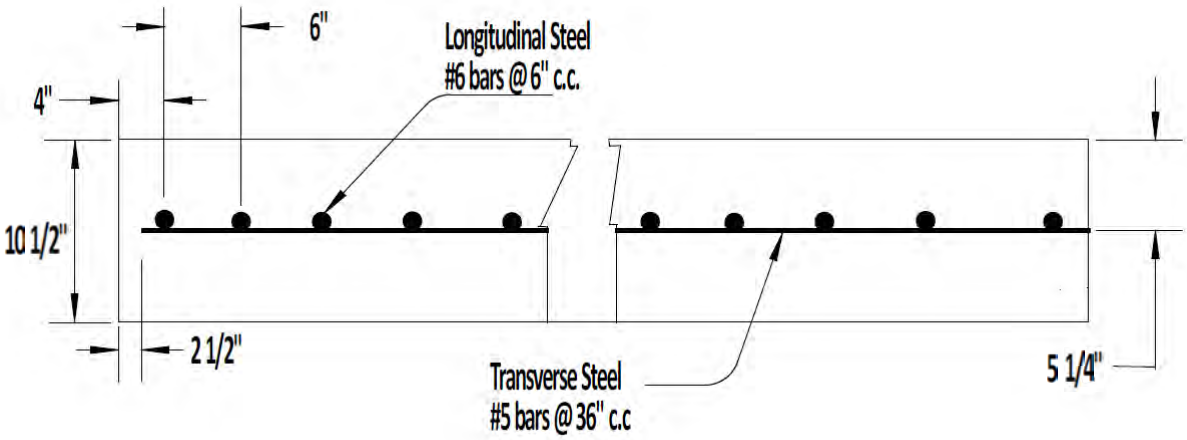
CRCP DETAILS

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



CRCP DETAIL

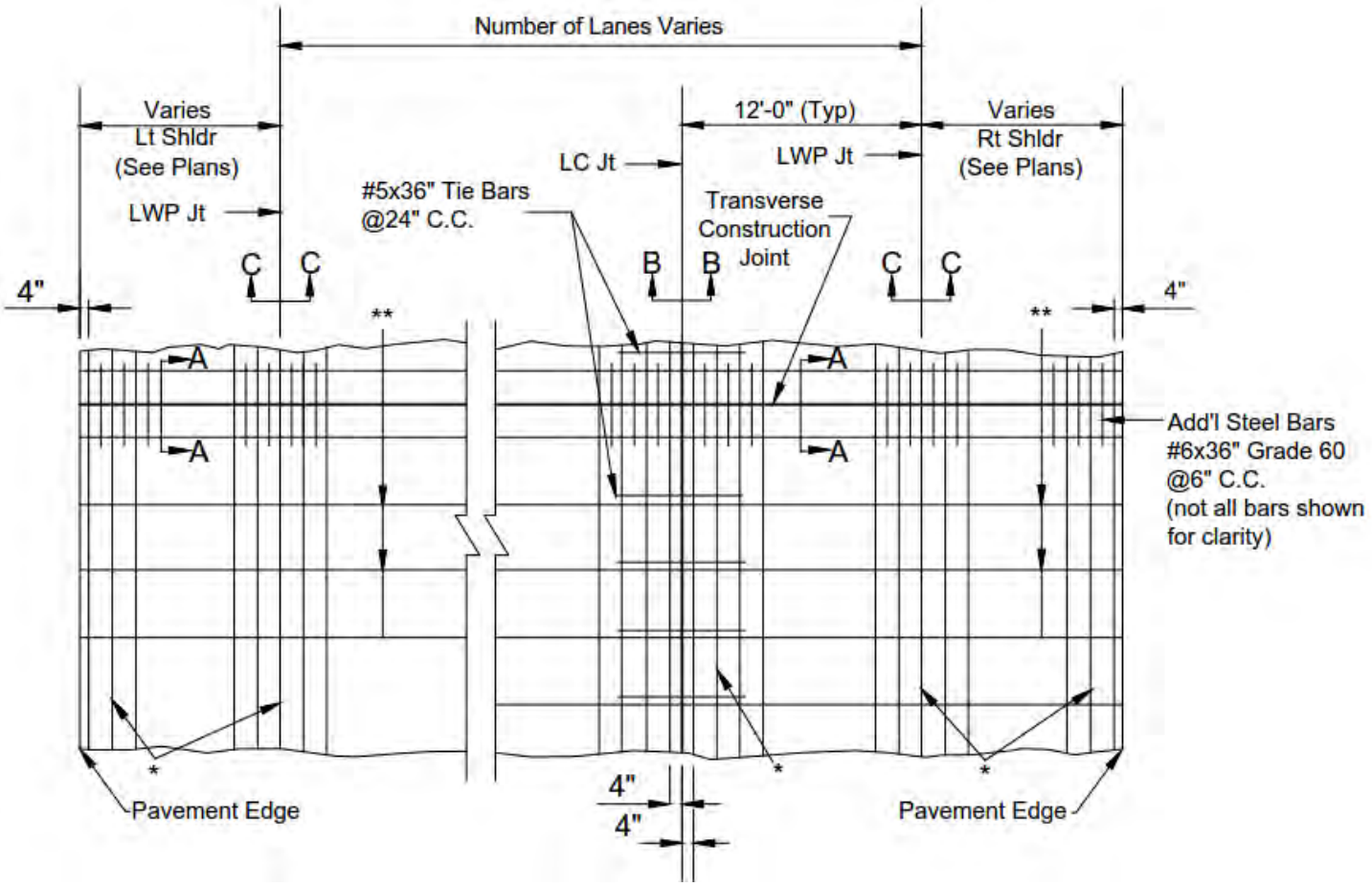
STEEL LAYOUT

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



CRCP DETAIL

CRCP STEEL REINFORCEMENT PLAN VIEW

SEE PLANS FOR STATIONS

* #6 LONGITUDINAL STEEL BARS @ 6" C.C. (TYP.) SEE DETAIL

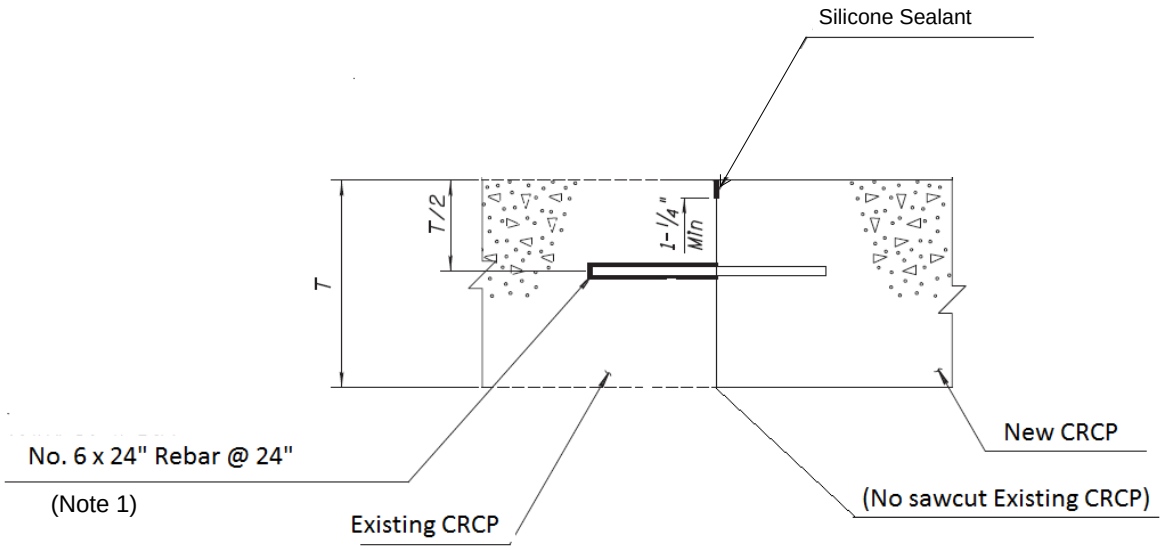
** #5 TRANSVERSE STEEL BARS @ **36"** C.C. (TYP.) SEE DETAIL

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



Note 1: The bars shall be anchored into the existing concrete with an approved high viscosity epoxy

CRCP DETAIL

LONGITUDINAL CONSTRUCTION JOINT

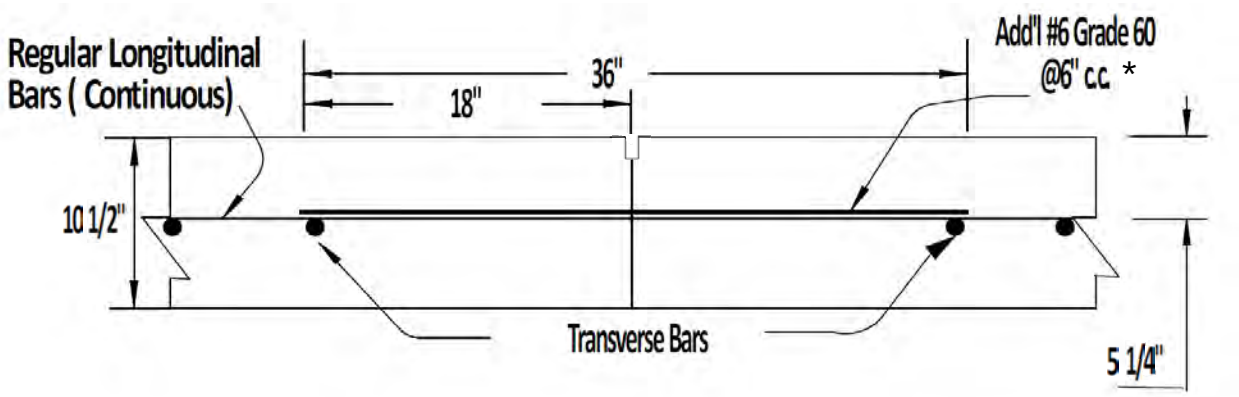
BETWEEN EXISTING CRCP AND NEW CRCP

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



CRCP DETAIL

*PLACED MIDWAY BETWEEN LONGITUDINAL BARS AND AT SAME DEPTH AS LONGITUDINAL BARS.

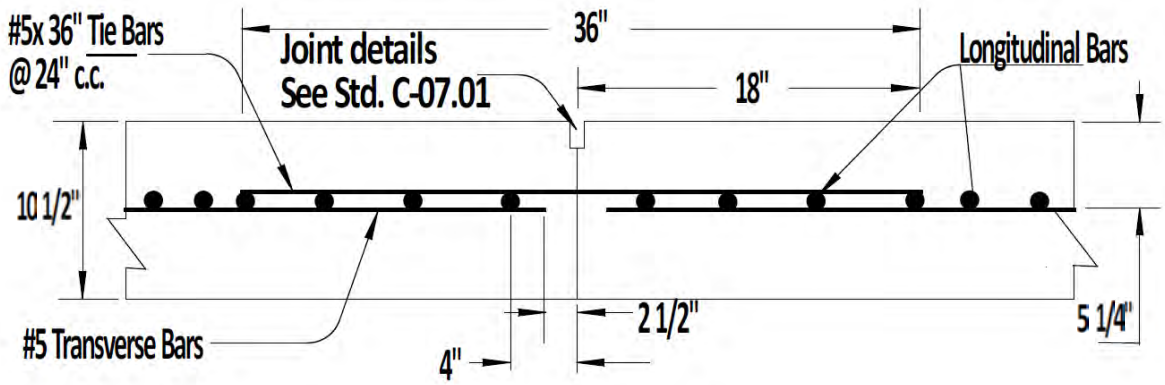
TRANSVERSE CONSTRUCTION JOINT
SECTION A-A

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



CRCP DETAIL

LONGITUDINAL CONSTRUCTION JOINT

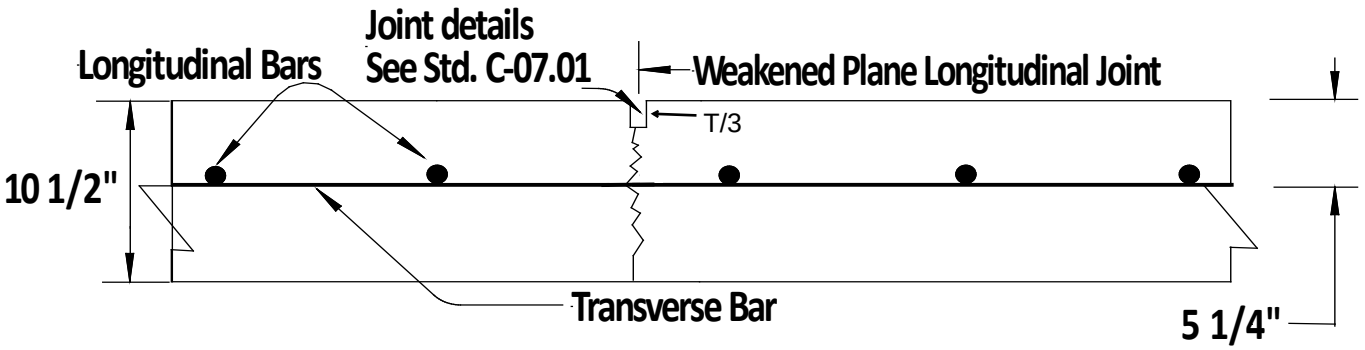
SECTION B-B

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



Note: Do not saw cut directly over longitudinal bars

CRCP DETAIL

WEAKENED PLANE LONGITUDINAL JOINT

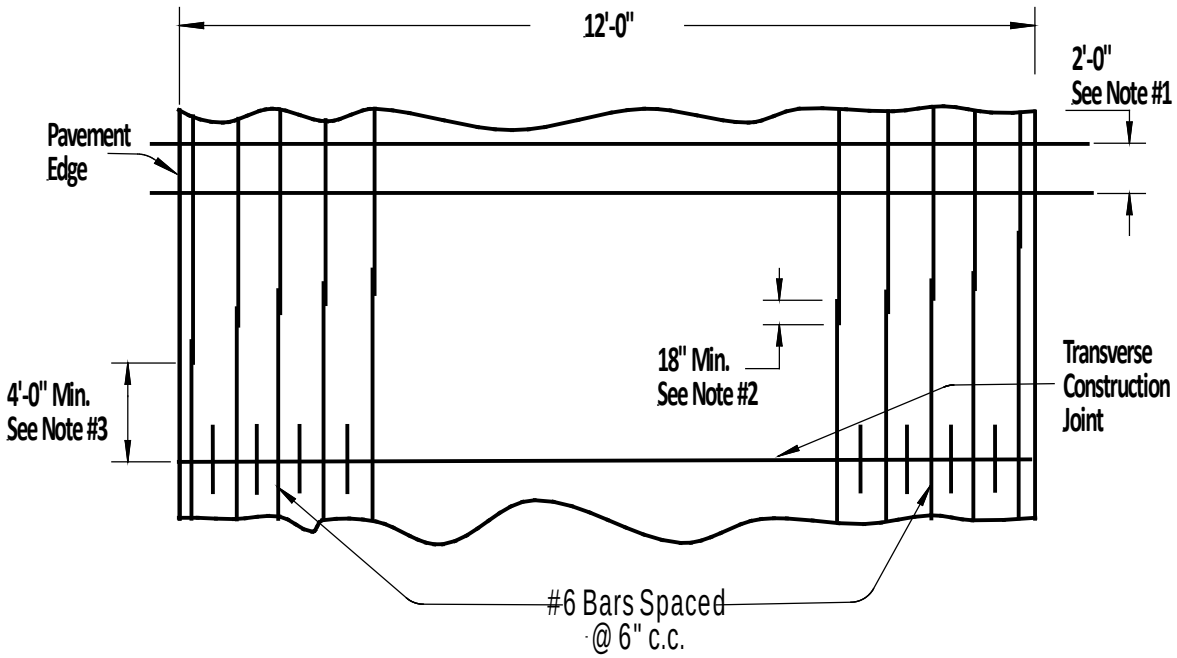
SECTION C-C

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



CRCP DETAIL

LONGITUDINAL STEEL SPLICE PATTERN

1. WITHIN ANY AREA BOUNDED BY 2'-0" OF PAVEMENT LENGTH MEASURED PARALLEL TO THE CENTERLINE AND 12' OF PAVEMENT WIDTH MEASURED PERPENDICULAR TO THE PAVEMENT CENTERLINE, NOT OVER 33% OF THE REGULAR LONGITUDINAL STEEL SHALL BE SPLICED.

2. SPLICES SHALL BE MINIMUM OF 24 TIMES THE NOMINAL DIAMETER OF THE BAR

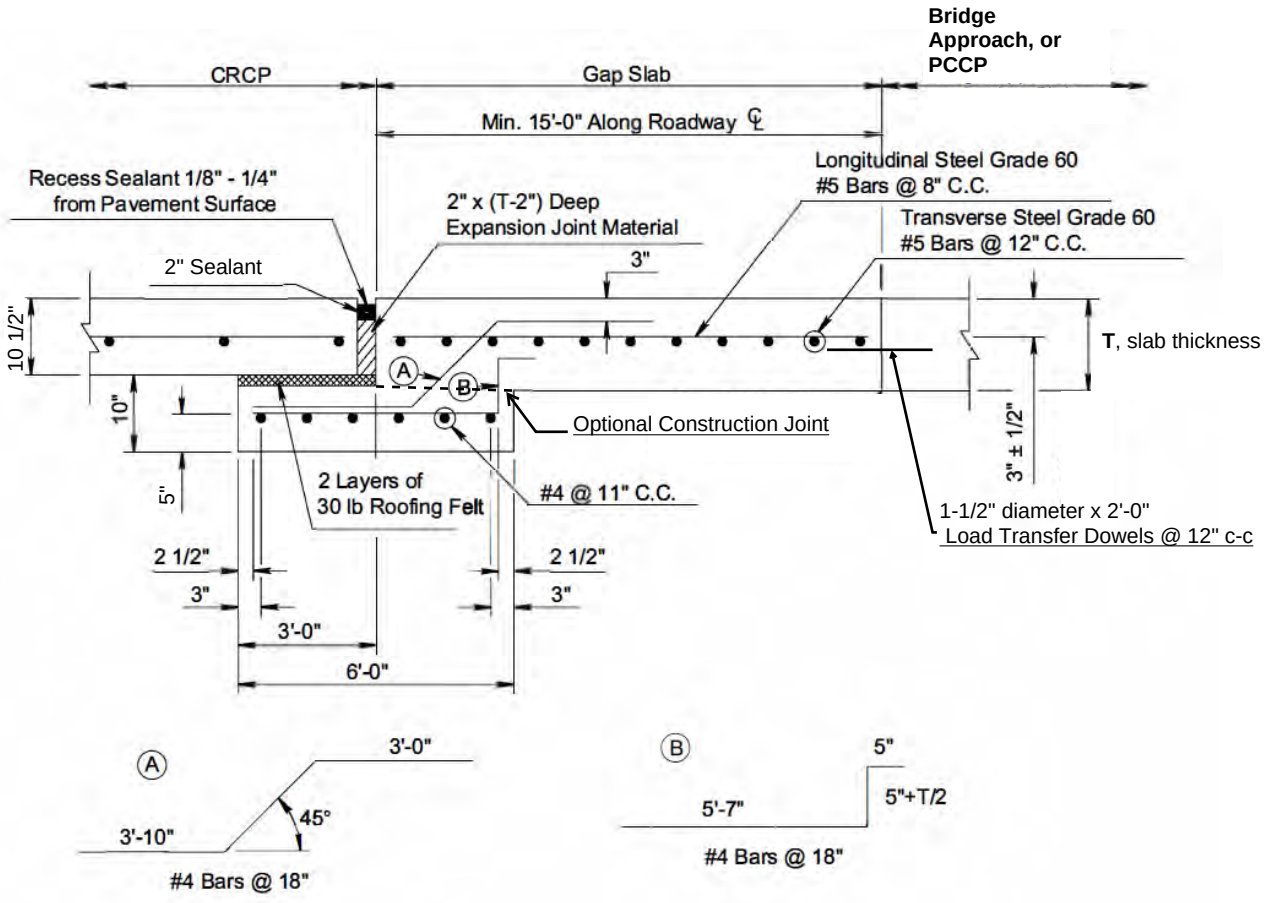
3. AT TRANSVERSE CONSTRUCTION JOINTS THE REGULAR LONGITUDINAL BARS SHALL EXTEND BEYOND THE JOINT SO THAT THE BAR SPLICES FOR THE REGULAR LONGITUDINAL BARS SHALL BE A MINIMUM OF 4'-0" FROM THE CONSTRUCTION JOINT. VIBRATION WITH HAND MANIPULATED MECHANICAL VIBRATORS WILL BE REQUIRED ADJACENT TO ALL TRANSVERSE CONSTRUCTION JOINTS.

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



EXPANSION JOINT DETAIL

GAP SLAB AT BRIDGE APPROACH OR PCCP

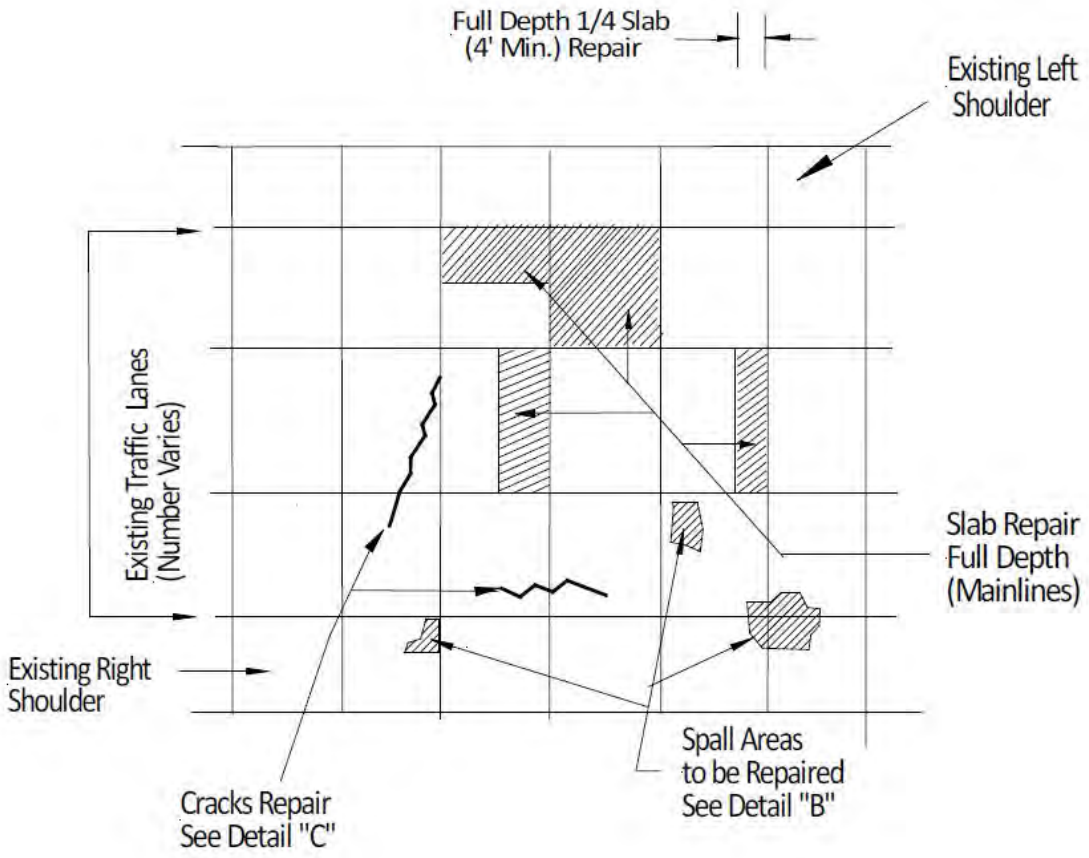
PCCP REPAIR DETAILS

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



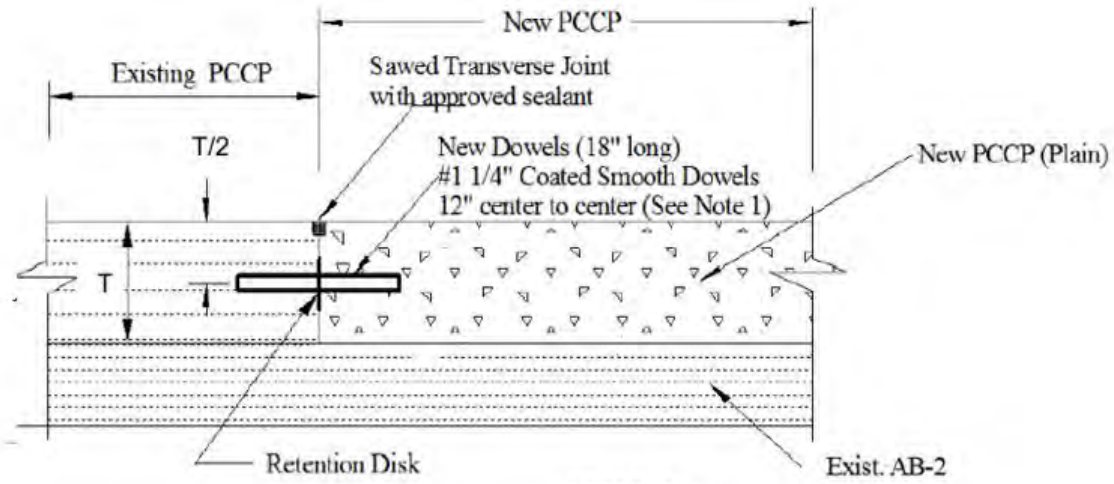
SCHEMATIC PLAN VIEW - PCCP REPAIR TYPES

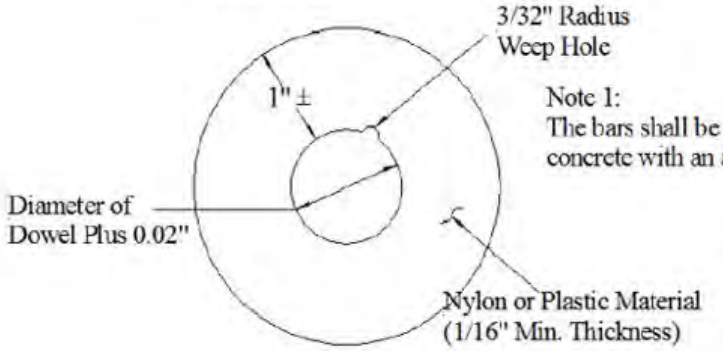
TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C





Note 1:
The bars shall be anchored into the existing concrete with an approved high viscosity epoxy

Note 2:
Immediately prior to concrete placement, the exposed half of the dowel bars shall be uniformly coated with a thin film of heavy waterproof grease

RETENTION DISK DETAILS

SLAB REPAIRS (FULL AND/OR PARTIAL)

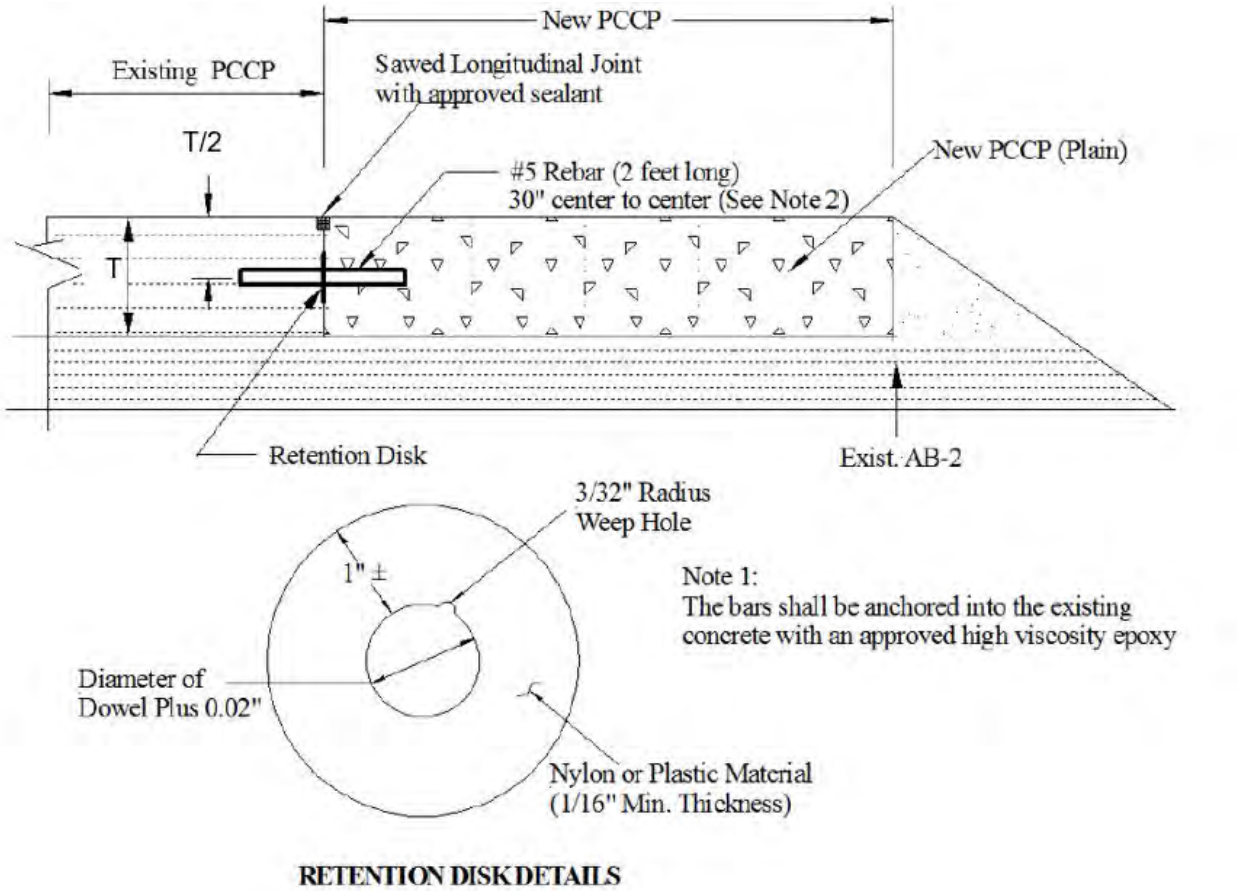
TRANSVERSE CONSTRUCTION JOINTS

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



RETENTION DISK DETAILS

Note 2: If the longitudinal joint is not located on a lane line or at the center of a lane, use #8 x 18" epoxy-coated smooth dowels at 18" center to center.

SLAB REPAIRS (FULL AND/OR PARTIAL)

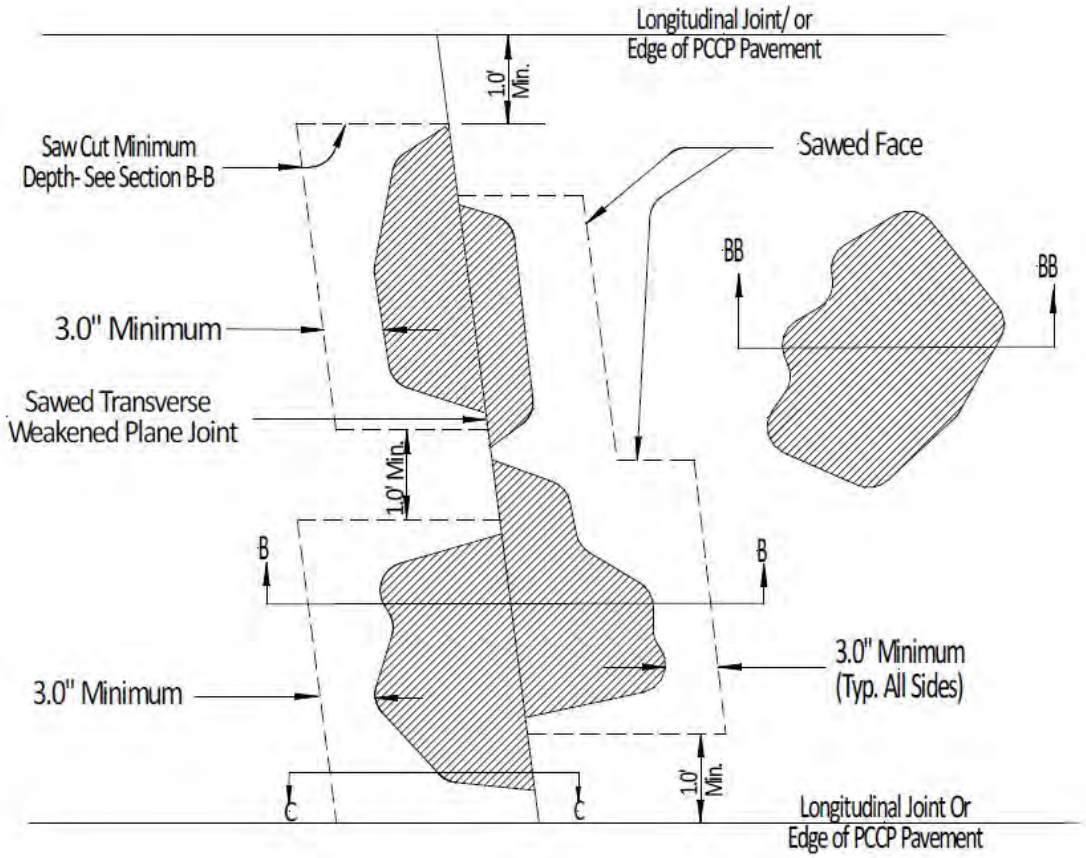
LONGITUDINAL JOINTS

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



SPALLS REPAIR

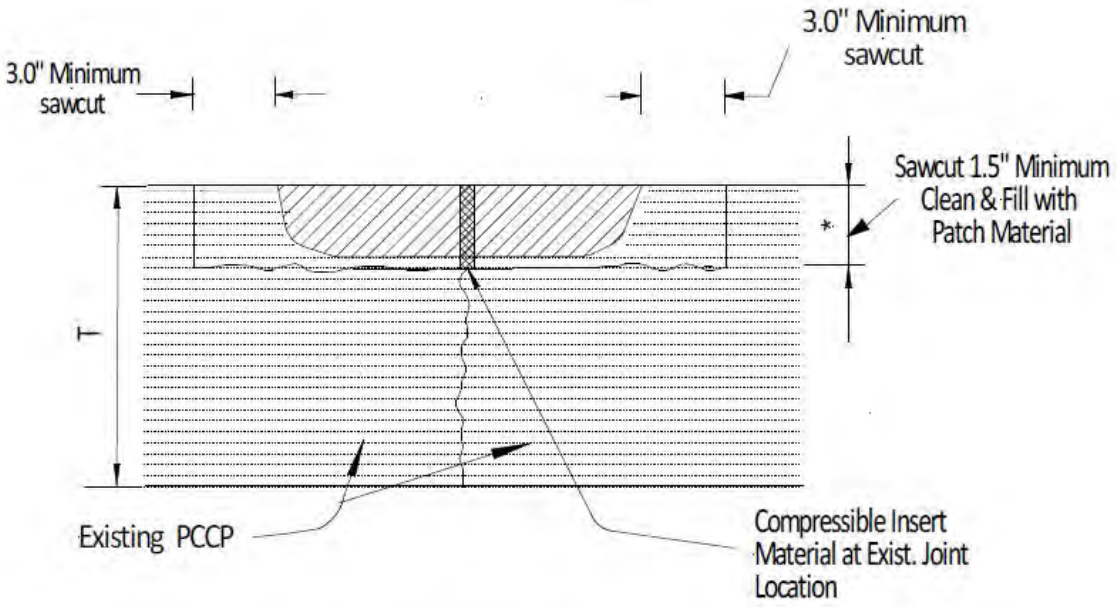
DETAIL B

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



* Maximum Depth cannot exceed T/2. If exceeds, remove Full Depth.

SPALLS REPAIR

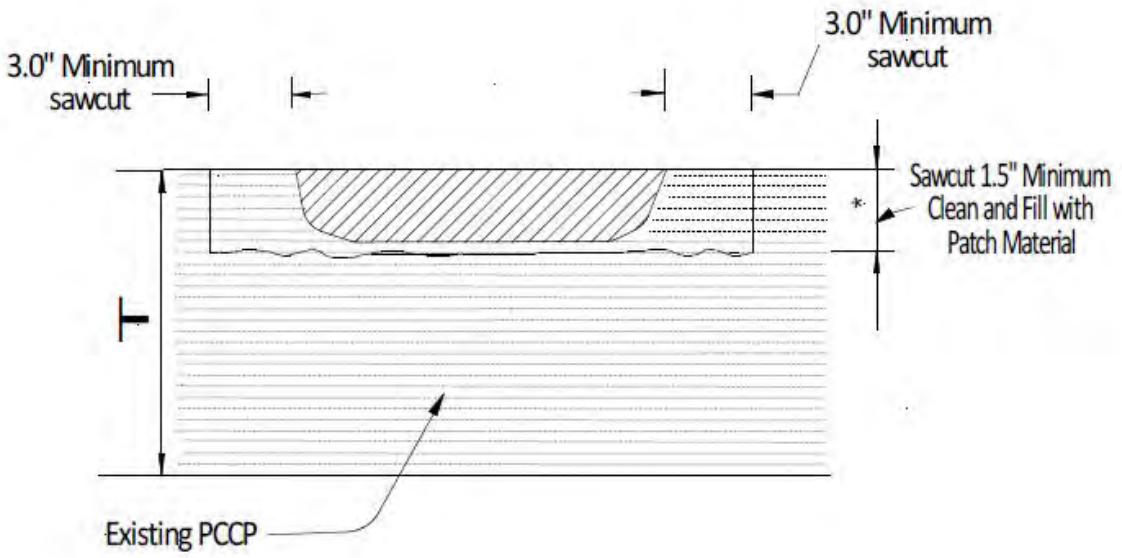
SECTION B-B

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



* Maximum Depth cannot exceed T/2. If exceeds, remove Full Depth.

SPALLS REPAIR

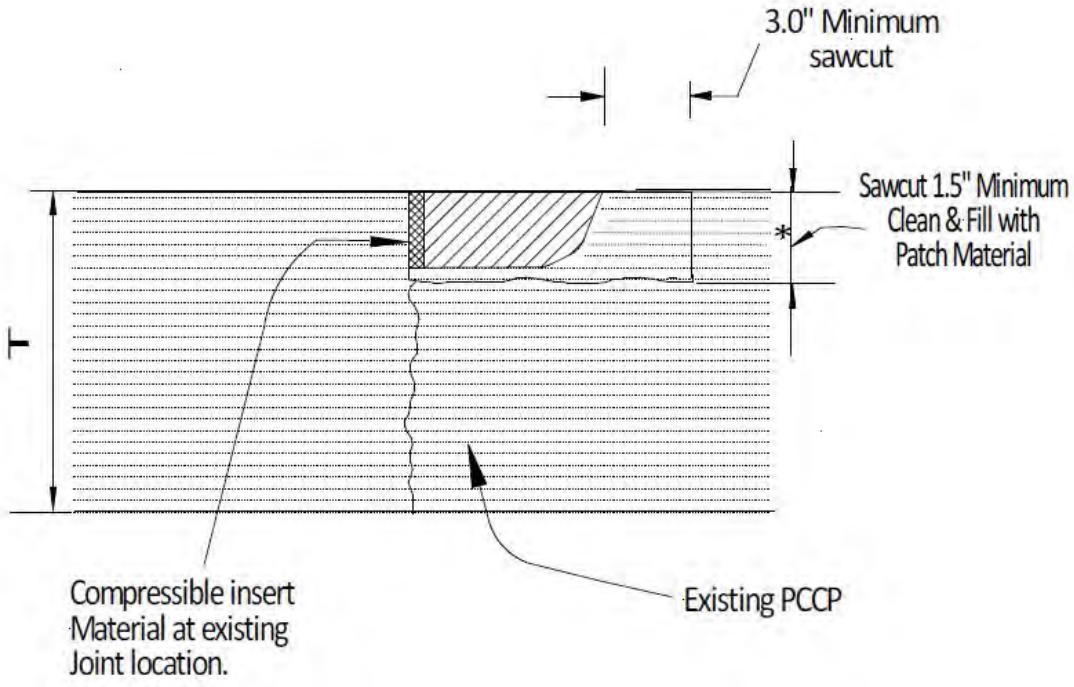
SECTION BB-BB

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C



* Maximum Depth cannot exceed T/2. If exceeds, remove Full Depth.

SPALLS REPAIR

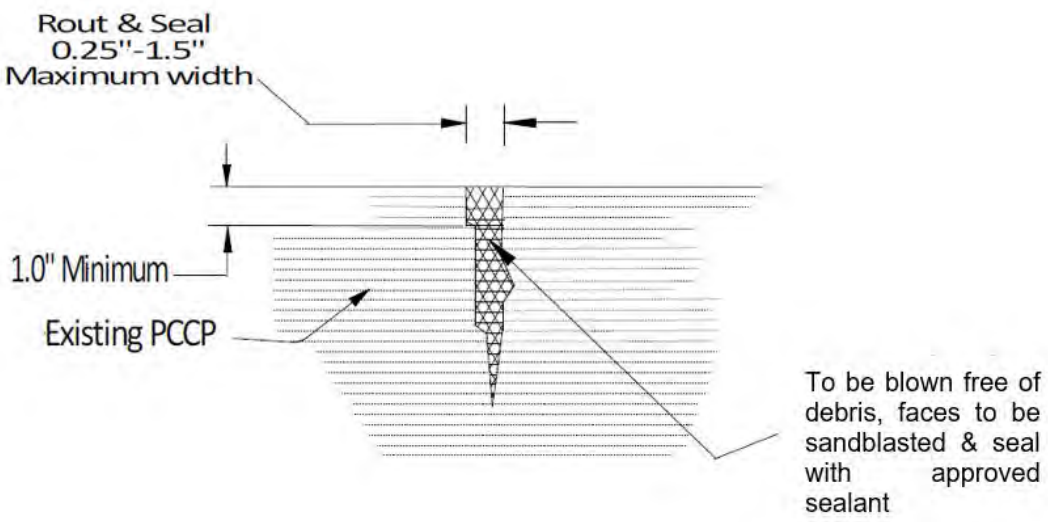
SECTION C-C

TYPICAL SECTION

I-10 BROADWAY CURVE, I-17 (SPLIT) TO

SR202 LOOP (SANTAN FREEWAY)

TRACS No. 010 MA 149 F 0072 01C

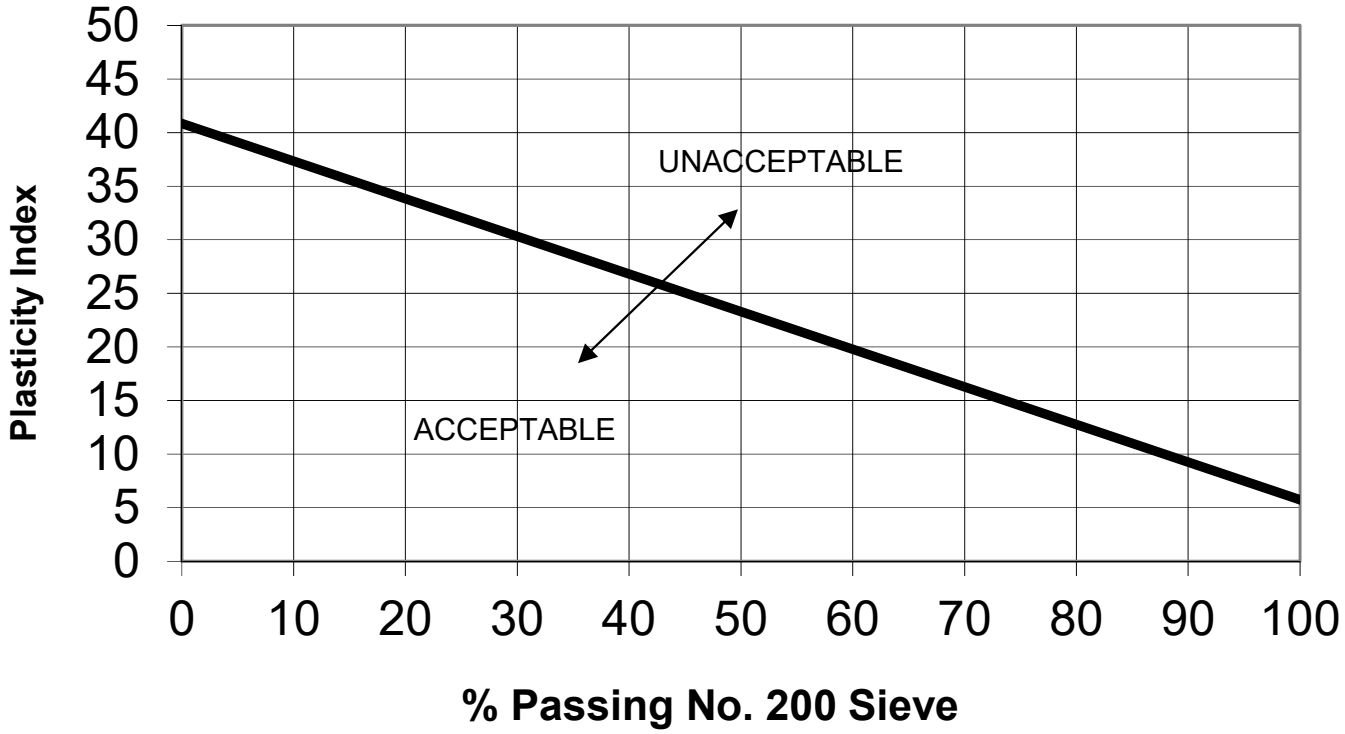


CRACK REPAIR

DETAIL C

SUBGRADE ACCEPTANCE CHART

I-10 BROADWAY CURVE, I-17 (SPLIT) TO
SR202 LOOP (SANTAN FREEWAY)
TRACS No. 010 MA 149 F 0072 01C



Subgrade Construction Control R-value:	20
Design R-value:	20

SECTION II - SUBGRADE, SUBBASES, AND BASES

ITEM 1 - SUBGRADE CONSTRUCTION CONTROL

The attached Subgrade Acceptance Chart shall be used during construction for determining whether subgrade materials are suitable as outlined in Section 203-3.03 (D) of the ADOT Construction Manual.

ITEM 2 - AGGREGATE BASE

The Aggregate Base may consist of one or both of the following:

1. The Aggregate Base shall be Class 2 and shall be as specified in Section 303 of the Standard Specifications.

2. The Aggregate Base shall be Class 2 and shall be as specified in Section 303 of the Standard Specifications, and Contracts and Specifications Stored Spec. “303SALV”.

ITEM 3 - SEPARATION GEOTEXTILE FABRIC

The separation geotextile fabric shall be as specified in Section 208 and 1014 of the Standard Specifications, and Contracts and Specifications Stored Spec. “1014FAB”.

The type of geotextile separation fabric to be used shall meet the requirements for a high survivability fabric.

The type of separation geotextile fabric shall be nonwoven.

ITEM 4 - GEOGRID BASE REINFORCEMENT

Geogrid base reinforcement shall be as specified in Section 306 of the Standard Specifications, and Contracts and Specifications Stored Spec. “306GEOBR”.

SECTION III - SURFACE TREATMENTS AND PAVEMENTS

ITEM 1 – PAVEMENT SMOOTHNESS (AC & AR-ACFC)

The final asphaltic concrete pavement surface shall be evaluated for smoothness as specified in Technical Provisions.

ITEM 2 - PORTLAND CEMENT CONCRETE PAVEMENT (PCCP) (Plain)

The work under this Item shall consist of furnishing all materials and constructing a Plain Jointed and Dowelled Portland Cement Concrete Pavement as specified in Section 401 of the Standard Specifications, and Contracts and Specifications Stored Specifications "401PCCP" and "1011JMAT”.

ITEM 3 - PORTLAND CEMENT CONCRETE PAVEMENT (PCCP) (Dowelled)

The work under this Item shall consist of furnishing all materials and constructing a Plain Jointed and Dowelled Portland Cement Concrete Pavement as specified in Section 401 of the Standard Specifications, and Contracts and Specifications Stored Specifications "401PCCP" and "1011JMAT”.

Load transfer dowel assemblies shall be placed at each transverse weakened plane joint on the mainline in the travel lanes. The transverse weakened plane joints shall be constructed according to construction standard drawings with the exception that the joints be placed perpendicular to the center line.

ITEM 4 - PORTLAND CEMENT CONCRETE PAVEMENT (CONTINUOUSLY REINFORCED (CRCP))

The work under this Item shall consist of furnishing all materials and constructing a Continuously Reinforced Portland Cement Concrete Pavement as specified in Section 401 of the Standard Specifications, and Contracts and Specifications Stored Specifications "401PCCP" and "1011JMAT".

ITEM 5 – LOAD TRANSFER DOWEL ASSEMBLY

The load transfer dowel assemblies shall be as specified in Contracts and Specifications Stored Spec. "401LTDA" and as detailed in Std. C-07.02.

The project engineer may permit the use of a mechanical dowel inserter in lieu of load transfer dowel assemblies, if in his opinion, the mechanical dowel inserter achieves no less tolerance than those achievable with dowel assemblies. Before the use of the mechanical dowel inserter is approved however, a plan to ensure the accurate placement of the transverse joints in relation to the location of the load transfer dowels shall be submitted to, and approved by both the project Engineer and the ADOT Materials Group.

The mechanical dowel inserter, if used, shall employ hydraulic hammers. Air driven hammers shall not be permitted.

If a mechanical dowel inserter is used, then the dowels and their placement shall be paid for at the same amount as the load transfer assembly.

ITEM 6 – FULL DEPTH SLAB REPAIRS (PCCP)

The work under this item shall consist of the removal and replacement of PCCP slabs or portions thereof as specified in Section 402 of the Standard Specifications with the following additions:

After the hole has been drilled, compressed air shall be used to clean and dry hole prior to dowel placement. The grout or epoxy shall be placed in the back of the dowel hole using a flexible tube or long nozzle that deposits the material to the rear of the dowel hole. The dowel shall be inserted into the hole with a slight twisting motion so that the materials in the back of the hole is forced up and around the dowel bar. A retention disk shall be slipped tightly over the dowel to prevent the anchoring material from flowing out of the hole. The retention disk shall be as details on the Project Plans.

The estimated quantity for full slabs and partial slabs that will require full depth removal and replacement will be determined in the field by the Engineer.

The existing PCCP is expected to vary between approximately 9 to 15.5 inches thick.

ITEM 7 – JOINT AND CRACK REPAIR (PCCP)

The work under this Item shall consist of renovating longitudinal and transverse joints in the existing Portland Cement Concrete Pavement and routing and sealing random cracks as specified in Section 402 of the Standard Specifications.

The random cracks to be renovated and sealed will be determined in the field by the Engineer.

ITEM 8 – SPALL REPAIRS (PCCP)

The work under this Item shall consist of repairing spalled areas of the existing PCCP as specified in Section 402 of the Standard Specifications.

The estimated quantity for spalled areas to be repaired will be determined in the field by the Engineer.

ITEM 9 - TACK COAT

The tack coat shall be as specified in Section 404 of the Standard Specifications, and Contracts and Specifications Stored Spec. "404BITUM".

ITEM 10 - ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL-SPECIAL MIX)

The asphaltic concrete shall be as specified in Section 409 of the Standard Specifications, and Contracts and Specifications Stored Spec. "409AGGR".

For estimating purposes the unit weight of the bituminous mix is 147 pounds per cubic foot.

The asphalt cement type shall be PG 76-16.

ITEM 11 - ASPHALTIC CONCRETE-END PRODUCT (3/4")

The asphaltic concrete shall be as specified in Sections 403 and 416 of the Standard Specifications, and Contracts and Specifications Stored Specs. "403ACHP" and "416ACES".

The effective voids shall be 5.5 ± 0.2%.

The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be a minimum of 0.8 to a maximum of 1.2.

For estimating purposes the unit weight of the bituminous mix is 147 pounds per cubic foot and the asphalt cement is 5.0%.

The asphalt cement type shall be PG 76-16.

ITEM 12 - ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT-RUBBER)

The asphaltic concrete friction course (asphalt-rubber) shall be as specified in Section 414 of the Standard Specifications, and Contracts and Specifications Stored Spec. "414ACFAR".

Quantities are estimated on a spread rate of 59 lbs per square yard which includes 25% for leveling to provide a minimum ½ inch thickness.

For estimating purposes the amount of asphalt-rubber is 9.7%.

The asphalt-rubber shall be CRA Type 1.

The average elevation of the roadway for this project is 1,230.

ITEM 13 - ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT-RUBBER) (Placed on PCCP)

The asphaltic concrete friction course (asphalt-rubber) shall be as specified in Section 414 of the Standard Specifications, and Contracts and Specifications Stored Spec. "414ACFAR," with the following exceptions:

414-7.04(A)(1) Placement Dates and Weather Requirements: is revised to read:

Asphaltic concrete shall be placed only between the dates of March 15th to May 31st, and September 1st to October 31st, and only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 85°F.

Overnight ambient temperatures shall be greater than 40°F on the day before placement and shall be forecast to be greater than 40°F on the day of and the day after placement of the asphaltic concrete.

No placement of asphaltic concrete shall occur if ambient temperatures exceed, or are forecast to exceed, 110°F the day before, the day of, or the day after paving.

No placement of asphaltic concrete shall occur if sustained wind velocities in excess of 15 MPH are forecast on the day of the scheduled placement. Placement of asphaltic concrete shall cease for the day if sustained wind velocities in excess of 15 MPH occur at the project. The Engineer may allow placement of asphaltic concrete during high wind conditions if the ambient temperature is 85°F and rising.

No asphaltic concrete placement shall occur if rain is forecast within three days of the scheduled placement of the asphaltic concrete.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

No traffic (including construction traffic, with the exception of required striping equipment) shall be allowed on the AR-ACFC overlay until at least 8 hours after the placement of AR-ACFC. The Engineer may reduce this time for materials placed on ramps and auxiliary lanes.

Prior to opening to any traffic, the Engineer may require up to three applications of lime water (a minimum of 50 pounds of lime per 2,000 gallons of water). Lime water shall be applied in a manner that uniformly covers the entire surface of the paving pass. No separate payment will be made for lime water or its application, the cost being considered as included in this contract item.

414-7.04(A)(2) Delivery to Screed Unit: is revised to read:

Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps, or migration of the asphalt-rubber.

Should any one or more of such conditions be evident in the material delivered to the screed unit, and which cannot be eliminated by one or more of the following methods, the Engineer will order the work to be stopped until conditions are conducive to the delivery of the material in the condition as hereinbefore required:

(a) Covering hauling units with tarpaulins.

Tarpaulins shall be made of a water-repellent material, be of sufficient strength to resist tearing, and be in good condition with no holes or tears. The tarpaulin shall be large enough to cover the top of the load and extend down over the sides of the truck at least 1 foot all around the truck bed to ensure that the mix is adequately protected from the elements. The tarpaulin shall have enough tie-down points so that it will be properly secured and will not flap in the wind during delivery of the mix from the plant to the paver. The method of tarping shall be approved by the Engineer.

(b) Dumping material directly into the paver.

(c) Moving the hot plant nearer to the point of delivery.

Other measures proposed by the contractor which will deliver asphaltic concrete meeting the above requirements will be considered by the Engineer.

Quantities on new PCCP are estimated on a spread rate of 100 lbs per square yard which includes 6.5% for leveling to provide a minimum 1 inch thickness.

Quantities on existing PCCP are estimated on a spread rate of 118 lbs per square yard which includes 25% for leveling to provide a minimum 1 inch thickness.

For estimating purposes the amount of asphalt-rubber is 9.7%.

The asphalt-rubber shall be CRA Type 1.

The average elevation of the roadway for this project is 1,230 feet.

ITEM 14 - ASPHALTIC CONCRETE – MISCELLANEOUS STRUCTURAL (BASE MIX) (Under PCCP)

The asphaltic concrete shall be as specified in Section 409 of the Standard Specifications, and Contracts and Specifications Stored Spec. "409ACMS".

For estimating purposes, the unit weight of the bituminous mix is 147 pounds per cubic foot.

The asphalt cement type shall be PG64-16.

ITEM 15 – CONVENTIONAL DIAMOND GRINDING

Scope

This standard specifies the procedures for operations of continuous diamond grinding Portland cement concrete or asphalt concrete pavement and roadway surfaces to provide desired surface characteristics such as ride, friction and drainage. This standard does not apply to corrective bump grinding. The standard also provides guidelines for levels of acceptance for the desired surface characteristics. The user of this standard shall be responsible to ensure that all local safety, health and environmental standards are made a part of the project specification.

Conventional diamond grinding is also utilized to reduce the noise created by the interaction of the tire with the pavement surface in areas of low to moderate noise concern. The profile requirements stated elsewhere in this specification may not apply to grinding solely for noise abatement.

Equipment

Grinding shall be performed using diamond blades mounted on a self-propelled machine designed for grinding and texturing pavement. The grinding equipment shall be at a minimum 35,000 pounds including the grinding head, and of a size that will grind a strip at least 3 feet wide. The effective wheel base of the machine shall be no less than 12 feet. The effective wheel base is defined as the distance from the front wheel assembly transverse pivot point to the transverse pivot point of the profile/depth control/ ground drive wheels.

The equipment shall have a positive means of vacuuming the grinding residue from the pavement surface, leaving the surface in a clean, near-dry condition.

Grinding equipment that causes raveling, aggregate fractures or disturbance to the joints shall not be permitted.

The equipment shall be maintained to ensure it is in proper working order, with attention paid to the "roundness" of the match and depth control wheels. Any wheels found to be out of round shall be immediately replaced.

Construction

The construction operation shall be scheduled and proceed in a manner that produces a neat, uniform finished surface. Shoulder, auxiliary or ramp lane grinding shall transition from the edge of the mainline as required to provide drainage leaving no more than a 3/16-inch ridge and an acceptable riding surface. Full- and partial-depth concrete repairs, slab stabilization and dowel bar retrofit shall be completed prior to any grinding. Joint sealing shall be completed subsequent to the diamond grinding operations.

Grinding shall be accomplished in a manner that eliminates joint or crack faults so there is no more than a 1/16-inch differential between the adjacent sides of the joints and cracks. Grinding shall also substantially remove pavement conditions such as warp and curl to provide an acceptable ride.

Lateral drainage shall be achieved by maintaining a constant cross slope between grinding extremities in each lane. The finished cross slope shall mirror the pregrind cross slope and shall have no depressions or misalignment of slope greater than 1/4-inch in 12 feet when measured with a 12-foot straightedge placed perpendicular to the centerline. Steps will be taken to ensure that wheel path rutting is substantially removed and that the grinding operation is simply not texturing the wheel path depressions. Areas of deviation shall be reground. Straightedge requirements will not apply across longitudinal joints or outside the ground area.

Grinding shall begin and end at lines normal to the pavement centerline at the project limits. Passes of the grinding head shall not overlap more than 1-inch. No unground surface area between passes will be permitted.

Smoothness Requirements

An initial smoothness index of representative portions of the project may be available through the project contact person upon written request. When available, this information represents the conditions that existed at the time the survey was made. The contractor is cautioned to note the date the survey was made since the conditions may have changed over time. This profile is for informational purposes only, to give the contractor an idea of the conditions that existed at the time of the survey. The contractor assumes the risk of error if the information is used for any purpose other than as stated. Contractors are responsible for visiting the project site to make their own condition determination prior to bidding.

Prior to performing any grinding work, the contractor shall provide a control profile developed using an inertial profiler with a laser that simulates the tire footprint. Single point lasers shall not be used. Line laser equipment such as RoLineTM, GocatorTM or an approved equal shall be used. All equipment shall have current certification and be approved by the contracting authority.

The control profile will be used to identify the required smoothness for the project as indicated in Table 1. The control profile will be obtained after any and all corrective work which impacts the pavement roughness such as slab repairs, DBR, pothole repair, etc. The profile will be obtained in 0.1 lane mile long segments (528 feet), and the location of each segment accurately established, either through stationing or GPS coordinates.

The finished surface shall have a final MRI improvement in accordance with Table 1 and grinding will not be considered acceptable until the smoothness requirements are achieved. It is important that the segment locations from the control profile match the segment locations tested in the smoothness acceptance measurements.

Table 1 Smoothness Requirement

Posted Speed Limit (mph)	<45		≥45	
Existing Segment MRI	≤330	>330	≤185	>185
Required Posted Grind MRI	≤115	≤0.35* (Existing Segment MRI)	≤65	≤0.35* (Existing Segment MRI)

Depressed pavement areas due to subsidence or other localized causes will be excluded from the smoothness requirements. These areas shall be reviewed and approved by the engineer.

The contractor shall measure profiles in both wheel paths and average the resulting IRI to determine acceptance (i.e. MRI). The profiles shall be measured 3 feet from each lane line. A guide shall be used to ensure proper alignment of the profile. The engineer shall have a representative with the inertial profiler during all testing periods. This representative shall sign the resulting profile form.

The engineer shall conduct comparison profiles on no less than 10 percent of the segments using the same type of certified equipment as the contractor. When light weight profilers are used, it is of great importance that a proper guide is used to ensure that all testing is completed over the same track. The contractor and agency testing should be completed during the same time of day and under similar climatic conditions. The results of these verification profiles shall not vary more than 10 percent from the contractor profiles.

The engineer may choose to accept isolated sections if the variance between the two profiles is less than 15 percent. When the difference exceeds 15 percent on an isolated basis or 10 percent on a consistent basis, referee testing will be required to determine which device is providing an accurate evaluation of the pavement surface. The party found to have the inaccurate equipment will pay for the referee testing. The engineer may choose to withhold payment for segments that do not meet these criteria until the problem is resolved. The engineer may choose to obtain verification profiles on the entire project if the comparison profiles are constantly outside the allowable tolerance. The engineer will charge for the additional testing if the contractor's operation is found to be in error. Segments found not meeting the smoothness requirements will require regrinding at no additional cost to the department.

For roadways with posted speeds less than 45 mph, the finished ground surface shall not include any bumps exceeding 0.3-inch in 25 feet. For roadways with posted speeds of 45 mph or more, the localized roughness (IRI) will be less than or equal to 125 inches per mile, when determined using the ProVAL Assurance Module with a 25 ft baseline.

Method of Measurement

Grinding will be measured by the square yard of area diamond ground. The measurement will be the final textured surface area regardless of the number of passes required to achieve acceptable results. Minor areas of unground pavement within the designated areas to be ground will be included in the measurement. The minimum length of feather pass will be 100 feet. Areas which were not designated to be diamond ground will not be measured for smoothness.

SECTION IV - MATERIALS SOURCES - GEOTECHNICAL ANALYSIS

The information about this Section will be supplemented by the Geotechnical Report prepared by the Developer.

ITEM 1 - BORROW REQUIREMENTS (Contractor-Furnished Source)

There is no Department-Furnished source for borrow on this project. Borrow shall be as specified in Section 203-9 of the Standard Specifications. Borrow placed within three (3) feet of finished subgrade shall meet the following requirements:

The Plasticity Index (PI) (AASHTO T90) and the percent passing the No. 200 Sieve (Minus 200) (Ariz. Test Method 201) when used in the equation below, shall give a value of X that does not exceed 116.5.

$$X = (\text{Minus } 200) + [2.83\ (PI)]$$

ITEM 2 - MATERIAL SOURCES

Materials sources shall be as specified in Contracts and Specifications Section Stored Specifications "1001MATL" and "104ENVIR".

SECTION V - MISCELLANEOUS

ITEM 1 - BITUMINOUS PAVEMENT REMOVAL BY MILLING (WHEN AN ASPHALTIC CONCRETE FRICTION COURSE IS NOT TO BE PLACED ON THE MILLED SURFACE)

The work under this Item consists of removing the existing bituminous pavement as specified in Section 202-3.03 (C) of the Standard Specifications, with the following exceptions:

202-3.03(C) Bituminous Pavement Removal By Milling: The title of the Standard Specification is revised to read and the text is modified to add:

202-3.03 (C) Bituminous Pavement Removal By Milling (When an Asphaltic Concrete Friction Course is not to be Placed on the Milled Surface):

If during the milling operation, the contractor breaks through the asphaltic concrete (AC) layer into the base/sub-base material, the disturbed base/sub-base material shall be re-shaped, re-graded and re-compacted at the direction and to the satisfaction of the Engineer prior to the placement of the new AC. After the milling operation, any unstable remaining bituminous material shall be completely removed and replaced with an adequate thickness of AC to achieve the final total thickness of AC, but not less than the existing thickness of bituminous material. Grading, compaction and removals will be reimbursed under sub-section 109.04 (D) of the Standard Specifications.

ITEM 2 - BITUMINOUS PAVEMENT REMOVAL BY MILLING (WHEN AN ASPHALTIC CONCRETE FRICTION COURSE IS TO BE PLACED ON THE MILLED SURFACE)

The work under this Item consists of removing the existing bituminous pavement as specified in Section 202-3.03 of the Standard Specifications, with the following exception:

202-3.03(D) Bituminous Pavement Removal By Milling (When an Asphaltic Concrete Friction Course is to be Placed on the Milled Surface): is hereby added to the Standard Specifications:

Existing asphaltic concrete shall be removed by milling in accordance with the details shown on the project plans and as specified herein. The milling equipment shall be specifically designed to remove material to a controlled line and grade by means of grinding or chipping. The equipment used shall be capable of removing the existing asphaltic concrete uniformly throughout the milled area at the required cross-slope and within 1/8 inch of the specified removal depth. The specified removal depth of the existing bituminous pavement shall be 1 inch. The removal shall be accomplished in a manner which does not destroy the integrity of any pavement that remains. During production milling, the contractor shall verify the actual depth of milling required to remove the AR-ACFC to the desired underlying pavement surface. If it is determined that the required milling depth is greater than the specified milling depth, the additional material shall be completely removed to the underlying pavement surface, as approved by the Engineer, at no additional cost to the Department. The milled material shall be removed and disposed of as specified by the Department.

The milled surface shall have a maximum mean macrotexture depth of 4.50 millimeters, as determined in accordance with Arizona Test Method 742 – Mean Macrotexture Depth of Milled Pavement.

At the start of the milling operation, the contractor shall mill a 500-foot test section. The milled surface of the test section shall be evaluated by the Engineer for compliance with the maximum mean macrotexture depth requirement. If the milled surface is in compliance with the macrotexture requirement, the contractor may begin production milling. If the milled surface is not in compliance with the macrotexture requirement, the contractor shall make adjustments to the milling operation and then mill another test section.

During production milling, the mean macrotexture depth shall be determined at a minimum frequency of one test per one-half mile per lane. If, at any time, during the milling operation the Engineer determines that the macrotexture requirement is not being achieved, the contractor shall stop milling. Milling shall not resume until the Engineer is satisfied that the macrotexture requirement can be met or until successful completion of another test section. The forward speed of the milling machine during production milling shall not exceed the speed used for the test section. The forward speed of the milling machine shall be checked throughout each production day, or at the discretion of the engineer.

The profile of the milled surface, in both the longitudinal and transverse directions, shall not vary by more than 1/8 inch over a distance of ten feet.

Under no circumstances shall the removal of existing asphaltic concrete begin until the mix design for replacement asphaltic concrete has been approved by the Engineer.

The extent of removal of existing asphaltic concrete must be in keeping with the contractor's ability to produce, haul, place and compact replacement asphaltic concrete so that at all times the length of milled surface is at a minimum. If the contractor's production of replacement asphaltic concrete is stopped for any reason, the removal of asphaltic concrete shall either cease or shall be reduced. The Engineer will be the sole judge as to whether the removal shall cease or be reduced. The Engineer's decision will be based on the reason for the stoppage in asphaltic concrete production, the expected length of the stoppage, the type and depth of the material being removed, and the time of day.

Asphaltic concrete shall be placed as soon as possible after the milling. The surface on which the material is to be placed shall be uniform and free of loose material.

The length of milled surface at any time shall not exceed two miles, or one-half the length of the work, whichever is less. Asphaltic concrete shall be placed on the milled surface before the end of each day's work. The lane shall be opened to traffic at the end of each day's work.

In the event of circumstances beyond the control of the contractor, such as equipment breakdown, or if the production of the replacement asphaltic concrete has been stopped by the Engineer and the contractor is unable to comply with the requirements in the preceding paragraph, the contractor shall provide and maintain such traffic control devices that the Engineer deems necessary under the circumstances in order to provide safe and efficient passage through the work zone.

If the Engineer deems it to be warranted, the Engineer will require that the contractor provide for the surface drainage of areas where the pavement surface has temporarily been removed.

Pavement, to be removed by milling, adjacent manholes, valve boxes, small radius curbs and other fixed objects that produce confined areas shall be removed with milling equipment specifically designed to operate in restricted areas and capable of removing asphaltic concrete of the specified thickness without damage or displacement of the adjacent object. At the discretion of the Engineer, such areas may be excluded from macrotexture testing.

On projects with existing curb and gutter, any asphaltic concrete buildup in the gutter designated to be removed, shall be removed prior to the pavement removal operation by equipment and methods approved by the Engineer. The equipment and methods used shall be capable of removing the asphaltic concrete buildup without causing damage to the curb and gutter.

ITEM 3 - DISPOSAL OF EXISTING ASPHALTIC CONCRETE

Upon removal, disposal of the existing asphaltic concrete shall be the responsibility of the contractor.

ITEM 4 – TEMPORARY CONNECTIONS AND DETORS

The temporary surfacing section will be reflected in the Developer's Final Report and will be determined based on the length of service expected.

TP Attachment 400-2 – City of Phoenix Technical Provision Stipulation for Pavement Design

City of Phoenix Technical Provision Stipulation for Pavement Design

1.1 Pavement Design

1.1.1 General Information

This section describes references for procedures to be used in the design of the structural section of flexible pavements which are to be constructed in Phoenix's public rights-of-way.

1.1.2 Definitions

1. "Structural section" means the combination of an asphalt concrete surface course and a base course of either rock aggregate materials or asphalt concrete.

2. "Subgrade" means native soil or fill material over which the structural section is to be placed.

3. "Asphalt concrete course" means the total depth of asphalt concrete which may be placed in one or more layers. The upper layer is called asphalt concrete surface course (ACSC) and the lower layer is called asphalt concrete base course (ACBC). The minimum thickness of any individual lift shall be as specified in MAG section 710, the maximum thickness of any individual lift of pavement will not be greater than 3-inches, unless approved by the City Engineer.

4. "Rock aggregate base material" means the total depth of rock aggregate material which may be placed in one or two layers. If one layer is placed, it will be "Aggregate Base Course" (ABC) in accordance with Table 702 of the MAG Specifications. If two layers are placed, the top four inches must be ABC and the bottom layer may be ABC or "Select material" in accordance with Table 702 of the MAG Specifications. For the sake of brevity, the rock aggregate base material is called the "base course" in this manual.

1.1.3 Geotechnical Investigation Requirements

General procedures for geotechnical investigation are provided in the City of Phoenix Street Transportation Department Design and Construction Management Division, Administrative Procedure (AP) No. 155, Project Development Requirements and Guidelines, February 2012.

A geotechnical investigation shall be performed for all projects that will include roadways; major structures in the right- of-way, such as bridges or box culverts; or underground facility design, including storm drain, water, and sewer. Additional borings shall be taken to clearly define limits of anomalous conditions including but not limited to poor soil conditions, hard rock if encountered, etc.

In addition to soil borings, most projects that will have significant underground work will also require seismic refraction surveys to provide understanding of subsurface soil conditions.

City of Phoenix Street Transportation Department, Materials Section will review the Consultant's

or Developer's geotechnical report and recommended pavement structural section(s) for the new pavement.

If applicable, the Consultant's or Developer's geotechnical report shall include the proposed measures to mitigate anomalous soil conditions.

1.1.4 Design Parameters

Resilient modulus (MR)

MR can be determined by any of the following methods,

A. From relationships proposed by AASHTO, MR=1000+555*R-value (for R-value<20) or MR (psi) = 2555 (CBR $)^{0.64}$)

B. From back-calculation of surface deflections measured using non-destructive devices such as Dynaflect or Falling Weight Deflectometer (FWD)

C. From laboratory test on representative sample using AASHTO T274 procedure

D. From ADOT procedure using actual and correlated R-values.

Consultant or Developer needs to verify with the City of Phoenix Engineer, the method they want to use to select the MR prior to moving forward with design to make sure City is on board.

Reliability

Arterials Reliability=95%

Collectors Reliability=90-95%

Local Streets Reliability=80%

Overall Standard Deviation(s)

Arterials s=0.4

Collectors and local streets s=0.45

Serviceability

Initial serviceability Po=5.0

Terminal serviceability Pt=2.5

Change in serviceability index PSI=2.5

Regional Factor

This factor is used to adjust the Structural Number for climatic and environmental conditions different from those of the AASHTO road test site. The Regional Factor to be used for Phoenix is 1.0.

Projected Traffic Loading

The Projected Traffic Loading is based on the cumulative expected 18-kip single axle load (ESAL) during the analysis period, which is a minimum of 20-years. The information is typically obtained from project specific traffic studies or geotechnical design reports.

1.1.5 Design Procedure

Pavement thickness designs shall be determined using the AASHTO Guide for Design of Pavement Structures 1993 version (1993 AASHTO Guide) except as modified herein. The minimum thickness of asphalt concrete shall be calculated using the Layered Design Analysis presented in section 3.1.5 of the 1993 AASHTO Guide. The analysis shall be provided as an appendix in the geotechnical report.

The geotechnical report shall address and provide roadway subgrade mitigation measures for conditions including but not limited to the following:

- Moderate to high plasticity and/or expansive (swelling) soils
- Non-granular soils with % fines >35% and Plasticity Index >10
- Collapsible soils
- Otherwise poor subgrade soils

1. Structural Coefficients

Design structural number (SN) can be converted to thickness of various flexible pavement layers by using structural layer coefficients. In the absence of specific values, the following structural coefficients are recommended (Table 4.1):

Table 4.1
Structural Coefficients

Material	Structural Coefficient
Asphaltic concrete	0.39
Aggregate base	0.12
Select material	0.11
Cement treated base	0.27
Bituminous Treated Base	0.31

2. Minimum Pavement Thickness

For the City's streets, the following are provided as the minimum allowable thicknesses for asphaltic concrete and base materials or full-depth sections on prepared subgrade (Table 4.2). Minimum pavement thickness only applies after a 20- year pavement design is conducted and

the resulting design pavement thickness is less than the required minimum values in table 4.2. If the resulting pavement design is thicker than the minimum, then the design thickness applies.

Table 4.2
Minimum Pavement Thickness

Street Type	Option 1		Option 2
	AC	ABC	Full-Depth AC on Prepared Subgrade
All Arterial Classifications	6”	8”	9”
All Collector Classifications*	5”	8”	8”
Local & Cul-de Sacs	3”	6”	5”
*Also applies to local commercial/industrial streets			

Base materials may not be required for full depth asphaltic concrete design. However, if base materials are required, then the minimum thickness will be (Table 4.3):

Table 4.3
Minimum Pavement Thickness for Base Materials with Full Depth Asphaltic Concrete Design

Base Material	Minimum Thickness
Aggregate base	6”
Cement treated base	6”
Select material	6”

3. Asphaltic Concrete Mixes

The following mixes and oil contents are general guides for arterial/high traffic volume streets, and local streets/low volume streets.

Arterial Streets/High Traffic Volume:

A-1 1/2” Base Course only, Oil Content: 4.3 +/- 0.4%

C- 3/4” Base and Surface Course, Oil Content: 5.0 +/- 0.4%

D- 1/2” Surface Course only, Oil Content: 5.1 +/- 0.4%

The binder type shall be PG 76-22TR+ for Surface Courses

Local Streets/Low Traffic Volume:

C- 3/4” Base and Surface Course, Oil Content: 5.5 +/- 0.4%

D- 1/2” Surface Course only, Oil Content: 5.6 +/- 0.4%

D-1/2” Asphalt Rubber Concrete Surface Course only, Binder 8.5 +/- 0.4%

4. Substitution of Asphalt Concrete for Aggregate Base Material

If the total structural section depth determined is undesirable, a deeper asphalt concrete section can be used in lieu of some or all the aggregate base material at a rate of 1 inch of asphalt concrete for 3 inches of aggregate base material.

5. Recycled Asphalt Concrete and Asphalt Millings (RAP)

If these materials meet the MAG specifications for aggregate base course, then these materials will be allowed in sub-base and as backfill. However, RAP can be used in the pavement structure on a case by case basis only with the approval of the City of Phoenix Engineer or his representative, and the City of Phoenix Materials Lab and City of Phoenix Street Transportation Department.

TP Attachment 400-3 – City of Tempe – Microsurfacing Specifications

Item XX Type III Microsurfacing

This item includes all labor, materials, tools and equipment required for preparation and installation of Type III Micro-surfacing per MAG Section 331, MAG Section 714 and as modified herein this bid item. Where applicable, all items shall conform with City of Tempe Standard Specifications.

1.) The application rate shall be 30 pounds of aggregate/square yard with a tolerance of +/- 2 pounds per square yard.

2.) The micro-surfacing emulsion shall be PMCQS-1hP. The emulsified asphalt shall be polymer modified.

3.) The area to be micro-surfaced shall be proceeded with crack sealing of all cracks between ¼-inch and 1.5-inch. The crack sealant material shall be Crafco Polyflex Type 3 or approved equal.

4.) All manholes, valve boxes and survey monuments shall be adjusted following the placement of micro-surfacing.
   a. Adjust to grade Valve Box and Cover shall conform to MAG Specification Sections 301, 630, 725, and 790 and the City of Tempe Supplement to the MAG Specifications; and COT Detail T-445, Type B.
   b. Adjust to grade Manhole Frame and Cover that shall conform to MAG Specification Sections 301, 630, 725, and 790 and the City of Tempe Supplement to the MAG Specifications; and COT Detail T-446, Type B.
   c. Developer shall provide all materials, equipment and labor necessary to uncover (1" to 6" depth), adjust or reconstruct survey monuments in hand holes to grade conforming to MAG Standard Detail 120-1, Type B and MAG Sections 270, 301, 405, 505, 601 and 725. City of Tempe Engineering Division Surveyors will locate existing, tie down and verify locations of all undamaged monuments. Monuments damaged by Developer during construction shall be reestablished by an Arizona Registered Land Surveyor

5.) Prior to micro-seal, Developer shall remove thermoplastic pavement markings by water blasting; and raised pavement markers that conforms to Section 460 of the Maricopa County Department of Transportation Supplement to MAG, latest edition.

6.) All existing Portland Cement Concrete travel lane driving surfaces shall not be covered with micro-surfacing.

7.) Existing pavement markings will be surveyed by Developer prior to micro-surfacing. Developer shall generate a Striping Plan, As-Built with enough detail to cover items such as, but not limited to, offsets, stationing, and type of traffic delineation materials present on the existing roadway. All lane marking materials must be called out on the plans and must be approved by the City Traffic

Engineer. Developer shall survey all curb returns and the existing in field curb lines at one-hundred (100) foot intervals in between the curb returns.

8.) Developer shall provide all materials, equipment and labor to apply temporary pavement markings to the new pavement conforming to Section 461 of the Maricopa County Department of Transportation Supplement to MAG, latest edition. Temporary markings shall begin twenty-four (24) hours after each placement of micro-seal.

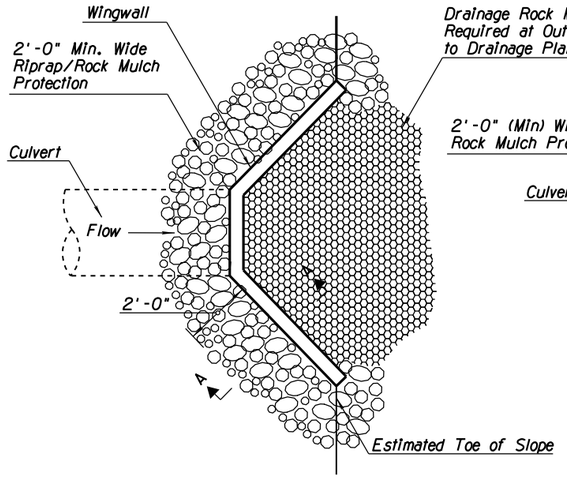
9.) Developer shall provide all materials, equipment and labor to apply thermoplastic reflectorized pavement markings to the new pavement conforming to Section 462 of the Maricopa County Department of Transportation Supplement to MAG, latest edition. Permanent markings shall begin thirty (30) calendar days after each new pavement placement section is complete. Areas to be marked shall be free of debris and swept prior to marking installation.

   a. Cross walks, stop bars, holding bars, railroad markings, arrows, bike symbols shall be installed with a thickness of ninety (90) mils. All longitudinal lines, such as lane lines, edge lines, center lines and taper lines shall be installed with a thickness of sixty (60) mils.

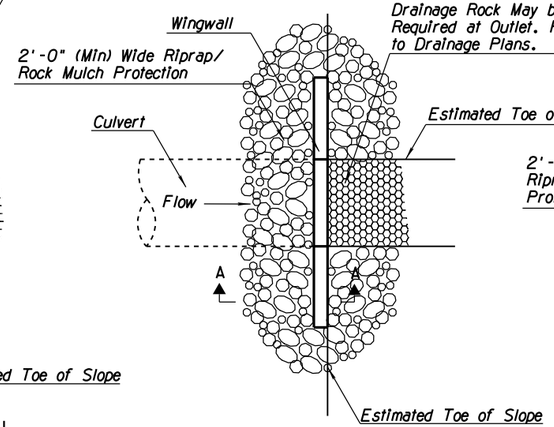
10.) Developer shall provide all materials, equipment and labor to apply raised pavement markers to the new pavement conforming to Section 463 of the Maricopa County Department of Transportation Supplement to MAG, latest edition. The raised pavement markers shall be raised reflective pavement markers per FHWA MUTCD 3B.11, 3B.12, 3B.13, 3B.14 and adhered to the street following the manufacture's recommendations. Pavement markers for fire hydrant locating shall also be replaced and/or installed per MAG Standard Detail 122. Areas with markers to be applied shall be free of debris and swept prior to marking installation.

11.) Developer shall provide all materials, equipment and labor to furnish and apply thermoplastic reflectorized pavement symbols and legends to the new pavement conforming to Section 462 of the Maricopa County Department of Transportation Supplement to MAG, latest edition; and as modified herein this section.

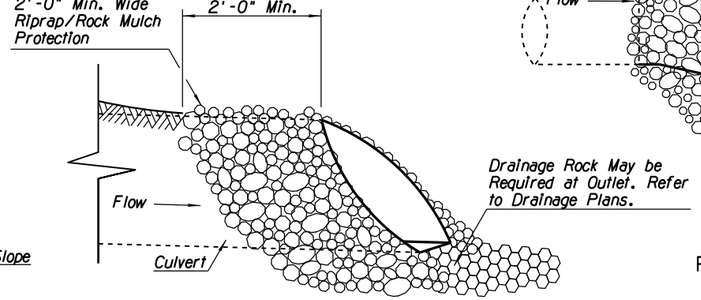
TP Attachment 500-1 – Rock Mulch Protection



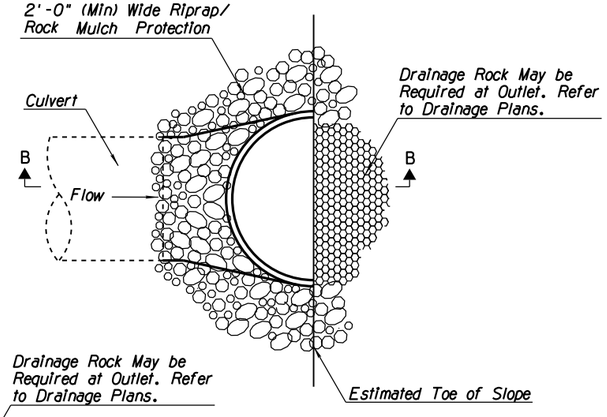
ANGLED HEADWALL
PLAN VIEW (NTS)



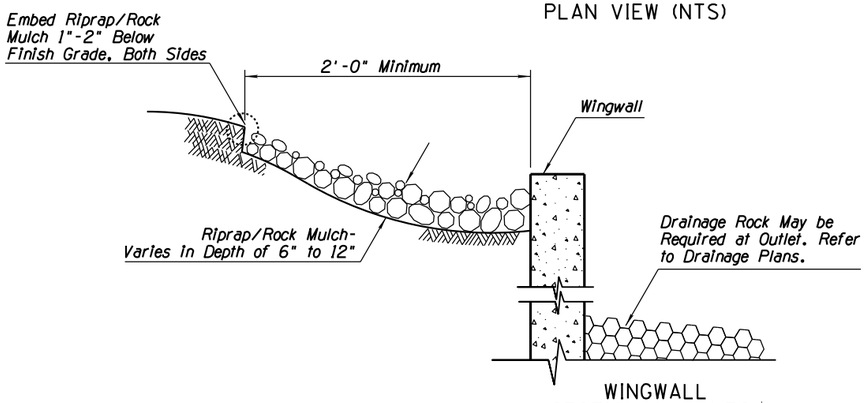
FLUSH HEADWALL
PLAN VIEW (NTS)



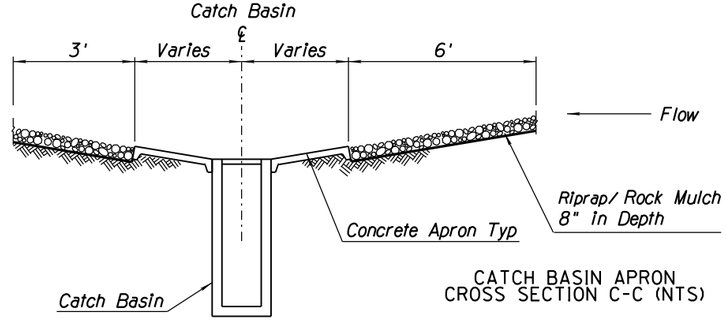
FLARED END
SECTION B-B (NTS)



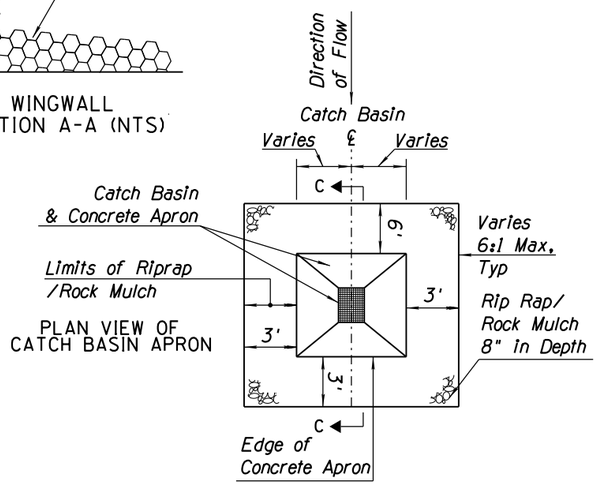
FLARED END
PLAN VIEW (NTS)



WINGWALL
SECTION A-A (NTS)



CATCH BASIN APRON
CROSS SECTION C-C (NTS)



PLAN VIEW OF
CATCH BASIN APRON

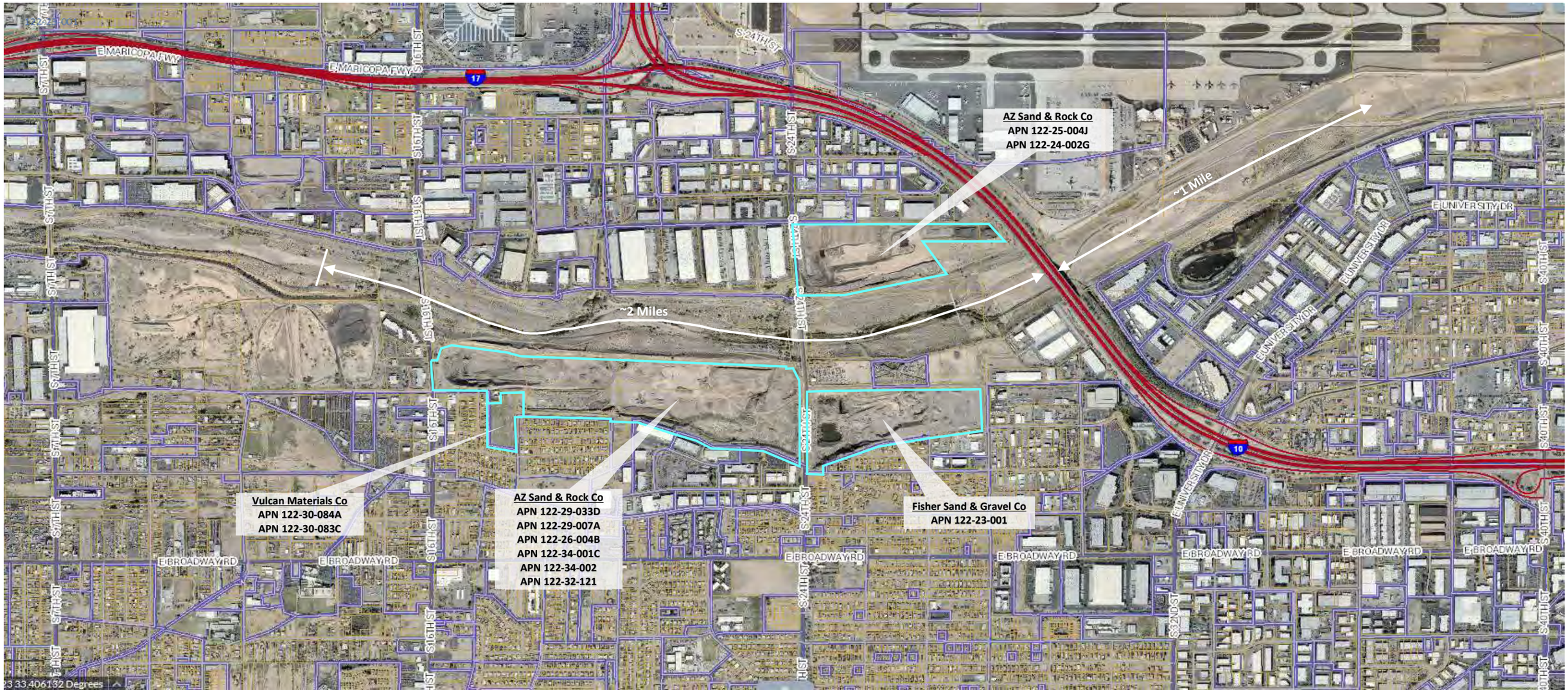
NOTES:

1. Use of Rip Rap or Rock Mulch material at each drainage feature shall sized appropriately based on site conditions for erosion protection; the term indicates location of necessary rock protection features.
2. Riprap/Rock Mulch shall be angular shaped, crushed rock materials. Color to match the Character Area Granite Color. Natural river-run materials such as rounded river rocks/cobblestones and pebbles are NOT acceptable.
3. Rock Mulch shall conform to the requirements Section 800.04.03 of the TP's and sieve requirements of Section 810-2.03 of the Standard Specifications. Rip rap shall conform to the requirements of Section 810-2.03 of the Standard Specifications.
4. Embed rock within traffic recovery area/clear zone into the finished grade so that any portion of the rock above the grade will be less than 2" in height.
5. See Drainage Plans for all locations of Catch Basins, Headwalls, and Flared End Sections.

ROCK PROTECTION FOR INLETS,
OUTLETS, CATCH BASINS
AND HEADWALL TRANSITION

TP Attachment 500-2 Sand and Gravel Company Locations

SAND & GRAVEL COMPANIES IDENTIFIED 1 MILE UPSTREAM & 2 MILES DOWNSTREAM OF I-10 BRIDGE



TP Attachment 600-1 – Bridge Repair Penetrating Deck Sealer - Methacrylate

BRIDGE REPAIR PENETRATING DECK SEALER – METHACRYLATE

1.0 Description:

The work under this Item shall consist of furnishing and applying a methacrylate penetrating crack seal material (hereinafter called sealant material) on the entire bridge deck, approach slabs, and anchor slabs in accordance with the requirements of the Technical Provisions, the manufacturer's recommendations, and the requirements of these specifications.

2.0 Materials:

2.1 High Molecular Weight Methacrylate:

The penetrating crack sealer material shall be a two-component, low viscosity, 100% solids, high molecular weight methacrylate (HMWM) penetrating crack sealer conforming to the physical and performance requirements shown in Table 1.

Table 1: Material Requirements of High Molecular Weight (HMW) Crack Sealers	
Viscosity, ASTM D2196	25 cP (or less)
Tack Free Time in the field	< 400 minutes (6.67 hours)
Dry Slant Shear, ASTM C882	1500 psi minimum
Compressive Yield Strength, ASTM D695	2500 psi 2-day minimum
Tensile Strength, ASTM D638	1500 psi minimum
Tensile Elongation, ASTM D638	3% minimum

The Developer shall review and follow the manufacturer's recommendations on how to use and mix the products.

2.2 Broadcast Sand:

Provide a commercial-quality, dry-blast sand for a skid resistant surface. The size of the sand shall be such that 95% or more shall pass the No. 8 sieve, and 95% or more shall be retained on the No. 20 sieve.

3.0 Safety and Construction Requirements:

The application of sealant material shall not begin until the completion of all bridge deck repair work as directed by ADOT or as required in the Technical Provisions.

Prior to start of the work, the Developer shall submit a safety plan for use of the penetrating crack sealers. The plan shall identify personnel that have been trained by the manufacturer in the handling, transport, and mixing of the penetrating crack sealer. Personnel who have not been certified by the manufacturer shall not handle, transport, or mix the material. Non-certified personnel may apply the crack sealer only while a certified person is present. The manufacturer certification shall be for personnel that have completed training including the following topics:

1. Compliance with pertinent OSHA and other federal, state, and local regulations governing the use of the equipment, the handling of materials, the methods for preventing the occurrence of hazardous conditions, and accidents.

2. Proper handling, storage, and waste disposal methods to eliminate fire, reactivity and explosion hazards and protect personnel from injury caused by exposure to and contact with the components of the material.

3. Use of effective protective clothing, especially aprons, gloves, goggles, respirators, emergency devices, and adequate ventilation in storage areas.

4. Training in safe work habits, first aid procedures, effective measures for coping with emergencies, and accidents.

The safety plan shall identify the location of storage, the method of transporting the material to the project location, the proposed mixing location, and the mixing procedure to be used at the project site.

The safety plan shall identify processes and precautions used to protect the public. This may include controlling temperatures for storage of the product, protective clothing, equipment used in the handling and application of the material, the transportation procedures, the transportation routes, safety protection plan in the event of a spill, fire, or required clean-up, and maintaining sound safety practices.

The Developer shall follow the approved safety plan. If it is determined by ADOT that the measures taken by the Developer are inadequate to provide for public safety, the Developer shall revise his operation. No further work shall be performed associated with the penetrating crack sealer until the public safety measures are adequate and, if required, a revised safety plan has been approved.

Application equipment shall be as recommended by the manufacturer. The spray equipment, tanks, hose, brooms, rollers, coaters, squeegees etc. shall be thoroughly cleaned, free of foreign matter, oil residue and water prior to applying the penetrating crack sealer to the bridge deck.

Surfaces, which are to be treated, shall meet the manufacturer's requirements for surface condition prior to application. Sealing shall not be done until all concrete repairs and any other corrective actions needed have been completed and the repaired concrete has cured. The Developer shall furnish the IQF with written instructions for surface preparation requirements and a representative of the manufacturer shall be present to assure that the surface condition meets the manufacturer's requirements.

At a minimum, the surface shall be thoroughly cleaned to remove dust, dirt, oil, wax, curing components, efflorescence, laitance, coatings, and other foreign materials. The manufacturer or manufacturer's representative shall approve the use of chemicals and other cleaning compounds to facilitate removal of these foreign materials before use. The penetrating crack sealer treatment shall be applied within 48 hours following surface preparation.

Cleaning equipment shall be fitted with suitable traps, filters, drip pans and other devices to prevent oil and other foreign material from being deposited on the concrete surface.

The concrete surface and ambient temperature during application should be in the range of 50 degrees F to 90 degrees F unless otherwise approved by the IQF or as specified by the manufacturer. The application temperature may affect the curing properties of the materials.

The sealer shall be applied at the application rate specified by the manufacturer. The material should be spread evenly across the surface of the concrete in a manner to prevent puddles or excessive concentrations of material in small areas. If the applicator is unable to complete the entire application continuously, the location where the application was stopped shall be noted and clearly marked.

When applying the treatment, the Developer shall protect the adjoining surfaces of the structure that are not to be sealed by masking them off or by other means.

A system approved by the ADOT shall be used to provide a watertight seal for existing bridge joints and bridge drainage systems. Care shall be taken to not damage the water tight systems, during construction operations.

Broadcast sand shall be applied following the placement of a penetrating crack sealer on the bridge decks, approach slabs, and anchor slabs. Broadcast sand shall be applied within the period of time and at the rate recommended by the manufacturer. If there is no manufacturer recommended period of time for application of broadcast sand; the sand shall be applied within 20 minutes of penetrating crack sealer placement. If there is no manufacturer recommended application rate for broadcast sand; the rate of application shall be 2 pounds per square yard. If the sand does not adhere to the sealer, an additional application shall be made. All non-adhered sand shall be removed from the bridge deck, approach slabs, and anchor slabs by power sweeping. All non-adhered sand shall be removed from the bridge deck joints by vacuuming the joints.

Vehicular traffic shall only be allowed on the treated deck after meeting manufacturer’s requirements and upon approval by the IQF.

TP Attachment 600-2 – Repairs and Modifications to Existing Bridges

TP Attachment 600-2		
The following table identifies the required repairs and modifications to existing bridges as part of this project		
Item Number	**Item Description**	**Description**
9240050	SN 02005 SR-143 University Dr OP REPAIR APPROACH SLAB SETTLEMENT	Previous inspections indicate that the approach slabs have settled between 1.5 inches and 3 inches. Settlement at the southeast and northwest barriers have also been observed. Settlement appears to be complete, with no further changes noted during the last inspection. • The approach slabs shall be rehabilitated or reconstructed to eliminate the settlement that has occurred. • Spalls and cracks on the approach barriers shall be repaired and restored to their original condition. • Roadway approach shall be rehabilitated as required to provide a smooth riding surface across the structure by restoring the roadway approach and the approach slab to the original design grade per the record drawings or to a proposed project grade designed by Developer. Changes to the original grade require approval by ADOT. Developer is advised that the existing approach slab is near existing MSE retaining walls. Repair approach should protect existing MSE walls. Proposed repairs require approval from ADOT and may require coordination with the original MSE fabricator. Information regarding original fabrication can be found in the associated bridge record drawings in the RIDs.
9240051	SN 02190 40TH ST TI UP JOINT REPAIR	The compression joints have failed causing debris buildup at the abutments. • Remove and replace/repair existing compression joint seals. • Clean debris from abutment and bearings.
9240052	SN 02700 I-10 to US60 HOV Ramp UP JOINT REPAIR	• Replace strip seal at Pier 7.

TP Attachment 600-2		
The following table identifies the required repairs and modifications to existing bridges as part of this project		
Item Number	**Item Description**	**Description**
9240053	SN 02368 Ramp W-S over I-10 DECK DRAINAGE REPAIR	The existing bridge drainage system appears to have failed in Span 1 and 11 of the bridge with water draining through existing air vents instead of the internal drainage system. Developer shall flush all existing deck drains on the bridge while monitoring the bridge for leaks and water egress. Developer shall video all systems after flush and document blockages and failed sections of the system. The video shall be of the complete drainage system and Developer shall remove blockages to ensure completion of the videoing. Developer shall document the condition of the system in a report and shall include recommendations for rehabilitation or replacement of the system and shall submit the report to ADOT for review. Any work to rehabilitate or replace the existing drainage system will be performed by Developer and will be paid for as an ADOT-Directed Change.

TP Attachment 600-3 – Repairs and Modifications to Existing Salt River Bridge

TP Attachment 600-3		
The following table identifies the required repairs and modifications to existing bridges as part of this project		
Item Number	**Item Description**	**Description**
9240054	SN 02003 I-10 Salt River Bridge OP REHABILITATE DECK	Previous modifications to the deck and approach slabs near the expansion joints of the bridge specifically found in the record drawings H695601C BID Quiet Pavement Project (Detail L) have created a “bump” in the riding surface. • The deck shall be rehabilitated and regraded to eliminate this bump and provide a smooth riding surface across the joints by restoring the deck to the original design grade per the record drawings or to a proposed project grade designed by the Developer. Changes to the original grade require approval by ADOT.
9240055	SN 02003 I-10 Salt River Bridge OP REPLACE EXISTING DECK JOINT	The existing modular joint shall be replaced. The Developer shall replace the existing joint with a strip seal, compression seal, or modular bridge joint system based on existing conditions. A Uniform Temperature Load Factor of 1.0 may be used to calculate the joint movement rating for this structure.
9240056	SN 02003 I-10 Salt River Bridge OP CONCRETE REPAIR	Diaphragms are experiencing spalls and deteriorated concrete at Pier 4 and the North Abutment. • Deteriorated concrete shall be removed and disposed of and the diaphragms shall be repaired.

TP Attachment 600-4 – Soil Nail Wall Systems

SOIL NAIL WALL SYSTEMS

Description:

General:

The work under this item shall consist of furnishing all materials, equipment, tools, and labor to construct permanent soil nail wall systems per the Technical Provisions.

The work under this item shall include excavation in staged lifts; drilling of the soil nail drill holes to the diameter and length required to develop the required capacity; providing and installing the specified nail bars; grouting the nails; verification and proof testing of the nails; providing and installing the specified drainage features; constructing the required reinforced shotcrete facing; and providing and installing bearing plates, washers, nuts, headed studs, and other required miscellaneous materials. The permanent soil nail system shotcrete facing consists of a layer of reinforced shotcrete applied to the exposed soil/rock wall face as excavation proceeds.

The permanent soil nail system shall be designed in accordance with the requirements of Federal Highways Administration (FHWA) *Geotechnical Engineering Circular No. 7: Soil Nail Walls Reference Manual* (FHWA-NHI-14-007) and the AASHTO *LRFD Bridge Design Specifications.* If the system is designed to use a pre-tensioned anchor system, the system shall be designed in accordance with the requirements of FHWA *Geotechnical Engineering Circular No. 4: Ground Anchors and Anchored Systems*.

Review of Subsurface Information, Site Visit, & Certification:

The Developer shall be responsible to review all available subsurface geotechnical information and reports and shall visit the site to assess the site geometry, equipment access conditions, and location of any existing structures and above- and below-ground utilities.

Submittals & Meetings:

The Developer shall submit material certifications, working drawings, and specifications in accordance with the requirements of Technical Provisions.

The submittal shall include:

1. The proposed schedule and construction sequence.
2. Method of staged excavation and excavation equipment.
3. Drilling method(s) and equipment.
4. Certified shotcrete mix design.
5. Soil nail testing equipment including jack or loading ram, pump, dial gages (minimum of two gages), bracing, and current calibrations of the jack/pump/pressure gauges as a system.
6. Example verification test and proof test data sheets.
7. The soil nail system contractor shall submit a project reference list verifying the successful construction/completion of at least three (3) permanent soil nail system projects during the past three (3) years totaling at least 40,000 square feet of finished face area and at least 2,000 permanent soil nails. A brief description of each project with the Owner's name and current phone number shall be included.
8. A registered Professional Engineer having experience in the construction of permanent soil nail system projects during the past three (3) years shall supervise the Work. The on-site supervisor

and drill rig operators shall have experience installing permanent soil nail system on at least three (3) completed projects over the past three (3) years.

No testing or excavation work shall be performed until after the approval of the submittal. All excavation shall be carried out in accordance with the construction sequence plan approved by ADOT.

A soil nail system Pre-Construction Meeting shall be scheduled prior to commencement of soil nail system construction activity. No soil nail system work shall commence until the Developer's final submittal has been approved by the ADOT.

Shotcrete Nozzlemen Certification/Qualification:

All shotcrete nozzlemen shall have experience on at least 3 projects within the past 3 years in similar shotcrete application work and shall demonstrate ability to satisfactorily place the shotcrete. Initial pre-qualification of nozzlemen will be based either on previous ACI certification or on satisfactory completion of pre-construction test panels. The requirement for nozzlemen to shoot pre-construction qualification test panels will be waived for nozzlemen who can submit documented proof of certification in accordance with ACI 506.3R “Guide to Certification of Shotcrete Nozzlemen”. The certification shall have been done by an ACI-recognized shotcrete testing laboratory and/or recognized shotcrete consultant, and shall have covered the type of shotcrete to be used for this project. All nozzlemen will be required to periodically shoot production test panels during the course of the work as required by IQF.

Each nozzleman without previous ACI certification shall furnish at least two pre-construction test panels for each proposed mixture being considered and for each shooting position to be encountered on the job. Pre-construction test panels shall be made prior to the commencement of production work using the same equipment, materials, mixture proportions and procedures proposed for this project.

Pre-construction test panels shall be made with minimum dimensions of 30 x 30 inches square and shall be at least 4 inches thick. The sides of pre-construction and production test panels shall be sloped at 45 degrees over the full panel thickness to release rebound. One pre-construction test panel shall include the maximum anticipated reinforcing congestion (welded wire reinforcing with vertical and horizontal reinforcing bars) shown on the Plans. Cores extracted from the test panel shall demonstrate encapsulation of the reinforcement in accordance with ACI 506.2 equal to core grade 2 or better. The second pre-construction test panel shall be constructed without reinforcement and have cores extracted for compressive strength testing.

IQF shall be notified not less than 2 days prior to the shooting of the preconstruction test panels to be used to qualify nozzlemen without previous ACI certification. The same shotcrete mix and equipment shall be used to make qualification test panels as is to be used for the work. Initial qualification of the nozzlemen will be based on a visual inspection of the shotcrete density and void structure and on achieving the specified 3-day and 28-day compressive strength requirements determined from test specimens extracted from the preconstruction test panels. Pre-construction and production test panels, core extraction, and compressive strength testing shall be conducted in accordance with ACI 506.2 and AASHTO T24/ASTM C42, unless otherwise specified herein. Nozzlemen without ACI certification will be allowed to begin production shooting based on satisfactory completion of the pre-construction test panels and on achieving 3-day strength test requirements. Continued qualification will be subject to passing the 28-day strength tests and shooting satisfactorily during production test panels.

Existing Utilities:

The Developer is responsible for field locating and verifying the location of all utilities shown on the Plans prior to starting the work. The Developer shall maintain uninterrupted service of those utilities designated to remain in service throughout the work.

Materials:

Drainage Network:

The drainage network shall consist of installing vertical prefabricated geocomposite wall drain strips with geotextile wall drain fabric (filter fabric), and weep hole drains.

The geocomposite wall drain strips shall be a minimum of 18 inches wide and shall be secured to the cut face in between vertical nail rows (the nominal horizontal spacing between drain strips shall be 6 feet), with the filter fabric side against the exposed soil/rock of the excavation face, before application of the shotcrete facing. The applicable requirements of Section 203-5 of the Standard Specifications shall be followed in installing the wall drain strips and filter fabric. Geocomposite wall drain strips and filter fabric shall be continuous from a point 6 inches below the top of the shotcrete wall facing to the bottom of the wall, provided with perforated connections to the weep hole drains. Geocomposite wall drain strips and filter fabric shall meet the requirements of Section 1014-6 of the Standard Specifications.

Weep hole drain perforations through the geocomposite wall drain strip and filter fabric shall be capped with geotextile filter fabric. Weep hole drains shall consist of 4-inch diameter, Schedule 40 PVC pipe.

Nail Bars:

Nail bars shall be solid, deformed bar or threadbar, minimum Grade 75 steel, conforming to ASTM A615, or ASTM A722 for Type 1 bars. Nail bars shall be continuous without welds, and shall be new, straight, undamaged, and encapsulated as described below. All nail bars shall be clean and free of excessive rust and mill scale at the time of installation. Nail bars shall be threaded a minimum of 6 inches on the wall anchorage end to permit proper attachment of the bearing plate, wedge washer and nut. Threading may be continuous spiral deformed ribbing provided by the bar deformations or may be cut into a deformed bar.

Nail Bar Encapsulation:

All nail bars shall be encapsulated in a corrugated plastic sheath consisting of a minimum 0.04-inch thick corrugated HDPE tube conforming to AASHTO M252 or corrugated PVC tube conforming to ASTM D1784, Class 13464-B. Encapsulation shall provide a minimum of 0.40 inches of neat cement grout cover over the nail bar and be resistant to ultraviolet light degradation, normal handling stresses, and grouting pressures. Encapsulation shall be done in the factory at the point of origin and not in the field. Encapsulation at the wall anchorage end of the encapsulated bars may be omitted over the length provided for threading the nut against the washer and bearing plate.

Nail Grout:

Nail grout shall comply with all applicable requirements of ACI 318 and the Standard Specifications. Nail grout shall consist of either a neat cement grout or a sand-cement grout. Cement shall be Type V conforming to AASHTO M85/ASTM C150. The proposed nail grout mix design shall be submitted to the Engineer for review and approval. The mix design submittal shall include compressive strength test results verifying that the proposed mix will have a minimum 3-day compressive strength of 1,500 psi and

a minimum 28-day compressive strength of 3,000 psi. All mix design and compression tests shall be performed by a qualified independent testing laboratory.

Previous test results for the proposed grout mix completed within one year or less of the start of work may be submitted for initial verification of the required compressive strengths, for installation of pre-production verification (sacrificial) test nails and initial production nails. During production, nail grout shall be sampled and tested by the Engineer in accordance with AASHTO T106/ASTM C109, at a frequency of no less than one sample/test for every 20 cubic yards of grout placed or no less than one sample/test per work shift.

Welded Wire Mesh and Reinforcing Steel:

Welded wire mesh reinforcing to be used in the temporary structural shotcrete facing shall be minimum 4x4 – W4.0xW4.0 Grade 60 conforming to Section 1003 of the Standard Specifications and the Technical Provisions. Welded wire mesh reinforcing shall be placed over the exposed soil/rock face using spacers to keep mesh at least 2 inches from the exposed face. Welded wire reinforcing laps shall be 8 inches minimum and in accordance with Section 605 of the Standard Specifications.

Vertical (bearing) reinforcing bars and continuous horizontal (waler) reinforcing bars for the structural shotcrete facing shall be No. 6, Grade 60 deformed steel bars conforming to ASTM A615, and shall be attached to the mesh. Waler bars shall be lapped a minimum of 24 inches with laps staggered at 3 feet from laps on adjacent bars.

Shotcrete:

Shotcrete shall conform to the requirements of Section 912 of the Standard Specifications, except as otherwise specified herein. The minimum structural shotcrete facing thickness shall be 4 inches, and the shotcrete shall be applied to the lines and thickness shown on the Plans. Shotcrete shall be applied in the same work shift as the excavation face is trimmed to final line. All voids created between shotcrete placed on the previous lift and the excavation face shall be filled with shotcrete. Shotcrete shall be a pumpable mixture with a minimum 3-day compressive strength of 1,500 psi and a minimum 28-day compressive strength of 3,000 psi. The average compressive strength of each set of three test cores extracted from test panels or from the shotcreted wall face shall equal or exceed 90 percent of the specified compressive strength, with no individual core strength less than 80 percent of the specified compressive strength, in accordance with ACI 506.2. The Developer shall submit the proposed shotcrete mix design to the IQF for review and approval.

Water for shotcrete shall be clean and potable. At all times, the water temperature shall be maintained below 85 degrees F.

Admixtures shall not be used unless approved by the IQF. Admixtures shall meet the requirements of Section 1006-2.04 of the Standard Specifications. The shotcrete shall be proportioned to be pumpable with the concrete pump furnished for the work. Admixtures shall be thoroughly mixed into the shotcrete at the rate specified by the admixture manufacturer. Use of accelerators shall not be permitted. The maximum allowable chloride ion content of all ingredients shall not exceed 0.10% when tested by AASHTO T260.

Curing materials shall meet the requirements of Section 1006-2.05 of the Standard Specifications, and AASHTO M148, Type 1-D or Type 2.

The Developer must receive notification from the IQF that the proposed mix design and method of placement are acceptable before shotcrete placement can begin.

Air entrainment shall be required for wet-mix shotcrete. The amount of air entrained in the shotcrete measured at the truck shall be not less than 4 percent, nor more than 7 percent, by volume, when tested in accordance with AASHTO T152/ASTM C231. Air entrainment shall not be required in dry mix shotcrete.

Nail Head Assemblies Structural Steel:

Structural steel, including for bearing plates, wedge washers, nuts and welded headed-stud shear connectors shall be in accordance with Subsection 604-2 of the Standard Specifications. All nail head assembly elements, including headed-studs/bearing plate, wedge washer and hexagonal nut, shall be galvanized to meet the requirements of Section 604-3.05 (ASTM A153) of the Standard Specifications. All welding and inspection of headed-stud shear connectors shall be performed in accordance with the requirements of AWS D1.1/D1.1M: (2004), Section 7. Welds for attachment of headed-stud shear connectors to the bearing plate shall be full-penetration buttwelds.

Handling & Storage:

Cement shall be stored to prevent moisture degradation and partial hydration. Cement that has become caked or lumpy shall not be used. Aggregates shall be stored so that segregation and inclusion of foreign materials are prevented.

Steel reinforcing and nail bars shall be stored on supports to prevent the steel from contacting the ground. Damage to the nail bars or encapsulated due to abrasion, cuts, nicks, welds, and weld splatter shall be cause for rejection. Welding leads shall not be grounded to nail bars. Nail bars shall be protected from dirt, rust, and other deleterious substances prior to installation. Heavy corrosion or pitting of nail bars shall be cause for rejection. Light rust that has not resulted in pitting shall be acceptable. Protective wrap shall be placed over the anchorage end of each nail bar to which the bearing plate, wedge washer and nut will be attached, to protect the bar during handling, installing, grouting, and shotcreting. Weep hole PVC pipe shall have ends capped, wrapped, and/or otherwise covered and protected during shotcreting.

Encapsulated nail bars shall not be moved or transported until the encapsulation grout has reached sufficient strength to resist damage during handling. Encapsulated nail bars shall be handled and stored in a way that will prevent large deflections, distortions, and damage. Damaged encapsulated nails bars shall be repaired in accordance with the manufacturers' recommendations and as approved by the Engineer, or shall be removed from the Project. Encapsulated nail bars that are determined to be defective in accordance with the manufacturer's recommendations shall be removed from the Project.

Construction Requirements:

General:

All materials and workmanship shall conform to the requirements of the Technical Provisions.

Equipment:

All equipment shall be maintained to ensure continuous and efficient production during soil nailing and associated operations. The Developer shall provide equipment with specialty drilling bits capable of

advancing through the site surface and subsurface conditions including, but not limited to: rock, concrete, brick, metal, wood, cobbles and boulders.

Monitoring:

Surface settlement survey points shall be installed at ground level along the soil nail retaining wall. In addition, survey points shall be installed on the face of the wall in two rows, one at the top row of nails and the second at mid-height of the wall. These survey points shall be located at a maximum horizontal spacing of 75 feet. Initial surface elevation readings shall be obtained by a Registered Land Surveyor in the State of Arizona at least one week before the start of excavation. All points shall be monitored by the Developer no less than once weekly during excavation and twice a month thereafter until the permanent soil nail retaining wall is completed.

The Developer shall take precautions to prevent damage to survey points. Survey points, which are damaged during or after installation, shall be replaced by the Developer, to the satisfaction of the IQF.

Soil Nail System Excavation:

Soil nail system excavation near the finished excavation face will require special care and effort. Excavation to the final face, defined as the back of the structural shotcrete facing, shall use procedures which: (1) prevent over-excavation; (2) prevent ground loss, swelling, air slaking, or mass loosening; (3) prevent loss of support for completed portions of the wall; (4) prevent gain or loss of soil moisture at the face; and (5) prevent ground freezing. Drilling of closely-spaced presplit line holes along the final excavation line shall be allowed to assist in excavation of a clean finished face in bedrock materials; blasting of presplit line holes along the final excavation line shall not be allowed.

The Developer shall notify the IQF immediately if raveling or local instability of the final wall face excavation occurs. Unstable areas shall be temporarily stabilized by means of buttressing the exposed face with an earthen berm or by other methods, as approved by the IQF. All work in unstable areas shall be suspended until remedial measures are developed and implemented. The Developer shall be responsible for maintaining stable and safe slopes. Remedial measures shall be proposed by the Developer and submitted for review and approval by the ADOT.

The exposed, unsupported, excavation lift height shall not exceed half the vertical nail spacing plus the required reinforcing lap, or the short-term stand-up height of the ground, whichever is less. The Developer shall complete excavation of (a portion of) a lift to the final excavation line, drilling and installation of (a portion of) row of nails, and application of the structural shotcrete facing in the same work shift unless otherwise approved by the IQF. Application of the structural shotcrete facing may be delayed up to 24 hours if the Developer can show that the delay will not adversely affect the excavation face stability. Should damage occur to existing structures, the damage shall be repaired by the Developer at no additional cost to the Department. In the event of precipitation, the Developer shall place a polyethylene film over the face of the excavation to reduce degradation of the cut face by erosion or moisture increase.

Excavation of the next lower lift shall not proceed until nail installation, reinforced shotcrete placement, attachment of bearing plates and nail head assemblies, and nail testing have been completed and accepted in the current lift. Nail grout and shotcrete shall have cured for at least 72 hours or attained at least the specified 3-day compressive strength before excavating the next underlying lift.

Wall Discontinuities:

Where the Developer's excavation and installation methods result in a discontinuous shotcrete facing along any nail row, the ends of the constructed shotcrete facing section shall extend beyond the ends of the next lower excavation lift by at least 10 feet. Temporary slopes at these discontinuities shall be constructed to prevent sloughing or failure of the temporary slopes. If sections of the shotcrete facing are to be constructed at different times, then sloughing or failure of the temporary slopes at the end of each shotcrete facing section shall be prevented.

Excavation Face Protrusions, Voids or Obstructions:

The Developer shall remove all or portions of all cobbles, boulders, rubble, miscellaneous fills, or other subsurface obstructions encountered at the final excavation face and which protrude into the structural shotcrete facing. The Developer shall determine methods for removal of face protrusions, including methods to secure remnant pieces left behind the excavation face and to promptly backfill voids resulting from removal of protrusions extending behind the excavation face. The IQF shall be notified in writing of the proposed method(s) for removal of face protrusions at least 24 hours prior to beginning removal. Voids, over-break or over-excavation operations shall be backfilled immediately with shotcrete or concrete, following approval by the Engineer. Removal of face protrusions and backfilling of voids or over-excavation is considered incidental to the work.

Nail Layout:

The soil nail layout shall be a uniform grid (square and rectangular) with the nail spacing as shown on the Plans and with nail inclinations at 15 degrees below the horizontal. The top row of nails shall be no lower than 3.0 feet from the top of the shotcrete wall facing. The bottom row of the nails shall be no higher than 5 feet from the bottom of the wall excavation.

Drilling of Soil Nails:

No drilling or installation of production nails shall be permitted in any soil/rock unit until successful pre-production verification testing of sacrificial nails is completed in that unit and approved by the IQF. Verification test nails shall be installed by using the same equipment, methods, nail inclination, and drill-hole diameter as for the production nails. Pre-production verification tests shall be performed in accordance with the Verification Testing subsection, prior to both the start of the soil nail system mass excavation and the installation of production nails in the specific lift in which the designated verification test nails are located. Locations of verification test nails are specified herein. The IQF may revise or add to the specified locations based on the encountered field conditions. Verification test nails may be installed into any of the following features of the construction: the existing slope face prior to start of the soil nail system mass excavation; the drill platform work bench; or slot cuts made for the particular lift in which the verification test nails are located. Slot cuts shall be large enough only to safely accommodate the drill and test nail reaction setup safely. Subject to the IQF’s approval, verification test nails may also be installed at locations different from those specified, as long as the Developer can demonstrate that the verification test nails are bonded into ground that is representative of the ground at the verification test nail locations specified herein.

The drill-holes for the soil nails shall be made at the locations, orientations, and lengths as directed by the soil nail system engineer. The minimum drill-hole diameter shall be 6 inches, and shall be large enough to develop the specified pullout resistance and provide a minimum 2.0 inches of grout cover over the encapsulated nail bar.

Drilling equipment and methods suitable for the ground conditions described in the geotechnical investigation reports and as described herein shall be selected. The use of drilling muds, such as

bentonite slurry, in dry drill-holes to assist in drill cutting removal shall not be permitted. Drilling with water shall not be permitted. Cased drilling methods shall be used to prevent drill-hole caving, if observed. Where hard drilling conditions are encountered such as through rock, cobbles, boulders, caliche or other difficult materials, percussion or other suitable drilling equipment capable of advancing and maintaining stable drill-holes through such materials will be used.

Use of bentonite slurry shall be permitted only if groundwater is encountered and is required to stabilize the drill-hole. It is the Developer's responsibility to flush the drill-hole adequately, upon completion of drilling, to obtain the required nail bond strength in accordance with the design. The IQF shall be notified immediately if groundwater is encountered.

The Developer shall immediately suspend drilling operations if ground subsidence is observed, the soil nail system is adversely affected, or adjacent structures are damaged by the drilling operation. The Developer shall immediately stabilize adverse conditions and shall notify the IQF of actions taken.

Nail Installation:

Centralizers sized to position the bar within 1 inch of the center of the drill-hole shall be provided. Centralizers shall be positioned within the drill-hole such that their maximum center-to-center spacing does not exceed 10 feet. Centralizers shall also be located within 1.5 feet from both the top and bottom of the drill-hole. Centralizers shall be securely attached to the bar such they do not shift during handling or insertion into the drill-hole, yet will still permit insertion of the grout tremie pipe to the bottom of the drill-hole and allow grout to flow freely up the hole.

The Developer shall inspect each nail bar before installation and shall repair or replace damaged bars or corrosion protection. Nail bars with centralizers shall be inserted into the drill-hole to the required length without difficulty and in a way that prevents damage to the drill-hole, bar, corrosion protection and centralizers. The Developer shall not drive or force partially-inserted soil nails into the drill-hole. Nails that cannot be fully inserted to the design depth shall be removed and the drill-hole cleaned to permit unobstructed installation.

All production soil nails shall be installed before the application of the structural reinforced shotcrete facing. In the event of cut face sloughing, at the Developer's request and subject to the ADOT's written approval, the shotcrete facing may be placed before drilling and installing all of the production nails on that face. Should this occur, a block-out through the shotcrete facing shall be provided. The block-out shall be placed at drill-hole locations and shall consist of PVC pipe or other suitable material, to prevent damage to the shotcrete facing during subsequent drilling. As part of the required construction submittals, the Developer shall provide the ADOT with acceptable structural design calculations demonstrating that the structural capacity of the shotcrete facing will not be reduced and that the bearing plates (size and thickness) will be adequate to span the nail drill-hole block-out through the shotcrete facing. In the event additional soil nails are required, the Developer shall be prepared to penetrate the existing shotcrete with minimal disturbance to the surrounding shotcrete at no additional cost. Details of the procedure proposed by the Developer to penetrate the shotcrete shall be subject to the ADOT's written approval.

Nail Installation Tolerances:

The allowable tolerances shall be as follows:

- Nail Position: $\pm$ 6 inches in any direction on wall excavation face
- Nail Length: $\pm$ 0.5 inches (10-foot minimum length)
- Nail Inclination: $\pm$ 3 degrees

- Shotcrete Thickness: ± 0.25 inches (4-inch minimum thickness)
- Minimum nail drill-hole diameter: 6 inches

Nail position tolerances are applicable to only one nail and are not accumulative over large wall areas. Nail bars shall be centered within 1 inch of the center of the drill-hole and the specified minimum required grout cover maintained.

Installed soil nails not satisfying the specified tolerances, due to the Developer's installation methods, shall be replaced.

Nails shall be installed in a horizontal sequence, with the ground level on the excavated side no more than four feet below the nails to be installed. Soil or rock below the level from which nails are installed may be excavated no sooner than two days after nail installation or after the shotcrete on the preceding lift has reached 25 percent of its 28-day strength and the nail grout has reached 50 percent of its 28-day strength.

For open-hole drilling, as soon as each drill-hole is completed, a clean encapsulated nail bar with centralizers shall be placed in the drill-hole and the hole shall be tremie-grouted. The space remaining between the top of the grout column and the top of drill-hole shall be filled with shotcrete.

If water is encountered in the drill-hole, the drill-hole shall be flushed with air before grout placement and the nail shall be tested as specified in the Nail Testing section below.

Abandoned Drill-Holes:

Nail drill-holes encountering unanticipated obstructions or caving materials during drilling that prevent installation of nails shall be relocated as approved by the Engineer of Record. Abandoned nail drill-holes shall be backfilled with tremied nail grout.

Grouting Equipment:

Grouting equipment shall produce a uniformly-mixed grout free of lumps and undispersed cement, and shall be capable of continuously agitating the mix. A positive-displacement grout pump equipped with a pressure gauge with pressure range of at least twice but no more than three times the intended grout pressure shall be used. The grouting equipment shall be of a size adequate to enable the entire nail to be grouted in one continuous operation. Grout shall be placed within 60 minutes after mixing or within the time recommended by the admixture manufacturer, if admixtures are used. Grout not placed in the allotted time limit will be rejected. The Developer is responsible for keeping the grout mix uniform and workable in hot weather without diluting the grout.

Grouting Methods:

The Developer shall grout the drill-hole immediately after installation of the nail bar. A soil nail bar shall be installed in each drill-hole and the drill-hole shall be grouted within 2 hours of completion of drilling, unless otherwise approved by the IQF. Grout will be injected at the lowest point of each drill-hole through a grout tremie tube, casing, or drill rods. The outlet end of the conduit (tremie) delivering the grout shall be kept a minimum of 12 inches below the surface of the grout as the tremie is withdrawn to prevent the creation of voids. The drill-hole shall be filled completely in one continuous operation. Cold joints in the grout column shall not be permitted except at the top of the test bond length of proof-tested production nails. At the Developer's option, the grout tube may remain in the drill-hole provided the tube is filled with grout.

During casing or auger extraction for drill-holes advanced by either cased or hollow-stem auger methods, sufficient grout level shall be maintained within the casing or auger to offset the external groundwater pressure and soil (overburden) pressure and prevent hole caving. Sufficient grout head or grout pressure shall be maintained to ensure that the drill-hole will be completely filled with grout and to prevent unstable soil or groundwater from contaminating or diluting the grout. The grout pressures for soil nails installed using pressure-grouting techniques shall be recorded. Grout pressures shall be controlled to prevent excessive ground heave or fracturing.

The Developer shall remove the grout and nail if grouting is suspended for more than 30 minutes, or if the grout or grouting procedures do not satisfy the requirements of this Special Provision, the Standard Specifications or the Plans. In such a case, the Developer shall install a new soil nail with fresh grout.

Nail Testing:

General:

The Developer shall perform both verification and proof tests of designated soil nails. Pre-production verification tests shall be performed on sacrificial test nails at the locations specified herein. The IQF may revise or add to the specified locations based on the encountered field conditions. A sacrificial test nail is also known as a verification test nail, and shall not be used as a production nail. The verification test nail is subjected to a load test to confirm the nail can meet the minimum required design adhesion (bond strength) with the indicated factor of safety. Proof tests shall be performed on production nails at locations selected by the IQF. Verification (sacrificial) nails shall not be allowed for proof tests. A proof test nail is defined as a production nail on which a pullout load test is performed and which demonstrates the ability to withstand design loads without excessive movement or long-term creep.

Nail test data shall be recorded by the Developer and furnished to the IQF. Nail testing shall not be performed until the nail grout and shotcrete facing have cured for at least 72 hours and have attained their specified 3-day compressive strength. Testing in less than 72 hours shall be permitted only if the Developer submits compressive strength test results, for tests performed by a qualified independent testing lab approved by the IQF, verifying that the nail grout and shotcrete mixes being used will provide the specified 3-day compressive strengths in the shorter time frame.

Testing Equipment:

Testing equipment shall include dial gauges, dial gauge support, jack and pressure gauge unit, electronic load cell, and reaction frame. The Developer shall provide a description of the test setup, and jack, pressure gauge and load cell calibration.

The Developer shall provide a testing reaction frame of sufficient stiffness and of adequate dimensions such that excessive deformation of the testing equipment does not occur during testing of the soil nails. If the reaction frame is to bear directly on the shotcrete facing, it should be designed to prevent damage to the shotcrete. The jack shall be independently supported and centered over the nail bar such that the bar does not carry the weight of the testing equipment. The jack, bearing plates, and stressing anchorage shall be aligned with the bar such that unloading and repositioning of the equipment will not be required during the test.

The Developer shall apply and measure the test load with a hydraulic jack and pressure gauge unit. The pressure gauge unit shall be graduated in 50-psi increments or less. The jack and pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure. Jack ram travel shall be sufficient to permit completion of the test without resetting the equipment. The Developer shall monitor

the nail load during verification tests with both the pressure gauge and the load cell. The load cell shall be used to maintain constant load during the creep test phase of the tests.

The Developer shall measure the nail head movement with dial gauges capable of measuring to 0.001 inch. The dial gauges shall have travel sufficient to permit completion of the test without resetting the gauges. The gauges shall be aligned visually to be parallel with the axis of the nail. The gauges shall be supported independently from the jack, wall or reaction frame. A minimum of two dial gauges shall be used. All dial gauges shall have been calibrated within the last year.

Pre-production Verification Testing of Sacrificial Test Nails:

A sufficient number of sacrificial test nails shall be installed prior to installation of production nails in order to verify the Developer's installation methods and the nail pullout resistance. Pre-production verification tests shall be performed at locations and elevations as directed by the IQF.

IQF may revise or add to the above-specified locations based on the encountered field conditions.

Verification test nails shall be sacrificial and shall not be incorporated as production nails.

Verification test nails shall have both bonded and unbonded lengths. Prior to testing, only the bonded length of the test nail shall be grouted. The unbonded length of the verification test nail shall be at least 3 feet. The bonded length of the test nail shall be determined based on the production nail bar grade and size such that the allowable structural load of the bar is not exceeded during testing, but shall not be less than 10 feet. The verification test nail maximum bonded length (L_{BV}) shall not exceed either the allowable structural load of the bar under test divided by 2 times the allowable pullout resistance value (Q_d), or 10 feet, whichever is greater. The Developer shall install the bonded length of the verification test nail completely into the specified soil or rock unit.

The following equation shall be used to determine the verification test nail maximum bonded length (L_{BV}) in order that structural overstress of the verification test nail bar is avoided:

$$L_{BV} = \frac{C \cdot F_y \cdot A_S}{2Q_d}$$ or 10 feet, whichever is greater

where:

L_{BV}	=	Verification Test Nail maximum bonded length (ft)
C	=	0.9 for Grade 60 and 75 bars (yield stress basis), 0.8 for pre-stress Type I bars (ultimate stress basis)
F_y	=	Bar yield, ultimate stress (ksi)
2	=	Pullout resistance safety factor
Q_d	=	allowable pullout resistance (kips/foot of grouted nail length, specified on the Plans)
A_s	=	bar steel cross-sectional area (in^2)

The allowable structural load of the bar during testing shall not be greater than 90 percent of the yield strength for Grade 60 and 75 bar steel, or 80 percent of the ultimate strength for pre-stress Type I bars. The Developer shall provide larger verification test bar sizes, if required, to safely accommodate the 10-foot minimum test bond length and testing to two times the allowable pullout resistance requirements at no additional cost to the Department. However, the diameter of the verification test nail drill-hole shall not exceed that of the production nails.

The Design Test Load (DTL) during verification testing shall be determined by the following equation:

$$DTL = \text{Design Test Load (kips)} = L_{BVF} \times Q_d$$

where:

L_{BVF} = actual field value of Verification Test Nail bonded test length (feet)
Q_d = allowable pullout resistance (kips/foot of grouted nail length, specified on the Plans)

Verification test nails shall be loaded incrementally to a Maximum Test Load (MTL) of 200 percent of the Design Test Load (DTL). The Alignment Load (AL) should be the minimum load required to align the testing apparatus. The Alignment Load shall not exceed 5 percent of the Design Test Load (DTL). Dial gauges should be set to "zero" after the alignment load has been applied, and the remainder of the test shall be performed in accordance with the following loading schedule:

VERIFICATION TEST LOADING SCHEDULE	
LOAD	**HOLD TIME**
AL (0.05 DTL max.)	1 minute
0.25 DTL	10 minutes
0.50 DTL	10 minutes
0.75 DTL	10 minutes
1.00 DTL	10 minutes
1.25 DTL	10 minutes
1.50 DTL (creep test)	60 minutes
1.75 DTL	10 minutes
2.00 DTL (MTL)	10 minutes
1.75 DTL	until stable
1.50 DTL	until stable
1.00 DTL	until stable
0.75 DTL	until stable
0.50 DTL	until stable
0.25 DTL	until stable
AL (0.05 DTL max.)	until stable

All load increments shall be maintained within 5 percent of the intended load. Each load increment shall be held for at least 10 minutes except as noted for the creep test. The soil nail movement shall be recorded at the end of the specified time interval for each load increment. The verification test nail shall be monitored for creep at the 1.50 DTL load increment. Nail movement during the creep portion of the test shall be measured and recorded by the Developer at the following time intervals after application of the full load: 1 minute, 2, 3, 4, 5, 6, 10, 20, 30, 50, and 60 minutes. The load during the creep test shall be maintained within 2 percent of the intended load by use of the load cell.

The Developer shall develop and submit the details for production verification testing including the method of distributing test load pressures to the excavation surface (reaction frame), test nail bar size, grouted drill hole diameter, and reaction frame dimensioning, to the IQF for approval. Pre-production verification testing of sacrificial test nails shall be performed by using the same drilling equipment, installation methods, nail inclination, and drill-hole diameter used for the production nails. Changes in the drilling or installation method may require additional verification testing as determined by the IQF.

Verification tests performed by the Developer without the presence of the IQF shall be considered invalid. The Developer shall notify the IQF at least 3 working days prior to the verification test so that suitable arrangements may be made by the IQF to observe the test(s).

Proof Testing of Production Nails:

The Developer shall perform proof testing on a minimum of 5 percent (1 in 20) of the production nails in each nail row with a minimum of one test per row. The locations of the proof test nails shall be designated by the IQF. At his discretion, the IQF may revise or add to the required minimum number of proof test nails based on the encountered field conditions. A verification test nail successfully installed and tested during production work shall be considered equivalent to the first proof test nail and shall be accounted for in determining the number of proof tests required in that particular row. A verification test nail, however, shall not be considered a production nail.

Proof Test Nail Unbonded Length:

The Developer shall provide temporary unbonded lengths for each proof test nail. The proof test nail bar shall be isolated from the shotcrete facing and/or the reaction frame used during testing. Isolation of a proof test nail from the shotcrete facing shall not affect the location of the reinforcing steel under the bearing plate. Accepted proof test nails may be incorporated as production nails provided the temporary test unbonded length is fully-grouted subsequent to testing. The Developer shall submit the proposed proof test nail isolation method(s), method(s) for providing an unbonded test length, and method(s) for grouting the unbonded length subsequent to testing to the IQF for review and approval. Where temporary casing of the unbonded length of proof test nails is provided, the casing shall be installed in a way that prevents any reaction between the casing and the grouted bond length of the nail and/or the nail testing apparatus.

Production proof test nails shall have both bonded and temporary unbonded lengths. Prior to testing, only the bonded length of the production proof test nail shall be grouted. The temporary unbonded length of the production proof test nail from the surface of the grout to the back face of the shotcrete facing shall be at least 3 feet. The bonded length of the production proof test nail shall be determined based on the production nail bar grade and size such that the allowable structural load of the bar is not exceeded during testing, but shall not be less than 9 feet for nails greater than 12 feet in length. Production proof test nails shorter than 12 feet in length may be constructed with less than the minimum 9-foot bonded length, with the unbonded length from the surface of the grout to the back face of the structural shotcrete facing limited to 3 feet. The allowable structural load of a bar during testing shall not be greater than 90 percent of the yield strength for Grade 60 bars and 80 percent of the ultimate strength for pre-stress Type I bars.

The proof test bonded length (L_{BP}) shall not exceed the test allowable bar load divided by 1.5 times the allowable pullout resistance value, or the above minimum bonded lengths, whichever is greater. The following equation shall be used for sizing the proof test nail bonded length (L_{BP}) to avoid overstressing the production nail bar:

$$L_{BP} = \frac{C \cdot F_y \cdot A_S}{1.5 Q_d}$$ or the above-specified minimum bonded lengths, whichever is greater.

where:

L_{BP} = proof test nail bonded length (feet)

C	=	0.9 for Grade 60 and 75 bars (yield stress basis), 0.8 for pre-stress Type I bars (ultimate stress basis)
F_y	=	bar yield, ultimate stress (ksi)
1.5	=	Pullout resistance safety factor
Q_d	=	allowable pullout resistance (kips/foot of grouted nail length, specified on the Plans)
A_s	=	bar steel cross-sectional area (in^2)

The Design Test Load (DTL) during verification testing shall be determined by the following equation:

$$\text{DTL = Design Test Load (kips)} = L_{BVF} \cdot Q_d$$

where:

L_{BVF}	=	actual field value of bonded test length (feet)
Q_d	=	allowable pullout resistance (kips/foot of grouted nail length, specified on the Plans)

Proof tests shall be performed by loading the proof test nail incrementally to a Maximum Test Load (MTL) of 150 percent of the Design Test Load (DTL). The nail movement at each load shall be measured and recorded by the Engineer in the same manner as for verification tests. The test load shall be monitored by a jack pressure gauge with a sensitivity and range meeting the requirements of pressure gauges used for verification test nails. At load increments other than MTL, the load shall be held long enough to obtain a stable reading. The alignment load (AL) is the minimum load required to align the testing apparatus. The alignment load shall not exceed 5 percent of the Design Test Load (DTL). Dial gauges should be set to "zero" after the alignment load has been applied, and the remainder of the test shall be performed in accordance with the following loading schedule. The soil nail movements shall be recorded at each load increment.

PROOF TEST LOADING SCHEDULE

LOAD	**HOLD TIME**
AL (0.05 DTL max.)	until stable
0.25 DTL	until stable
0.50 DTL	until stable
0.75 DTL	until stable
1.00 DTL	until stable
1.25 DTL	until stable
1.50 DTL (MTL/creep test)	see below
AL (0.05 DTL max.)	until stable
1.00 DTL	until stable

All load increments shall be maintained within 5 percent of the intended load. Depending on performance, either 10-minute or 60-minute creep test shall be performed at the maximum test load (1.50 DTL). The creep period shall start as soon as the maximum test load is applied and the nail movement shall be measured and recorded by the IQF at the following time intervals after the maximum test load is applied: 1, 2, 3, 4, 5, 6, and 10 minutes. If the nail movement between 1 minute and 10 minutes exceeds 0.04 inch, the maximum test load shall be maintained for an additional 50 minutes and movements shall be recorded at 20, 30, 50, and 60 minutes.

Test Nail Acceptance Criteria:

A verification test nail or proof test nail shall be considered acceptable when:

For verification tests, the total creep movement is less than 0.08 inch per log cycle of time between the 6- and 60-minute readings as measured during creep testing, and the creep rate is linear or decreasing throughout the specified period of the creep test.

For proof tests, the total creep movement is less than 0.04 inch as measured between the 1- and 10-minute readings, or the total creep movement is less than 0.08 inch as measured between the 6- and 60-minute readings, and the creep rate is constant or decreasing throughout the specified period of the creep test.

For either test, the total measured movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.

For either test, a pullout failure does not occur at the maximum test load. Pullout failure is defined as the load at which attempts to further increase the test load are unsuccessful and simply result in continued pullout movement of the test nail. The pullout failure load shall be recorded as part of the test data.

Successfully proof-tested nails meeting the above test acceptance criteria may be incorporated as production nails, provided that: (1) the temporary unbonded length of the test nail drill-hole has not collapsed during testing; (2) the minimum required drill-hole diameter has been maintained; (3) the specified corrosion protection is provided, and (4) the test nail length is equal to or greater than the scheduled production nail length. Test nails meeting these requirements shall be completed by satisfactorily grouting the unbonded test length. Maintaining the temporary unbonded length for subsequent grouting is the Developer's responsibility. If the temporary unbonded length of production proof test nails cannot be grouted satisfactorily subsequent to testing, the proof test nail shall become sacrificial and shall be abandoned. An additional production nail shall be installed adjacent to the abandoned nail and shall be proof-tested at no additional cost to the Department. Proof test nails which do not meet all of the above-listed criteria shall be abandoned and shall not be considered part of the soil nail retaining wall. Re-testing of either a verification test nail or a proof test nail is not allowed.

Test Nail Rejection:

Test nail failures may require additional nails to be tested to further assess the reason(s) for failure or to verify the existing soil conditions. If a test nail does not satisfy the applicable acceptance criterion specified herein, the Developer shall determine and correct the cause(s).

Verification Test Nails:

The IQF will evaluate the results of each verification test. Installation methods which fail to satisfy the nail testing requirements shall be rejected. The Developer shall propose alternative methods and install replacement verification test nails. Replacement test nails shall be installed and tested at no additional cost to the Department.

Proof Test Nails:

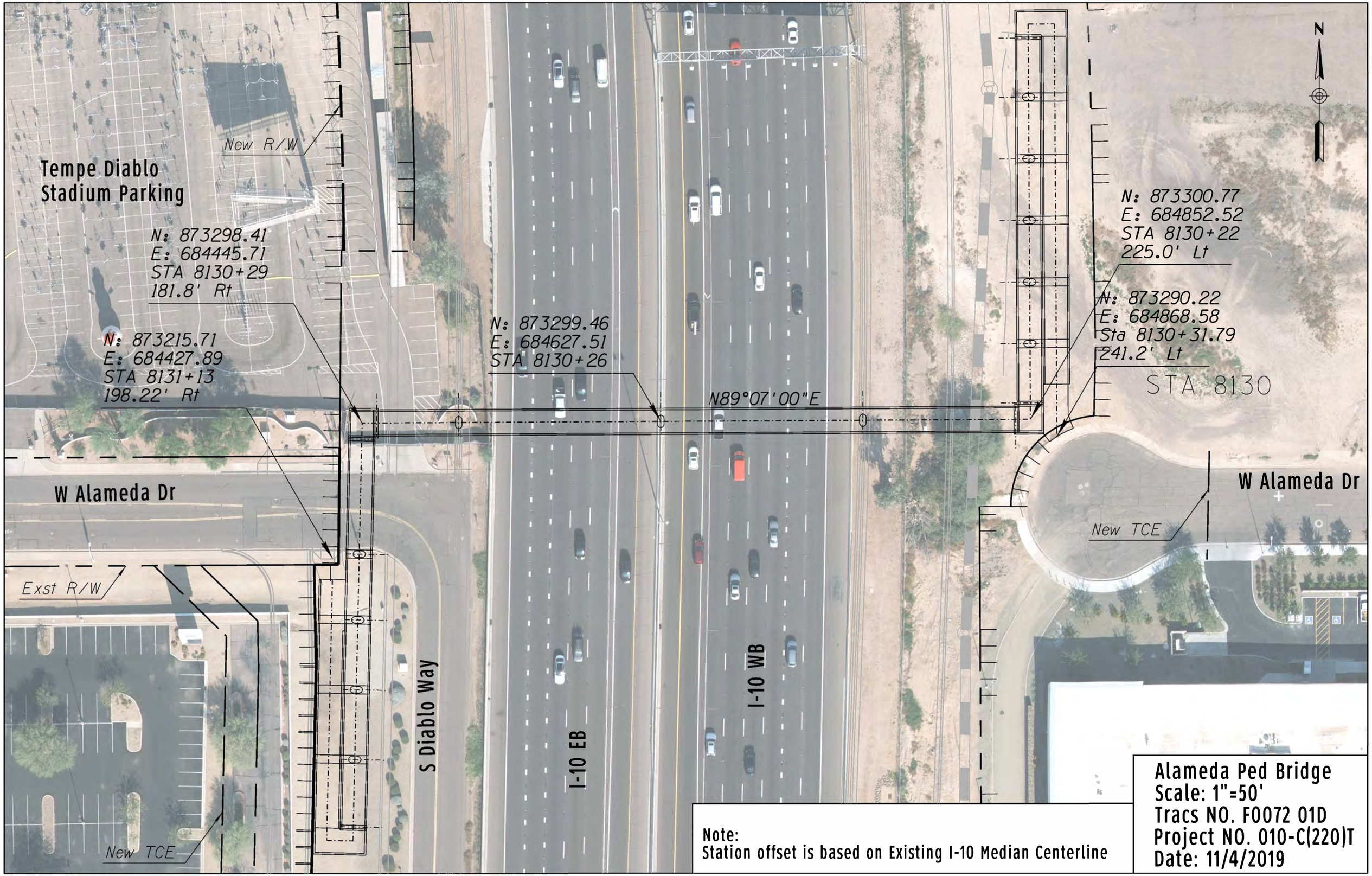
The IQF may require the Developer to abandon and replace some or all of the installed production nails between a failed proof test nail and an adjacent passing proof test nail. Alternatively, the IQF may require the installation and testing of additional proof test nails to verify that adjacent previously installed production nails have sufficient load-carrying capacity. Developer modifications may include, but are not limited to: installation of additional proof test nails; increasing the drill-hole diameter to provide increased

capacity; modifying the installation and/or grouting methods; reducing the production nail spacing from that shown on the project plans; installing more production nails at a reduced capacity; or installing longer production nails if sufficient right-of-way and/or underground easement is available and the pullout capacity behind the theoretical failure surface controls the allowable nail design capacity. Nails may not be lengthened beyond the temporary construction easements or the permanent right-of-way.

Installation Records:

Records documenting the soil nail system construction shall be maintained by the Developer and provided to the IQF. The Developer shall also provide the IQF with record drawings showing as-built nail locations and as-built shotcrete facing line and grade.

TP Attachment 600-5 – Alameda Pedestrian Bridge



Note:
Station offset is based on Existing I-10 Median Centerline

Alameda Ped Bridge
Scale: 1"=50'
Tracs NO. F0072 01D
Project NO. 010-C(220)T
Date: 11/4/2019

TP Attachment 600-6 – Mechanically Stabilized Earth (MSE) Wall Systems

MECHANICALLY STABILIZED EARTH (MSE) WALL SYSTEMS

929-1 Description:

929-1.01 General:

The work under this section consists of designing, furnishing all materials and constructing Mechanically Stabilized Earth (MSE) retaining walls in accordance with these specifications and in compliance with the lines and grades, dimensions and details shown on the project plans.

The Developer shall provide the MSE wall designer with a complete set of project plans and specifications and shall ensure that the wall design is compatible with all other project features that can impact the design and construction of the wall.

The terms used in this specification for identification of various entities responsible for MSE Wall designs are defined in table 929-1:

TABLE 929-1

Term	Entity Responsibilities
Wall Manufacturer/Supplier	The entity contractually retained by the Developer to provide materials and construction support services for an accepted MSE wall system as identified in Subsection 929-1.03 of this Specification or as approved pursuant to Subsection 929-1.04 of this Specification.
Wall Designer	The entity contractually retained by the Developer to provide internal design of an accepted MSE wall system as identified in Subsection 929-1.03 of this Specification or as approved pursuant to Subsection 929-1.04 of this Specification. The Wall Designer is also responsible for evaluating certain aspects of external stability as discussed herein using the geotechnical information provided by the Geotechnical Engineer. The Wall Designer may be a representative of the Wall Manufacturer/Supplier. Internal design includes evaluation of compound stability, which is defined as a failure mode passing through the reinforced soil mass and the retained fill and/or foundation. Geotechnical properties for the retained fill and foundation are to be obtained from the Geotechnical Engineer. The aspects of external stability as discussed below for Geotechnical Engineer that are the responsibility of the Wall Designer to evaluate are as follows:

	(1) Verify the bearing pressures do not exceed the bearing resistance of the foundation soils shown on the bearing resistance charts provided by the Geotechnical Engineer (2) Estimate the settlements along the length of the MSE wall system using the Service I limit state settlement curves shown on the bearing resistance charts provided by the Geotechnical Engineer. (3) Evaluate limited eccentricity and sliding of the MSE wall system using the geotechnical properties for the retained fill and foundation material provided by the Geotechnical Engineer.
Geotechnical Engineer	The entity responsible to evaluate or provide geotechnical information needed for the Wall Designer to evaluate certain aspects of external stability of the accepted MSE wall system as identified in Subsection 929-1.03 of this Specification or as approved pursuant to Subsection 929-1.04 of this Specification. External stability includes the analysis of: 1. Bearing Capacity 2. Settlement (short term and post construction) 3. Limited Eccentricity 4. Sliding 5. Global slope stability The bearing capacity and settlement (short term) shall be evaluated by the Geotechnical Engineer and provided to the Wall Designer in the form of a bearing resistance chart developed in accordance with ADOT SF-1 (2010) Memorandum (3). Bearing resistance charts shall be developed for each boring advanced along the length of the proposed MSE walls. Long-term settlements (post construction) shall be evaluated by the Geotechnical Engineer and provided to the Wall Designer so that the Wall Designer can account for such settlements in their design. Geotechnical properties of the retained fill and foundation material shall be provided by the Geotechnical Engineer to the Wall Designer to allow the Wall Designer to evaluate limited eccentricity and sliding of the MSE wall system.

Notes:

(1) The geotechnical properties for the retained fill provided by the Geotechnical Engineer to the Wall Designer are minimum properties based on global stability analysis performed by the Geotechnical Engineer, and the Wall Designer may elect to use material exceeding those minimum property values for design. In such case, the geotechnical properties used by the Wall Designer exceeding those provided by the Geotechnical Engineer shall become the required geotechnical properties for the retained fill during construction.

(2) ADOT SF-1 (2010): Development of Factored Bearing Resistance Chart by a Geotechnical Engineer for Use by a Bridge Engineer to Size Spread Footings on Soils for Service and Strength Limit States Based on Load and Resistance Factor Design (LRFD) Methodology, Memorandum from N. H. Wetz and J. D. Wilson to J. Lawson, dated March 19, 2008 (Revision 1).

929-1.02 Certifications:

(A) Certification of Review of Geotechnical Report(s):

The Developer shall be responsible to review all available geotechnical investigation reports, and the Developer's signature on the proposal form shall certify that this review has been performed and that this specification and any relevant geotechnical information has been provided to the firms designing and supplying the MSE wall.

(B) Certification of Design Parameters:

See Subsection 929-2.01 herein specified.

(C) Certification of Materials:

See Subsections 929-3.04, 929-3.06 and 929-3.09 herein specified.

929-1.03 Accepted Systems:

Unless Developer uses an earth retaining system approved by ADOT pursuant to Subsection 929-1.04, the Developer shall select one of the appropriate ADOT pre-approved earth retaining systems to be constructed for the MSE walls designated on the plans.

Pre-approved systems are listed on the ADOT Bridge Group website:

https://azdot.gov/business/engineering-and-construction/bridge/guidelines/geotech-services

The features of the system(s) furnished, including design and configuration of precast elements, fasteners, connections, soil reinforcements, joint fillers, geotextile filter, and other necessary components shall be those that meet the requirements of Subsection 929-2 of this Specification.

Heights and lengths of earth retaining MSE walls may vary from, but shall not be less than, those shown on the plans. The height and length to be used for any system shall be the minimum for that system that will effectively retain the earth behind the wall for the loading conditions and the contours, profile, or slope lines shown on the plans, and in accordance with all relevant internal and external stability design criteria.

929-1.04 Unlisted Systems Acceptance Process:

If the Developer elects to use an earth retaining system not listed on the ADOT Bridge Group website, the approval process for such system is as follows:

(1) No consideration will be given to a request for approval of an unlisted system prior to contract award. After award, and in time to allow for consideration without delaying work, the Developer shall submit a written request for approval of a new system.

(2) If the Developer wishes to propose multiple systems, separate written requests shall be submitted for each system. All requests must be received within the timeframes specified herein.

(3) The Developer's progress schedule shall indicate when the proposed system is to be used on the project. The schedule shall include time for the Department to evaluate the proposed system and shall demonstrate that there will be no impacts to the critical path. If, in the opinion of the Department, the schedule shows that the evaluation and approval timeframe of the proposed system is not reasonable, the Department will not consider the proposed system.

(4) A request for the use of an unlisted system shall include all information necessary to determine that a system is an equal, including samples for testing, if required. Unlisted systems will not be entertained as Value Engineering (VE) Proposals.

(5) The Department will evaluate the information submitted, perform tests when necessary and make comparisons. The Department will then make the final decision as to whether the proposed system is an equal. The Department will neither be liable for any delay in acting upon any request nor for any failure to approve a request pursuant to the use of an unlisted system.

(6) The Department will review the Developer's request for the use of an unlisted system within 45 days of the Developer's complete submittal and inform the Developer in writing if the request is rejected, approved, or if the Department will take additional time for evaluation. If any additional information is needed to evaluate the proposed system, Developer shall submit the information in a timely manner, at which point the 45-day

review period is restarted. Untimely submittals of additional information shall result in rejection of the proposed system.

(7) The Developer shall not be entitled to additional compensation or an extension of contract time resulting from the Department's acceptance or rejection of a proposed system.

929-1.05 Manufacturer's Field Representative:

The manufacturer's field representative performing the work described in this specification shall have, in the past three years, successfully installed at least four MSE retaining walls of heights, lengths and complexity similar to those shown on the plans and meeting the tolerances specified herein. The manufacturer's field representative may make field changes subject to the approval the Wall Designer prior to any modifications. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer, who is registered as a Civil Engineer in the State of Arizona.

929-1.06 MSE Pre-Activity Meeting:

A pre-activity meeting will be scheduled prior to commencement of MSE wall construction activity. As a minimum, this meeting shall be attended by the IQF, ADOT, Developer (including wall construction crew chiefs), the MSE wall sub-contractor, MSE wall manufacturer's and MSE wall designer's representatives. No wall construction activity shall be performed until the Developer's final submittals have been approved as having satisfactorily resolved all review comments and the pre-activity meeting has been held.

929-1.07 Wall Aesthetics:

Wall aesthetics shall be as specified in the Technical Provisions.

929-2 Submittals (Working Drawings and Design):

929-2.01 Submittals:

The submittals required shall include working drawings, construction procedures, supporting design calculations, verification of experience, and a transmittal letter. The transmittal letter shall only list the documents included in the submittal. No technical information shall be included in the transmittal letter.

Working drawings and calculations shall be signed and sealed by a Professional Engineer (P.E.), who is registered as a Civil Engineer in the State of Arizona. The MSE wall designer/supplier shall document on the working drawings all assumptions made in the design. The following statement shall be included near the P.E. seal on the first sheet of the working drawings: "All design assumptions are validated through notes or details on these drawings".

Working drawings, design calculations, and MSE wall supplier's construction procedures modified as necessary by the Developer and wall designer for site-specific conditions shall be submitted for review.

Construction of the wall shall not commence until the complete wall package (drawings, calculations, and construction procedures) is accepted. Fabrication of any of the wall components before acceptance shall be at the sole risk of the Developer.

929-2.02 Working Drawings:

The Developer shall submit complete working drawings and specifications for each installation of the system in accordance with the requirements of Section 116 of the TPs as modified herein.

Working drawings shall include the following at a minimum:

(1) Layout of the wall including plan and elevation views;

(2) All design parameters and assumptions including design life;

(3) Existing ground elevations and utilities impacted by the wall shall be field verified by the Developer for each location;

(4) Complete details of all elements and component parts required for the proper construction of the system at each location and any required accommodations for drainage systems, foundation subgrades or other facilities shown on the contract documents;

(5) Clear details of any special design requirements. These special design requirements may include, but are not limited to; structural frames to place reinforcements around obstructions such as deep foundations and storm drain crossings, drainage systems within the reinforced backfill, placement sequence of drainage and unit core fill with respect to reinforced (structure) fill behind a wall face using modular block facing units, guardrail post installation, scour protection, foundation subgrade modification, all corner details (acute, obtuse and 90 degrees), slip joints, connection details of MSE walls with other cast-in-place structures, wedges, shims and other devices such as clamps and bracing to establish and maintain vertical and horizontal wall facing alignments;

(6) A complete listing of components and materials specifications; and

(7) Other site-specific or project specific information required by the contract.

929-2.03 MSE Wall Design:

(A) General:

The working drawings shall be supplemented with all design calculations for the particular installation as required herein.

The proposed design shall satisfy the design parameters shown on the project plans and listed in these specifications, and comply with the design requirements of the following documents:

- FHWA (2009), "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes; Publication No. FHWA-NHI-10-024 and FHWA-NHI-10-025; Authors: Berg, R. R., Christopher, B. R., and Samtani, N. C.

- AASHTO (2017), "AASHTO LRFD Bridge Design Specifications", 8th Edition, including latest Interims.

All references made to AASHTO (2017) herein shall mean "AASHTO LRFD Bridge Design Specifications", 8th Edition, including latest Interims.

Maximum reinforcement loads shall be calculated using the "Simplified Method" as presented in AASHTO (2017) and as per the requirements specified herein. No other design method will be allowed.

Sample analyses and hand-calculations shall be submitted to verify the output from software used by the MSE wall designer. Sample analyses and hand calculations shall be required for complex walls having geometries and loading conditions that are not readily amenable to computer analysis. Failure modes, including circular, non-circular, and multi-part wedge shall be analyzed for compound stability to verify the most critical failure case (slip surface with lowest factor of safety) within each section of the wall where the length of the reinforcement changes. For compound stability, all potential slip surfaces for each failure mode passing through all Three Search Zones shown in Figure 929-2.03(A) shall be analyzed to determine the most critical failure case. Each failure mode shall be analyzed individually and not be forced to mimic the results of other failure modes. The compound stability analyses are required for all wall geometries including walls with level ground in front of wall and level backfill behind wall. Global stability requirements are contained in the MSE wall design summary plan sheet.

The Developer and wall designer shall identify the specific locations on working drawing plan and profiles based on subgrade evaluation and at other key locations to control the deformation along the wall. The soil reinforcement attached to the slip joints shall be oriented perpendicular to the slip joint panels and shall be the full design length. Special connection and compaction details shall be provided on the working drawings.

At all corners formed by two MSE walls, the leveling pad along the shorter wall forming the corner shall be at the same elevation as the leveling pad for the taller wall for a distance of at least 80 percent of the height of the taller wall or a distance of 10 feet, whichever is greater.

All structures shall be designed to conform to the requirements shown in Table 929-2 and other requirements specified herein.

TABLE 929-2
DESIGN PARAMETERS

Description	Limit State	Value	Note
1. Design Life	All limit states	75 Years	
2. Effective (Drained) Friction Angle			
a. Retained Backfill	All limit states	(Project specific as detailed in the MSE wall design summary sheet)	1
b. Reinforced Backfill	All limit states	34° ,110 pcf	1
3. Length of soil reinforcement, B	All limit states	0.7H min or 8-ft whichever is more	2
4. Limiting eccentricity	Strength (all)	B/3 (soil), 0.45B (rock)	
	Service I	B/6 (soil), B/4 (rock)	
5. Coefficient of Sliding Friction	Strength (all)	$\tan[\min(\phi_r, \phi_f, \phi_i)]$	3
6. Resistance factors			
a. Sliding	Strength (all)	1.0	4
b. Bearing	Strength (all)	0.65	5
c. Overall (slope) stability			
I. Deep Seated Stability	Service I	0.65	6
II. Compound Stability	Service I	0.65	6
d. Pullout resistance			
I. Static	Strength (all)	0.90	7
II. Combined static/earthquake	Strength (all)	1.20	7
e. Tensile resistance of metallic reinforcements and connectors			
I. Static - Strip reinforcement - Grid reinforcement	 Strength (all) Strength (all)	 0.75 0.65	 8 8,9
II. Combined static/earthquake - Strip reinforcement - Grid reinforcement	Strength (all) Strength (all)	1.00 0.85	8 8,9
f. Tensile resistance of geosynthetic			

	reinforcements and connectors			
	I. Static	Strength (all)	0.90	
	II. Combined static/earthquake	Strength (all)	1.20	

Notes:

1	Retained backfill requirements shall be project specific as noted on the MSE wall summary plan sheet developed by the Geotechnical Engineer.
2	H is the design height of the wall and is defined as the difference in elevation between the finished grade at top of wall and the top of leveling pad. The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for that location. The length of the soil reinforcement, B, is measured from the backface of the wall facing unit. In case of grid type reinforcements the length of the soil reinforcement is measured from the backface of the wall to the last full transverse member. For modular block facing units, the total length of the reinforcement, BT, as measured from the front face of the wall is the length B as defined above plus the width of the modular block unit (the horizontal dimension of the block unit measured perpendicular to the wall face). Depending on the configuration of the reinforcements and properties of the various actual fills selected by the Developer, the minimum length of the reinforcement may need to be increased to satisfy the required resistance factors for compound stability analyses.
3	ϕ_r= friction angle of reinforced wall fill. ϕ_f = friction angle of foundation soil (As reported on the MSE wall design summary plan sheet). ϕ_i = friction angle of the interface between reinforcement and soil for cases of sheet reinforcement such as geotextiles. All friction angles are effective (drained) friction angles. Refer to the MSE wall design summary plan sheet for friction angle and unit weight of foundation soil.
4	Passive resistance shall not be considered in evaluation of sliding resistance.
5	For all limit states, the design loading for the MSE retaining wall system shall not exceed the factored general and local bearing resistances specified in the Geotechnical Report(s).
6	For earthquake loading condition, a resistance factor of 0.90 shall be used.
7	Live load due to vehicular traffic shall be included in the computations to determine the maximum tensile forces in reinforcement layers, but shall be neglected in the computations for pullout resistance. Intensity of live load shall be considered as a uniform surcharge using the equivalent height of soil in accordance with Section Article 3.11.6.4 of AASHTO (2017).
8	Apply to gross cross-section less sacrificial area. For sections with holes, reduce gross area in accordance with Article 6.8.3 of AASHTO (2017) and apply to net section less sacrificial area.
9	Applies to grid reinforcements connected to a rigid facing element, e.g., a concrete panel or block. For grid reinforcements connected to a flexible facing

	mat or which are continuous with the facing mat, use the resistance factor for strip reinforcements.
10	Unless otherwise specified, all resistance factors shall be taken as 1.0 when investigating an extreme event limit state.

(B) Subsurface Drainage Systems:

Walls shall be provided with subsurface drainage measures as shown on the project plans and specifications. As a minimum, an underdrain system shall be provided for leading subsurface and surface water away from the backfill and outside the limits of the wall. Geocomposite drains, if used for subsurface drainage, shall be in accordance with Subsection 203-5.02 and 203-5.03(C) of the Standard Specifications.

The Wall Designer is responsible for drainage measures within the reinforced backfill. Drainage measures outside the MSE wall backfill shall be designed by the project civil designer.

(C) Obstructions in Backfill:

(1) General:

Where obstructions, such as deep foundations or storm drains crossings, are located in the reinforced backfill zone, cutting of reinforcements to avoid obstructions shall not be permitted. A minimum offset of one diameter but not less than 3 feet shall be maintained between the face of any pipe crossings and the back face of MSE retaining wall panels. A minimum clearance of 3 feet shall be maintained between the face of any other obstruction and the back face of MSE retaining wall panels.

(2) Horizontal Deflection of Reinforcements:

In the horizontal plane at a reinforcing level, a deviation up to 15 degrees from normal to the face of the wall may be allowed for strip reinforcement and bolted connection. This deviation is herein referred to as the splay angle. Grid reinforcements may not be splayed, unless connection has been specifically fabricated to accommodate a splay and the connection detail and supporting calculations has been submitted by the MSE Designer and the detail has been approved by the Department. If used, the splay in grid reinforcements is limited to five degrees. For obstructions that cannot be accommodated with splayed reinforcement, structural frames and connections shall be required, and shall be designed in accordance with Section 10 (“Steel Structures”) of AASHTO (2017) for the maximum tension in the reinforcements. The structural frame design shall be such that bending moments are not generated in the soil reinforcement or the connection at the wall face. The design, along with supporting calculations, shall be included in the working drawings.

(3) Vertical Deflection of Reinforcements:

Vertical deflection of the reinforcement to avoid obstructions such as utilities along the wall face shall be limited to a maximum of 15 degrees from normal to face of wall. Bends in the reinforcement shall be smooth and gradual to ensure that galvanization remains intact.

(D) Hydrostatic Pressures:

For walls potentially subject to inundation, such as those located adjacent to rivers, canals, detention basins or retention basins, a minimum hydrostatic pressure equal to 3 feet shall be applied at the high-water level for the design flood event. Effective unit weights shall be used in the calculations for internal and external stability beginning at levels just below the equivalent surface of the pressure head line. Where the wall is influenced by water fluctuations, the wall shall be designed for rapid drawdown conditions which could result in differential hydrostatic pressure greater than 3 feet. As an alternative to designing for rapid drawdown conditions, Size 57 coarse aggregate, as specified in AASHTO M 43, shall be provided as reinforced backfill for the full length of the wall and to the maximum height of submergence of the wall. Separation fabric shall be class I needle-punched polypropylene non-woven geotextile with the highest permittivity shown in AASHTO M 288. The fabric shall be provided at the interface of the Size 57 coarse aggregate and reinforced backfill above it, and at the interface of the retained backfill behind it. Adjoining sections of separation fabric shall be overlapped by a minimum of 12 inches.

(E) Acute Angle Corners:

Wall corners with an included angle of less than 70 degrees shall be designed for bin-type lateral pressures for the extent of the wall where the full length of the reinforcement cannot be installed without encountering a wall face. Acute angle corner structures shall not be stand-alone separate structures. Computations shall be provided that demonstrate deformation compatibility between the acute angle corner structure and the rest of the MSE wall. Full-height vertical slip joints shall be provided at the acute angle corner and after the last column of panels where full length of the reinforcements can be placed. The soil reinforcement attached to the slip joints shall be oriented perpendicular to the slip joint panels and shall be the full design length. Special connection and compaction details shall be provided on the working drawings.

(F) Slip Joints:

For walls with precast concrete panels, vertical slip joints shall be included in the wall face at the following locations and as shown on the plans, whichever is more stringent:

(1) Boundaries of limits where differential settlement exceeds 1/100.

(2) All locations where a wall height changes by more than 5 feet.

(3) All corners within an MSE wall.

(4) Each side of a stiff element such as a reinforced concrete box culvert (RCBC) or any other wall face penetration larger than 5 feet.

(5) Each side of a drilled shaft foundation constructed prior to and within 8 feet of the face of wall. Approximate locations of slip joints are shown on the project plans.

(G) Spacing of Metallic Reinforcement for Flexible Face Wall Systems:

For permanent walls, vertical and horizontal spacing of metallic reinforcements for flexible face (welded wire or similar) wall systems shall not exceed 18 inches. The stiffness of the facing and spacing of reinforcements shall be such that the maximum local deformation between soil reinforcement layers shall be limited to less than 1½ inches. Facing elements shall not yield in bending and tension.

For temporary walls, i.e., walls with less than 36 months service life, the Developer may adjust the stiffness of the facing and spacing of the reinforcements such that the local deformation between the reinforcement is within the elastic range in bending and tension, and the overall geometry meets the line and grade requirements for the temporary walls.

(H) Soil Reinforcement for Modular Block Wall (MBW) Systems:

The soil reinforcement lengths and percent coverage at a given reinforcement level shall be in accordance with the plans. All soil reinforcement shall be positively connected to the modular block facing units by a connection that is capable of resisting 100 percent of the maximum tension in the soil reinforcements at any level within the wall. Detailed documentation for connection strength shall be submitted as noted in Subsection 929-3.09 of this specification. The vertical spacing of the soil reinforcement for walls with modular block facing units shall be as follows:

(1) The first (bottom) layer of soil reinforcement shall be no further than 16 inches above the top of the leveling pad.

(2) The last (top) layer of soil reinforcement shall be no further than 20 inches on the average below the top of the uppermost MBW unit.

(3) The maximum vertical spacing between layers of adjacent soil reinforcement shall not exceed 24 inches. For walls deriving any part of their connection capacity by friction the maximum vertical spacing of the reinforcement shall be limited to two times the block depth (front face to back face) to assure construction and long-term stability. The top row of reinforcement shall be placed at a depth no more than two times the block height from the top of finished grade.

(I) Initial Batter of Wall:

The initial batter of the wall, both during construction and upon completion, shall be within the vertical and horizontal alignment tolerances included in this specification. The initial batter of the wall at the start of construction and the means and methods necessary to achieve the batter shall be provided on the working drawings. The initial batter may be modified at the start of construction by the manufacturer's field representative based on the evaluation of the backfill material selected by the Developer subject to the approval the Wall Designer prior to any modifications. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer who is registered as a Civil Engineer in the State of Arizona. Details of the wedges or shims or other devices, such as clamps and external bracing used to achieve or maintain the wall batter, shall be as shown on the working drawings and/or accompanying construction manual. Permanent shims shall comply with the design life criteria and shall maintain the design stress levels required for the walls.

929-3 Material Requirements:

929-3.01 Precast Concrete Elements:

Precast concrete elements shall conform to the requirements for precast minor structures in Sections 601 and 1006 of the Standard Specifications. The concrete shall be Class S with minimum design strength of 4,000 pounds per square inch. The mix design shall conform to the requirements of Subsection 1006-3 of the Standard Specifications.

Prior to casting, all embedded components shall be set in place to the dimensions and tolerances designated in the plans and specifications. Rustication for wall aesthetics shall be in accordance with project plans, special provisions, and applicable requirements of Sections 601, 610, 1002 and 1006 of the Standard Specifications.

(A) Concrete Testing and Inspection:

Precast concrete elements shall be subjected to compressive strength testing in accordance with Subsection 1006-7, and inspected for surface conditions and dimensional tolerances in accordance with Subsections 601-3.05 and 601-4.02 of the Standard Specifications respectively. Panels delivered to the site without the ADOT acceptance stamp will be rejected.

(B) Casting:

Precast concrete face panels shall be cast on a horizontal surface with the front face of the panel at the bottom of the form. Connection hardware shall be set in the rear face. The concrete in each precast concrete panel shall be placed without interruption and shall be consolidated by deploying an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corner of the forms, and to eliminate the formation of stone pockets or cleavage planes. Form release agents as specified in Subsection 601-3.02(C)(1) of the Standard Specifications shall be used on all form faces for all casting operations.

The Developer shall advise the IQF and ADOT of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State of Arizona, or 21 calendar days if the casting operation is outside the State of Arizona.

(C) Finish:

(1) Non-Exposed Surfaces:

Rear faces of precast concrete panels shall receive a Class I finish in accordance with Subsection 601-3.05 of the Standard Specifications.

(2) Exposed Surfaces:

The type of finish required on exposed surfaces shall be as shown in the plans.

(a) Exposed Aggregate Finish:

(i) Prior to placing concrete, a set retardant shall be applied to the casting forms in accordance with the manufacturer's instructions.

(ii) After removal from the forms and after the concrete has set sufficiently to prevent its dislodging, the aggregate shall be exposed by a combination of brushing and washing with clear water. The depth of exposure shall be between ⅜ inch and ½ inch.

(iii) An acrylic resin sealer consisting of 80 percent thinner and 20 percent acrylic solids by weight shall be applied to the exposed aggregate surface at a rate of 1 gallon per 250 square feet.

(b) Concrete Panel Finish:

Concrete panel finish shall be in accordance with Subsection 601-3.05 of the Standard Specifications.

(D) Tolerances:

Precast concrete elements shall comply with Subsection 601-4.02(B)(1) and 601-4.02(B)(4) of the Standard Specifications. Connection device placement shall be within ± ⅜ inch of the dimensions shown on the drawings. Panel squareness as determined by the difference between the two diagonals shall not exceed ½ inch.

(E) Identification and Markings:

The date of manufacture, the production lot number, and the piece mark shall be inscribed on a non-exposed surface of each element.

(F) Handling, Storage, and Shipping:

All panels shall be handled, stored, and shipped in such a manner to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported in firm blocking to protect panel connection devices and the exposed exterior finish. Storing and shipping shall be in accordance with the manufacturer's recommendations.

(G) Compressive Strength:

Precast concrete elements shall not be shipped or placed in the wall until a compressive strength of 3,400 pounds per square inch has been attained. The facing elements shall be cast on a flat and level area and shall be fully supported until a compressive strength of 1,000 pounds per square inch has been attained.

(H) Precast Concrete Panel Joints:

(1) General:

Where the wall wraps around an inside corner, a corner block panel shall be provided with flange extensions that will allow for differential movement without exposing the panel joints. The back face of vertical and horizontal joints shall be covered with geotextile filter. Joint filler, bearing pads, and geotextile filter shall be as recommended by the wall manufacturer and shall meet the requirements shown on the approved working drawings.

If required, as indicated on the plans, flexible open-cell polyurethane foam strips shall be used for filler for vertical joints between panels, and in horizontal joints where pads are used.

All joints between panels on the back side of the wall shall be covered with a geotextile meeting the requirements for filtration applications as specified by AASHTO M 288. The minimum width shall be foot.

(2) Bearing Pads:

All horizontal and diagonal joints between panels shall include bearing pads. Bearing pads shall meet or exceed the following material requirements:

(a) Preformed EPDM (Ethylene Propylene Diene Monomer) rubber pads conforming to ASTM D2000 Grade 2, Type A, Class A with a Durometer Hardness of 70.

(b) Preformed HDPE (High Density Polyethylene) pads with a minimum density of 0.946 grams per cubic centimeter in accordance with ASTM D1505.

The stiffness (axial and lateral), size, and number of bearing pads shall be determined such that the final joint opening shall be ¾ inch ± 1/8 inch unless otherwise shown on the plans. The MSE wall designer shall submit substantiating calculations verifying the stiffness (axial and lateral), size, and number of bearing pads assuming, as a minimum, a vertical loading at a given joint equal to 2.5 times the weight of facing panels directly above that level. As part of the substantiating calculations, the MSE wall designer shall submit results of certified laboratory tests in the form of vertical load-vertical strain and vertical load-lateral strain curves for the specific bearing pads proposed by the MSE wall designer. The vertical load-vertical strain curve shall extend beyond the first yield point of the proposed bearing pad.

929-3.02 Steel Components:

Steel components shall conform to the applicable requirements of Sections 605 and 1003 of the Standard Specifications.

(A) Galvanization:

Soil reinforcement steel shall be hot-dip galvanized in accordance with AASHTO M 111 (ASTM A123). Connection hardware steel can be galvanized by hot-dipping or other means, provided the method satisfies the requirements of AASHTO M 111 (ASTM A123). A minimum galvanization coating of 2.0 oz./ft^2 (605 g/m^2) or 3.4 mils (85 µm) thickness is required. Soil reinforcement steel shall be adequately supported while lifting and placing such that the galvanization remains intact. Steel members with damaged (peeled) galvanization shall be repaired according to ASTM A780-01 and as specified in approved working drawings.

(B) Metallic Reinforcing Strips and Tie Strips:

Reinforcing strips shall be hot-rolled from bars to the required shape and dimensions. The strips' physical and mechanical properties shall conform to the requirements of ASTM A572, Grade 65 minimum.

Tie strips shall be shop fabricated of hot-rolled steel conforming to the requirements of ASTM A1101, Grade 50 minimum. The minimum bending radius of the tie strips shall be ⅜ inch. Galvanization shall be applied after the strips are fabricated, inclusive of punch holes for bolts as shown on approved drawings.

(C) Metallic Reinforcing Mesh:

Reinforcing mesh shall be shop fabricated of cold-drawn steel wire conforming to the requirements of AASHTO M 32, and shall be welded into the finished mesh fabric in accordance with AASHTO M 55. Galvanization shall be applied after the mesh is

fabricated. A minimum galvanization coating of 2.0 oz./ft^2 (605 g/m^2) or 3.4 mils (85 µm) thickness is required.

(D) Connector Pins:

Connector pins and mat bars shall be fabricated and connected to the soil reinforcement mats as shown in the approved working drawings. Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32.

(E) Welded Wire Fabric:

All welded wire fabric shall conform to the requirements of AASHTO M 32, AASHTO M 55, and the approved working drawings. Welded wire fabric shall be galvanized in conformance with the requirements of ASTM A123.

(F) Fasteners:

Connection hardware shall conform to the requirements shown in the approved working drawings. Connection hardware shall be cast in the precast concrete panels such that all connectors are in alignment and able to transfer full and even load to the soil reinforcement. Once the reinforcement is connected to the panel, the amount of slack shall not exceed ⅛ inch between the connector and the reinforcement during field installation. Fasteners shall be galvanized and conform to the requirements of AASHTO M 164 or equivalent.

929-3.03 Geosynthetic Reinforcement:

Geosynthetic soil reinforcement shall be limited to geosynthetics manufactured from polypropylene, high density polyethylene, and polyester. Geosynthetic reinforcement shall be evaluated through the NTPEP REGEO (National Transportation Product Evaluation Program – Geosynthetic Reinforcements) for installation damage reduction factor RF_{ID} and creep reduction factor RF_{CR}. The geogrid shall be a regular network of integrally connected polymer tensile elements, with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil. Geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport, and installation. Geosynthetic reinforcements other than geogrids may be utilized if an independent evaluation has been performed through NTPEP REGEO.

The nominal long-term tensile design strength (T-AL) of specific geosynthetic material shall meet or exceed the creep and durability reduction factors required by the wall manufacturer, as well as those required by AASHTO (2017). The wall designer may not select installation damage reduction factor RF_{ID} and creep reduction factor RF_{CR} to be less than the results obtained through the NTPEP REGEO program.

929-3.04 Certificate of Analysis for Soil Reinforcements:

The Developer shall submit a Certificate of Analysis conforming to the requirements of Subsection 106.05 of the Standard Specifications and Sections 106 and 113 of the TPs for all materials.

For geosynthetics, the Certificate of Analysis shall verify that the supplied geosynthetic is the approved type and as measured in full accordance with all test methods and standards specified herein. The manufacturer's certificate shall state that the furnished geosynthetics meet the requirements of the specifications, as evaluated by the NTPEP REGEO program.

For metallic wall reinforcement, a mill test report containing the ultimate tensile strength for the soil reinforcement shall be included in the certification. For metallic wall reinforcement, a mill test report containing the galvanization coverage shall be included in the certification. For metallic mesh wall reinforcement, a mill test report containing the ultimate weld strength for the soil reinforcement shall be included in the certification.

929-3.05 Reinforced and Retained Backfill Material:

(A) General:

Reinforced backfill material shall be free of shale, organic matter, mica, gypsum, smectite, montmorillonite, or other soft poor durability particles. No salvaged material, such as asphaltic concrete millings or Portland Cement Concrete rubble, etc., will be allowed.

Retained backfill material shall be project specific as noted on the MSE wall summary plan sheet developed by the Geotechnical Engineer.

(B) Soundness:

The reinforced backfill material shall have a soundness loss of 30 percent or less when tested in accordance with AASHTO T 104 using a magnesium sulfate solution with test duration of four cycles. Alternatively, the material shall have a soundness loss of 15 percent or less when tested in accordance with AASHTO T 104 using a sodium sulfate solution with test duration of five cycles. Aggregate sources with recent testing data within the past year may submit previous testing results for soundness determination.

(C) Gradation and Fractured Coarse Aggregates:

Gradations will be determined by Arizona Test Method 201 and shall be in accordance with Table 929-3, unless otherwise specified.

Material retained on the #4 and larger sieves must have a minimum of 50 percent particles with two or more mechanically induced crushed faces when tested by Arizona Test Method 212.

Table 929-3 BACKFILL GRADATION REQUIREMENTS	
Sieve Size	**Percent Passing**

4 inch	100
No. 40	0-60
No. 200	0-15

(D) Separation Fabric:

A class I needle-punched polypropylene non-woven separation geotextile fabric, meeting the minimum requirements for filtration applications specified in AASHTO M 288 and Subsection 1014-4 of the Standard Specifications shall encapsulate the rock backfill. Adjoining sections of separation fabric shall be overlapped by a minimum of 12 inches.

(E) Limits of Reinforced Backfill:

For all walls, except back-to-back walls, the reinforced backfill shall extend to at least two (2) feet beyond the free end of the reinforcement. For back-to-back walls wherein the free ends of the reinforcement of the two walls are spaced apart less than or equal to one-half the design height of the taller wall, reinforced wall fill shall be used for the space between the free ends of the reinforcements as well. The design height of the wall is defined as the difference in elevation between the top of coping and the top of leveling pad. The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for the location under consideration.

929-3.06 Certificate of Analysis for Reinforced Backfill Materials:

At least three weeks prior to construction of the MSE wall, the Developer shall submit test results for an 80 pound representative sample of the reinforced backfill material, and a Certificate of Analysis conforming to the requirements of Subsection 106.05 of the Standard Specifications and certifying that the reinforced backfill material comply with the requirements Sections 106 and 113 of the TPs specified herein. During construction, the reinforced backfill material shall be sampled and tested by the IQF for acceptance and by the Developer for quality control testing in accordance with the requirements stated in Table 929-4. A new sample and Certificate of Analysis shall be provided any time the reinforced backfill material changes as noted in Table 929-4.

Table 929-4
Sampling Frequency for Reinforced Backfill Material

Test	Frequency
Gradation (Arizona Test Method 201), Plasticity Index (AASHTO T 90) Fractured Coarse Aggregate Particles (ARIZ 212)	One per 500 CY At production facility

929-3.07 Cast-in-Place Concrete:

Cast-in-place concrete shall conform to the requirements of Sections 601 and 1006 of the Standard Specifications. Unless otherwise approved, all cast-in-place concrete shall be Class S with a minimum compressive strength of 4,000 pounds per square inch.

929-3.08 Modular Block (Segmental) Facing Units:

This section covers dry cast hollow and solid wet cast concrete masonry structural retaining wall units, machine made from Portland cement, water, and suitable mineral aggregates. The units are intended for use as facing units in the construction of mortarless, modular block walls (MBW) also known as segmental retaining walls (SRW). Metallic or geosynthetic reinforcement specified in Section 929-3.02 and 929-3.03 of this specification respectively may be used as soil reinforcement in the reinforced (structure) backfill zone.

(A) Casting:

Cementitious material in the modular block facing unit shall be Portland cement conforming to the requirements of ASTM C150. If fly ash is used it shall not exceed 20 percent by weight of the total cement content, and shall conform to ASTM C618. Aggregates used in concrete blocks shall conform to ASTM C33 for normal weight concrete aggregate. Efflorescence control agent shall be used in concrete mix design to prevent efflorescence on the block.

The Developer shall advise the IQF and ADOT of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State of Arizona, or 21 calendar days if the casting operation is outside the State of Arizona.

(B) Physical Requirements:

At the time of delivery to the work site, the modular block facing units shall conform to the following physical requirements:

(1) Minimum required compressive strength of 4,000 psi (average 3 coupons)

(2) Minimum required compressive strength of 3,500 psi (individual coupon)

(3) Minimum oven dry unit weight of 125 pcf

(4) Maximum water absorption of 5 percent after 24 hours

(5) Maximum number of blocks per lot of 2,000. Tests on blocks shall be submitted at the frequency of one set per lot.

Acceptance of the concrete block, with respect to compressive strength, water absorption and unit weight, will be determined on a lot basis. The lot shall be randomly sampled and tested in accordance with ASTM C140. The manufacturer shall perform the tests at an ADOT approved laboratory and submit the results to IQF and ADOT for approval. Compressive strength test specimens shall be cored or shall conform to the saw-cut coupon provisions of ASTM C140. Block lots represented by test coupons that do not reach an average compressive strength of 4,000 psi will be rejected.

(C) Freeze-Thaw Durability:

In areas above 3000 feet, where repeated freezing and thawing under saturated conditions occur, the units shall be tested to demonstrate freeze-thaw durability in accordance with Test Method ASTM C1262. Freeze-thaw durability shall be based on tests from five specimens made with the same materials, concrete mix design, manufacturing process, and curing method, conducted not more than 18 months prior to delivery. Specimens used for absorption testing shall not subsequently be used for freeze-thaw testing. Specimens shall comply with either or both of the following acceptance criteria depending on the severity of the project location as determined by the Department:

(1) The weight loss of four out of five specimens at the conclusion of 150 cycles shall not exceed 1 percent of its initial weight when tested in water.

(2) The weight loss of each of four out of the five test specimens at the conclusion of 50 cycles shall not exceed 1.5 percent of its initial mass when tested in a saline (3 percent sodium chloride by weight) solution.

(D) Tolerances for Modular Block Dimensions:

Modular blocks shall be manufactured within the following tolerances:

(1) The length and width of each individual block shall be within ± ⅛ inch of the specified dimension. Hollow units shall have a minimum wall thickness of 1¼ inches.

(2) The height of each individual block shall be within ± 1/16 inch of the specified dimension.

(3) When a broken (split) face finish is required, the dimension of the front face shall be within ± 1.0 inch of the theoretical dimension of the unit.

(E) Finish and Appearance:

Units that indicate imperfect molding, honeycomb or open texture concrete and color variation on front face of block due to excess form oil or other reasons shall be rejected. All units shall be visually efflorescence free. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Minor cracks (e.g. no greater than 1/50 inch in width and no longer than 25 percent of the unit height) incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery, are not grounds for rejection.

The exposed faces shall be free of chips, cracks or other imperfections when viewed from a distance of 30 feet under diffused lighting. Up to 5 percent of a shipment may contain slight cracks or small chips not larger than 1.0 inch.

Color and finish shall be as shown on the plans and shall be erected with a running bond configuration.

(F) Pins:

If pins are required to align modular block facing units, they shall consist of a non-degrading polymer or hot-dipped galvanized steel and be made for the express use with the modular block units supplied. Connecting pins shall be capable of holding the geogrid in the proper design position during backfilling.

(G) Cap Units and Adhesive:

The cap unit connection to the block unit immediately under it shall be of a positive interlocking type and not frictional. Cap units shall be cast to or attached to the top of modular block facing units in strict accordance with the requirements of the manufacturer of the blocks and the adhesive. The surface of the block units under the cap units shall be clear of all debris and standing water before the approved adhesive is placed. The Developer shall provide the owner in writing an acceptable 10-year warranty that the integrity of the materials used to attach the cap blocks will preclude separation and displacement of the cap blocks for the warranty period.

(H) Unit (Core) Fill:

Unit (core) fill is defined as free draining, coarse grained material that is placed within the empty cores of the modular block facing units. Unit (core) fill shall be a crushed stone or granular fill.

929-3.09 Certificate of Analysis for Modular Block Connection

For modular block facing units, a certification shall be provided with detailed calculations according to AASHTO (2017) and the results of laboratory test results performed in accordance with Section A.3 in Appendix A of FHWA NHI-00-043, dated March 2001 (“Mechanically Stabilized Earth Walls and Reinforced Soil Slopes”). Such certification shall demonstrate that all connections, including block-to-reinforcement and block-to-block connections, and all related components meet or exceed the current AASHTO 75-year design life requirements and are capable of resisting 100 percent of the maximum tension in the soil reinforcements at any level within the wall. Long-term connection testing for extensible reinforcements is also required. The effect of wall batter and normal pressures representative of the full range of wall configurations and heights shall be incorporated in the tests.

929-4 Construction Requirements:

929-4.01 Excavation:

The Developer shall ensure that temporary slopes are safe during the period of wall construction, and shall adhere to all applicable local, state, and federal regulations. During construction of the MSE walls, the Developer shall design, construct, maintain, and when called for, remove temporary excavation support systems (shoring). Temporary excavation support systems may be left in place if approved by ADOT. The back slope of the excavation shall be benched. Where shoring is required, the Developer shall submit the shoring design, and a plan outlining construction and removal procedures for review and approval prior to proceeding with the work. Shoring plans shall be prepared and submitted as part of the working drawings, as specified in Section 116 of the TPs, and shall bear the seal and signature of a licensed Professional Civil or Structural Engineer, registered in the State of Arizona. All shoring design shall include appropriate input and review by the Developer's Professional Engineer.

929-4.02 Foundation Preparation:

(A) General:

In the absence of specific ground improvement requirements in the plans and special provisions, the following applies:

The foundation for the reinforced and retained wall fill shall be graded level for the entire area of the base of such backfills, plus an additional 12 inches on all sides, or to the limits shown in the plans.

If soil reinforcement components are to be positioned on native soil, the top one (1) foot of native soil shall meet the requirements of the reinforced backfill material specified in Subsection 929-3.05.

If soil reinforcement components are to be positioned on native rock mass, the rock mass shall be classified as at least Class II rock mass in accordance with Subsection 10.4.6.4 of AASHTO LRFD Bridge Design Specifications, 6th edition (2012).

(B) Proof-Rolling:

Proof-rolling shall be performed to evaluate the stability and uniformity of the subgrades on which retaining wall structures will be constructed. Proof-rolling shall be performed on the entire areas at the following locations and at other locations shown on the project plans:

(1) At the bottom of the overexcavation and recompaction zones if specified;

(2) At the bottom of the overexcavation and replacement zones if specified;
(3) At the base of all retaining walls;

(4) At the base of all concrete box culverts;

(5) At the top of native soil layers that have been scarified, moisture conditioned and recompacted (if different from the bottom of the

overexcavation and recompaction or overexcavation and replacement zones).

The proof-rolling shall be done immediately after subgrade compaction while the moisture content of the subgrade soil is near optimum or at the moisture content that achieved the required compaction.

If proof-rolling is performed after installation of pipe underdrains, do not use the proof-roller within 1.5 feet of the underdrains. Proof-rolling shall be performed with a pneumatic tired tandem axle roller with at least 3 wheels on each axle, a gross weight of 25 tons (50 kips) (This weight shall be determined on a project by project bases, depending on the soils and purpose of the proof-rolling), a minimum tire pressure of 75 psi and a minimum rolling width of 75 inches. A Caterpillar PS-300B (or PF-300B), Ingersoll-Rand PT-240R, BOMAG BW24R, Dynapac CP271 or equipment with equivalent capabilities shall be used for proof-rolling. The use of water trucks, scrapers, or other equipment for proof-rolling of the subgrades is not allowed.

Proof-rolling equipment shall be operated at a speed between 1.5 to 3 miles per hour or slower as required by IQF to permit measurements of ruts and/or pumping deformations.

Proof-rolling shall be carried out in two directions at right angles to each other with no more than 24 inches between tire tracks of adjacent passes. In cases where proof-rolling perpendicular to the wall alignment is not possible due to space constraints, proof-rolling shall be performed parallel to the wall with minimum 6 inches overlap between the tracks of adjacent passes. The Developer shall operate the proof-roller in a pattern that readily allows for the recording of deformation data and complete coverage of the subgrade.

The following actions shall be taken based on the results of the proof-rolling activity:

If rutting is less than ¼ inch; the grade is acceptable.

If rutting is greater than ¼ inch and less than 1½ inches; the grade needs to be scarified and re-compacted.

If rutting is greater than 1½ inches; the compacted area shall be removed and reconstructed.

If pumping (deformation which rebounds or materials are squeezed out of wheel's path) is greater than 1 inch; remediate.

The Developer is responsible for maintaining the condition of the accepted proof-rolled soils throughout the duration of the retaining MSE wall construction. Wall construction shall not commence until the subgrade has been accepted by IQF.

929-4.03 Concrete Leveling Pad:

Leveling pads shall be constructed of unreinforced concrete as shown on the working drawings. Gravel leveling pads shall not be allowed. As a minimum, the concrete for leveling pads shall meet the requirements of Section 922 of the Standard Specifications. The elevation of the top of leveling pad shall be within ⅛ inch from the design elevation when measured by a straightedge over any 10-foot run of the leveling pad.

The minimum width of the leveling pad shall be the width of the facing unit plus 8 inches. The centerline of the leveling pad shall be within ½ inch from design location. When the facing units are centered on the leveling pad, the leveling pad shall extend approximately 4 inches beyond the limits of the facing unit as measured in the direction perpendicular to the face of the wall.

Cast-in-place leveling pads shall be cured for a minimum of 24 hours before placement of wall facing units. A geotextile shall be applied over the back of the area of any openings between the facing units and leveling pad steps. The geotextile shall extend a minimum of 6 inches beyond the edges of the opening. The opening shall be filled with concrete, conforming to Section 1006 of the Standard Specifications, or shall be concurrently backfilled on both sides with soil.

929-4.04 Subsurface Drainage:

Prior to wall erection, the Developer shall install a subsurface drainage system as shown on the working drawings.

929-4.05 Wall Erection:

(A) General:

Walls shall be erected in accordance with the manufacturer's written instructions. The Developer shall be responsible for ensuring that a field representative from the manufacturer is onsite during construction of the initial 10-foot height of the full length of each wall, and as called upon thereafter by the IQF or ADOT. Such instances may include, but are not restricted to, when the wall construction crew chief is changes, when construction exhibits continuous deviations from the approved working drawings, or when other concerns about wall construction are raised. All temporary construction aids (e.g., wedges, clamps, etc.) shall be in accordance with the manufacturer's recommendations.

(B) Placement Tolerances for Walls with Rigid (Precast) Facing:

For walls with rigid facing, such as precast concrete panels, the panels shall be placed such that their final position is vertical or battered as shown on the working drawings. As wall fill material is placed, the panels shall be maintained in the correct vertical alignment by means of temporary wedges, clamps, or bracing as recommended by the manufacturer. A minimum of two, but not more than three, rows of panel wedges shall remain in place at all times during wall erection. Wedges shall be removed from lower rows as panel erection progresses, so as to prevent chipping or cracking of concrete panels. The Developer shall

repair any damage to erected concrete panels and to the IQF's acceptance. No external wedges in front of the wall shall remain in place when the wall is complete.

Erection of walls with rigid facing shall be in accordance with the following tolerances:

(1) Vertical and horizontal alignment of the entire wall face shall not vary by more than ¾ inch when measured along a 10-foot straightedge.

(2) The overall vertical tolerance (plumbness) of the finished wall shall not exceed ½ inch per 10 feet of wall height at any point along the wall. Negative (outward leaning) batter is not acceptable.

(3) The maximum permissible out-of-plane offset at any panel joint shall not exceed ⅜ inch.

(4) The final horizontal and vertical joint gaps between adjacent facing panel units shall be within -⅛ inch and ±1/4 inch, respectively, of the design final joint opening per the approved calculations required in Subsection 929-3.01(H) of this specification.

Wall sections not conforming to these tolerances shall be reconstructed.

(C) Placement Tolerances for Permanent Walls with Flexible Facing:

Erection of permanent walls with flexible facing (such as welded wire mesh) shall be in accordance with the following tolerances:

(1) Vertical and horizontal alignment of the wall face shall not vary by more than 2 inches when measured along a 10-foot straightedge, or as shown in the plans and specifications.

(2) The overall vertical tolerance (plumbness) of the wall shall not exceed 1 inch per 10 feet of wall height. Negative (outward leaning) batter is not acceptable.

(3) The offset limit between consecutive rows of facing shall not exceed 1 inch from planned offset.

Wall sections not conforming to these tolerances shall be reconstructed.

(D) Placement Tolerances for Modular Block Units:

Erection of walls with Modular Block Units shall be as per the following requirements:

(1) Vertical and horizontal alignment of the entire wall face shall not vary by more than ¾ of an inch when measured along a 10-foot straightedge.

(2) Overall vertical tolerance (plumbness) of the wall shall not exceed 1¼ inch per 10 feet of wall height from the final wall batter at any point along the wall. Negative (outward leaning) batter is not acceptable.

(3) The first row of units shall be level from unit-to-unit and from front-to-back. Use the tail of the units for alignment and measurement.

(4) All units shall be laid snugly together and parallel to the straight or curved line of the wall face.

(5) Unless otherwise noted, all blocks shall be dry-stacked and placed with each block evenly spanning the joint in the row below (running bond). Shimming or grinding shall control the elevations of any two adjacent blocks within 1/16 of an inch.

(6) The top of blocks shall be checked with a straight edge bubble level that is at least 3 feet long. Any high points identified by the straight edge shall be ground flat. Block front to back tilting shall be checked frequently; however correction by shimming shall be done no later than 3 completed courses.

Wall sections not conforming to these tolerances shall be reconstructed.

(E) Placement of Metallic Reinforcement Elements:

Metallic reinforcement elements shall be placed normal (perpendicular) to the face of the wall, unless otherwise shown on the approved plans. All reinforcement shall be structurally connected to the wall face.

At each level of the soil reinforcement, the reinforced wall fill material shall be roughly leveled and compacted before placing the next layer of reinforcement. The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to 2 inches higher than the connection elevation.

For geosynthetic reinforcement where overlapping of reinforcing may occur, such as at corners, reinforcing connections to panels shall be adjusted to maintain at least 6 inches of vertical separation between overlapping reinforcement.

(F) Placement of Geotextile Fabric:

All joints between precast concrete panels shall be covered with geotextile fabric on the back side of the wall. Adhesive shall be applied to panels only. Adhesive shall not be applied to geotextile fabric or within 2 inches of a joint. The Developer shall provide geotextile fabric having a minimum width of 12 inches, and shall overlap the fabric a minimum of 4 inches. For modular block walls, the placement of the geotextile fabric shall be in accordance with the plans.

(G) Joint Pads and Fillers:

The Developer shall install joint pads and fillers as shown on the working drawings.

(H) Placement of Geosynthetic Reinforcement:

Geosynthetic reinforcement shall be installed in accordance with the manufacturer's site-specific wall erection instructions.

The geosynthetic reinforcement shall be rolled out with the stronger direction perpendicular to the wall face. The reinforcement shall be continuous for their full length. Joints parallel to the wall shall not be permitted, except as shown on the working drawings.

Reinforcement coverage shall be 100 percent of embedment area unless otherwise shown in the working drawings. Adjacent sections of geosynthetic reinforcement need not be overlapped except when exposed in a wrap-around face system, at which time the reinforcement rolls shall be overlapped or mechanically connected per the manufacturer's requirements.

Geosynthetic reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geosynthetic reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geosynthetic reinforcement in position until the subsequent soil layer can be placed.

During construction, the surface of the fill shall be kept approximately horizontal. Geosynthetic reinforcement shall be placed directly on the compacted horizontal fill surface.

The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to 2 inches higher than the connection elevation.

929-4.06 Reinforced Wall Fill Placement:

(A) General:

Reinforced wall fill placement shall closely follow erection of each course of facing panels. Backfill shall be placed in such a manner to avoid damage or disturbance of the wall materials, misalignment of facing panels, or damage to soil reinforcement or facing members. The Developer shall place backfill to the level of the connection and in such a manner as to ensure that no voids exist directly beneath reinforcing elements.

For walls with modular block facing units, the backfill shall not be advanced more than the height of a modular block unit until the drainage fill, core fill and all fill in all openings within

the blocks at that level have been placed. The filled units shall be swept clean of all debris before installing the next level of units and/or placing the geogrid materials.

For walls with flexible facing with gabion style facing, the rock near the wall face shall be hand-placed in accordance with the recommendations of the wall manufacturer.

The maximum lift thickness before compaction shall not exceed 12 inches.

For geosynthetic reinforcements, the fill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the geogrid remains taut. Construction equipment shall not operate directly on the geogrid. A minimum fill thickness of 6 inches over the geogrid shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

For metallic reinforcements, the fill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the steel reinforcement remains normal to the face of the wall. Construction equipment shall not operate directly on the steel reinforcement. A minimum fill thickness of 3 inches over the steel reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

Wall materials, including but not limited to wall panels, reinforcements, and drainage items, which are damaged during backfill placement shall be removed and replaced by the Developer. The Developer may submit alternative corrective procedures for consideration. Proposed alternative corrective procedures shall have the approval of the MSE wall supplier and designer, in writing, prior to submission for consideration. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer, who is registered as a Civil Engineer in the State of Arizona.

(B) Compaction:

Reinforced wall fill compaction requires a minimum of 2 roller passes of a vibratory roller having a minimum dynamic force of 6,000 pounds impact per vibration, and a minimum frequency of 1,000 vibrations per minute.

The vibratory roller shall be operated at speeds less than 3 feet per second.

Backfill within 3 feet of the wall face shall be compacted utilizing a hand operated vibratory plate.

Retained backfill shall be compacted and tested per section 203-10.03 (Embankment Construction Requirements) of the Standard Specifications which require 100 percent of the maximum density for an additional 50 feet beyond the limits of approach slabs.

(C) Protection of the Work:

The Developer shall not allow surface runoff from adjacent areas to enter the wall construction site at any time during construction operations. In addition, at the end of each day's operation, the Developer shall slope the last lift of backfill away from the wall facing so that runoff is directed away from the structure. If the subgrade is damaged due to water or otherwise, such that it does not meet the requirements of Subsection 929-4.02 of this specification, then the Developer shall rework and repair the damaged subgrade. The criteria in Subsection 929-4.02 of this specification shall be used to judge the adequacy of the repair. Rework and repair shall extend to a depth where undamaged work is encountered as determined by IQF and ADOT.

TP Attachment 700-1 – City of Phoenix Traffic Specifications and Details

SECTION 470

GENERAL REQUIREMENTS FOR TRAFFIC SIGNAL AND INTERSECTION LIGHTING SYSTEMS

470.1 DESCRIPTION:

It is the purpose of this section to provide general information necessary for completion of the installation of traffic signals, High Intensity Activated Crosswalk (HAWK) Pedestrian Beacon systems and intersection lighting in accordance with the details shown on the Approved Traffic Signal Plan, requirements of these specifications, and City of Phoenix Specifications for Public Works Construction, latest version; which is a combination of the Phoenix Supplement to the MAG Specifications in concert with the MAG Specifications.. All electrical systems and appurtenances shall be complete, functional and in operating condition at the time of acceptance.

470.2 DEFINITIONS:

The words defined in the following section shall for the purpose of these specifications have the meanings ascribed to them pertaining to signals and lighting.

470.2.1 Actuation: The operation of any type of controller initiated by a detector.

470.2.2 Back Plate: A thin metal strip extending outward parallel to the signal face on all sides of a signal housing to provide suitable background for the signal indications.

470.2.3 Controller: That part of the controller assembly, which performs the basic timing and logic functions for the operation of the traffic signal.

470.2.4 Controller Assembly: The complete assembly for controlling the operation of a traffic signal, consisting of a controller unit, and all auxiliary and external equipment housed in a weatherproof cabinet.

470.2.5 Coordinated Traffic Signal System: A group of signals timed together to provide a specific relationship among signal phases.

470.2.6 Cycle: A complete sequence of signal indications.

470.2.7 Detector: A device for indicating the passage or presence of vehicles or pedestrians.

> **470.2.7.1 Inductive Loop Detector:** A detector capable of sensing the passage or presence of a vehicle (or bicycle for loop placed in an exclusive bike lane) by a change in the inductance characteristics of the wire loop.
>
> **470.2.7.2 Pedestrian Detector (Pedestrian Push Button):** A detector for pedestrians, usually of the push button type.

470.2.7.3 Accessible Pedestrian Signal Detector (APS Push Button): A pedestrian detector that has added capabilities to meet the requirements of the MUTCD Section 4E.

470.2.7.4 Video Detector: Video Camera capable of detecting the presence or passage of vehicles or pedestrians.

470.2.7.5 Other Detector: A combination of a sensor and system processor capable of detecting the presence or passage of vehicles, bicycles, or pedestrians. Examples of such detection systems include, but are not limited, to a wireless embedded detector in pavement, infrared camera images, radar detection, or other detection devices used in concert with system processors.

470.2.8 Flasher: A device used to open and close signal circuits at a repetitive rate.

470.2.9 Flashing Feature: This feature, when operated, discontinues normal signal operation and causes a predetermined combination of flashing signal lights.

470.2.10 Interval: The part or parts of the signal cycle during which signal indications do not change.

470.2.11 Luminaire: The assembly, which houses the light source and controls the light emitted from the light source. Luminaires consist of a housing, lamp socket, reflector, lamp, photo cell, and glass globe or refractor when specified.

470.2.12 Manual Operation: The operation of a signal controller unit by means of a hand-operated switch.

470.2.13 Mounting Assembly: The framework and hardware required to mount the signal face(s) and pedestrian signal(s) to the pole.

470.2.14 Pedestrian Signal: A traffic control signal for the exclusive purpose of directing pedestrian traffic at signalized locations.

470.2.15 Pre-timed Controller Assembly: A controller assembly for operating traffic signals in accordance with a predetermined fixed-time cycle.

470.2.16 Red Clearance Interval: A clearance interval, which follows the yellow, change interval displaying a red indication to both the terminating phase and all conflicting phases prior to display of green for the next right-of-way phase.

470.2.17 Signal Face: An assembly controlling traffic in a single direction and consisting of one or more signal sections. Circular and arrow indications may be included in a signal assembly. The signal face assembly shall include back plate and visors.

470.2.18 Signal Indication: The illumination of a signal section or other device, or of a combination of sections or other devices at the same time.

470.2.19 Signal Section: A complete unit for providing a signal indication, consisting of a housing, lens, reflector, lamp receptacle and lamp, or LED unit.

470.2.20 Traffic Phase: A part of the time cycle allotted to any traffic movement or combination of movements receiving the right-of-way during one or more intervals.

470.2.21 Traffic-Actuated Controller Assembly: A controller assembly for operating traffic signals in accordance with the varying demands of traffic as registered with the controller unit by detectors.

470.2.22 Vehicle: Any motor vehicle normally licensed for highway use.

470.2.23 Yellow Change Interval: The first interval following the green right-of-way interval in which the signal indication for the phase is yellow.

470.3 REGULATIONS AND CODES:

All electrical equipment shall conform to the current standards of the National Electrical Manufacturers Association (NEMA), National Electric Safety Code (NESC), Underwriters' Laboratory Inc. (UL), when applicable. All material and workmanship shall conform to the requirements of the National Electric Code (NEC), Illumination Engineers Society (IES), Standards of the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the Approved Traffic Signal Plan, these specifications, the special provisions, and to any other codes, standards, or ordinances which may apply. Whenever references are made to any of the standards mentioned, the reference shall be interpreted to mean the code, ordinance, or standard that is in effect at the time of the bid advertisement.

470.4 SOURCE OF SUPPLY:

The Contractor shall furnish all traffic signal material and equipment required to complete the work except as noted on the Foundation Sheet of the Approved Traffic Signal Plan.

470.4.1 Quality Requirements: Only materials and equipment conforming to the requirements of these specifications shall be incorporated into the work. Material and equipment shall be new except as may be provided in the special provisions.

City of Phoenix reserves the right to reject proposed traffic signal material or equipment if, in the judgment of the Engineer or designee any or all the following may apply:

1) The equipment does not meet the requirements of the specifications.

2) The material or equipment’s past field performance has been unsatisfactory.

In addition, City of Phoenix reserves the right to pre-approve traffic signal material and equipment by brand name model or part number which in the judgment of the Engineer or designee meets the intended purpose of these specifications.

Deviations from the pre-approved materials list, if any, will be listed in the project special provisions or construction plans.

470.4.2 Approval of Material and Equipment: All traffic signal materials and equipment shall be approved by the Engineer or designee prior to incorporation in the work. Any work in which materials or equipment not previously approved are used shall be performed at the Contractor's risk and may be considered as unauthorized and unacceptable and not subject to the payment provisions of the contract. Such materials or equipment may be subject to removal at the discretion of the Engineer or designee.

The Contractor shall obtain the Engineer’s or designee’s approval before ordering or installing any material or equipment. The Contractor shall submit three (3) copies of each proposed material and/or

equipment list, including shop drawings. Each set shall include a three ring binder with section tabs separating the documentation for each major item being submitted. Submittal shall be to the City prior to or at the pre-construction conference. Allow two (2) weeks for the City to review the submitted documentation for each submittal. To be acceptable, the list shall be complete and comprehensive containing all items to be supplied on the project by the Contractor, including pre-approved items. COP reserves the right to reject any incomplete or unclear material submittal. All items on the list shall be identified by manufacturer's part number, model, accessories, specification, or other pertinent catalogue information. The materials from any catalog cuts shall be clearly indicated by the contractor. If standard manufacturer documentation does not specifically address all the product requirements that are required, then the Contractor shall obtain a letter from the manufacturer certifying compliance with each referenced requirement that is not indicated on the standard documentation. One (1) copy will be returned to the Contractor for further action.

All equipment or material specified or shown on approved signal plans, or other drawings, by brand name, part number, or model number is intended to be descriptive of the type and quality of material or equipment desired. Another equal brand name, part number, or model number may be substituted so long as it is in accordance with these specifications and is equal in form, fit, function, performance, reliability, and is approved by the Engineer.

The contractor shall provide complete wiring diagrams for controller assemblies and auxiliary controller cabinets at the time of delivery for testing. Four (4) sets of prints shall be provided with each controller assembly. The wiring diagram shall illustrate all circuits and components in detail. All components shall be identified by name or number so as to be clearly noted in the drawings.

Final approval, in writing by the COP Traffic Signal Engineer or designee, on all items within the submitted documentation is required to be obtained by the Contractor.

It is the Contractor’s responsibility to ensure adequate lead time in ordering signal equipment to prevent project delay. The Contractor shall notify the Engineer or designee in the event signal equipment is not received in a timely manner.

470.4.3 Warranties and Guaranties: The following is required by the City of Phoenix for traffic signal related items. The warranty period will begin the day the Work of this Section is accepted by the City of Phoenix. Submit all manufacturer warranties to the City of Phoenix prior to installation. Expiration of the contractor’s warranty under this section does not relieve the manufacturer should the manufacturer warranties exceed that of the contractor. The warranty period for the following items are extended beyond the one-year requirement as noted herein.

470.4.3.1 LED Indications Warrant all LED indication modules furnished by the Contractor for five years following commencement of the warranty period against manufacturing and installation defects.

470.4.3.2 Pedestrian Signal Heads Warrant the entire pedestrian signal head assemblies, including the housing, doorframe, and visor for two years from the date of acceptance by the COP against defects in workmanship and/or Material.

470.4.3.3 Traffic Signal Heads Warrant the entire traffic signal head assembly, including the housing, doorframe, and visor for two years from the date of acceptance by the COP against defects in workmanship and/or Material.

470.4.3.4 Detectors Warrant all detectors, including loops, video detection cameras, pedestrian buttons and APS Pushbuttons for two years from the date of acceptance by the COP against defects in workmanship and/or Material.

470.5 CITY OF PHOENIX FURNISHED MATERIAL AND EQUIPMENT:

Traffic signal material and equipment furnished by City of Phoenix or tested by City of Phoenix that is to be installed by the contractor will be made available at the following address:

City of Phoenix Traffic Signal Shop

2141 E. Jefferson St.

Phoenix, Arizona 85034

The Contractor shall contact the City of Phoenix Traffic Signal Supervisor (602) 262-6733 five working days prior to desired pick-up date to confirm the item list, availability, date and time. Warehouse hours for pick-up and delivery are 8:00 am – 2:00 pm Monday through Friday.

The cost of handling and placing all material and equipment, including pick-up by the Contractor is included in the contract price of the associated pay item. The Contractor using the Contractor's equipment shall load the furnished materials (poles, mast arms, etc.) onto the Contractor's vehicle for transportation to the project site. COP personnel shall not load the materials. The Contractor shall be responsible for any damage that occurs during the loading process.

The Contractor will be held responsible for all material and equipment received. The Traffic Signal Supervisor or designee will issue a receipt for the materials provided. All materials will be issued in serviceable condition; the Contractor will note any exceptions on the receipt. The receipt will be placed in the project file and a copy given to the Contractor. The cost to make good any shortages or deficiencies, from any cause whatsoever and for any damage which may occur after receipt will be deducted from any monies due or becoming due to the Contractor.

470.6 INSTALLATION OF TRAFFIC SIGNALS AND RELATED ITEMS:

470.6.1 General: The Contractor shall furnish labor and supervision with experience in the construction of the traffic signals and all materials, equipment, tools, transportation, and supplies required to complete the work in an acceptable manner; within the time specified, and in full compliance to these specifications, terms of the contract, the Approved Traffic Signal Plan and COP Traffic Signal Details.

The contractor shall have a competent supervisor capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the construction of traffic signals assigned to the project. The Contractor's supervisor shall possess a current International Municipal Signal Association (IMSA) Level II Traffic Signal Electrician Certification. The Contractor shall have a complete set of construction drawings including current City of Phoenix standards and Traffic Signal Details on site at all times during signal & lighting systems construction.

A Level II IMSA certified Technician/Electrician must be on each Work Site at all times while work is being performed on traffic signal and other traffic control systems installed within the City of Phoenix.

Conductor splices and terminations may only be made by a qualified Journeyman Electrician, who has successfully completed a recognized four (4) year electrical apprenticeship program or equivalent

training, or by a person enrolled in a recognized four (4) year electrical apprenticeship program, while under the direct supervision of a Journeyman Electrician

470.6.2 Traffic Signal Plan: The Approved Traffic Signal Plan graphically describes the location of signal component parts, the equipment and materials to be used, and the standards for construction. The plans shall be supplemented by City of Phoenix Traffic Signal Standard Details or other drawing(s) deemed necessary for the acceptable completion of the work.

After completion of the project, the Contractor shall provide the Engineer with a set of as-built drawings on clean prints of the original drawings. The as-built drawing shall indicate in a neat and accurate manner all changes and revisions in the original design. As-built drawings shall be submitted before final payment for completed work will be made.

470.7 MAINTENANCE OF TRAFFIC SIGNALS AND RELATED ITEMS DURING CONSTRUCTION:

Unless otherwise specified, the City of Phoenix will operate and maintain the existing traffic signal equipment during construction. Once new traffic signal equipment is in place and accepted, the City of Phoenix will assume operation and maintenance responsibilities.

Unscheduled traffic signal work or maintenance calls performed by the City caused by contractor damage or negligence to an existing signalized intersection will be billed directly to the contractor.

SECTION 471

ELECTRICAL UNDERGROUND INSTALLATION

471.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing electrical conduit, and pull boxes for traffic signals and intersection lighting including jacking, drilling, excavating, placing, and compacting backfill material in accordance with the locations shown on the Approved Traffic Signal Plan.

471.2 MATERIALS:

471.2.1 Electrical Conduit: All conduit and conduit fittings shall be listed by UL, and conform to NEC standards. Except as specified below, all conduit to be installed underground or in concrete structures shall be rigid polyvinyl chloride (PVC) conforming to the requirements of UL 651 for Rigid Nonmetallic Conduit. PVC conduit and conduit fittings shall be Schedule 40, heavy wall, manufactured from high impact material and shall be rated for use at 90º C.

All exposed conduit and conduit fittings to be installed above ground shall be rigid metallic type manufactured of galvanized steel conforming to requirements of UL 6 for Rigid Metallic Conduit and to NEC standards.

471.2.2 Pull Boxes: Pull boxes, pull box covers, and pull box extensions shall be constructed of polymer concrete with reinforced heavy-weave fiberglass. Pull boxes and covers shall be concrete gray color, rated for and meet AASHTO H-20 specifications. Pull boxes shall be stackable for extra depth. Box sizes shall be acceptable industry standard and use nominal lid sizes of:

#3.5 Junction box 10” x 15”

5 Junction box 13” x 24”

#7 Junction box 17” x 30”

Additionally, boxes shall be a minimum of 12” in depth, and have no floors or mouse holes.

Covers shall be cast to allow securing with two (2) corrosion resistant metallic hex bolts with corrosion resistant metallic washers and nuts. Covers shall also be cast with a non skid resistant surface and have a nominal thickness of two inches and meet AASHTO H-20 specifications.

The words “TRAFFIC SIGNAL” shall be cast in the pull box covers in 1-inch high letters.

At the request of the Engineer, the Contractor shall furnish pull box plans and specifications.

Chipped or cracked pull boxes, covers, and extensions will not be accepted.

Metal covers are NOT acceptable.

471.2.3 Detectable Mule Tape: A detectable mule tape is a flat, woven, polyester tape with an insulated locating conductor. The conductor shall be a metallic 22 gauge insulated wire. The mule tape shall be a minimum ¼” width with a pull strength of 400 pounds.

471.3 CONSTRUCTION REQUIREMENTS:

471.3.1 General Requirements for Installation of Electrical Conduit: Conduit shall be furnished and installed at the locations and of the sizes shown on the Approved Traffic Signal Plan. Unless changes are necessary to avoid underground obstructions, all underground conduit shall be installed in a straight line from pull box to pull box and/or from foundation to pull box and shall be of one continuous size. Any change in conduit routing must be approved by the Engineer and documented by the Contractor on as-built traffic signal plans.

Conduit will be placed in a variety of locations such as under existing pavement or sidewalk, under sod or other pervious surface, under new pavement or attached to a structure such as a bridge pier, metal or wood pole. Conduit under existing pavement or sidewalk requires additional labor and materials over that which would be required under new pavement, sod, or other pervious surface. The payment for this section will be divided into three categories, Under Existing Pavement, Under New Pavement or Landscaping, and Attached to Structure. The contractor can choose the method of construction for each type.

All PVC conduits shall be stored and handled in an approved manner to minimize ultraviolet deterioration due to exposure to sunlight.

The PVC conduit shall be cut square and trimmed to remove all rough edges. PVC conduit connections shall be of the solvent weld type. Purple primer conforming to the requirements of ASTM F 656 shall be applied to the joined surfaces prior to use of cement. The joint cement shall be the gray PVC cement conforming to the requirements of ASTM D 2564. Where a connection is made to rigid metallic conduit, the coupling used shall be a PVC female adapter.

All existing conduits and conduit embedded in concrete structures shall be cleaned out with a mandrel and blown out with compressed air.

Field PVC conduit bends shall be made without crimping or flattening, using the longest radius practical but not less than specified by the NEC. Collapsed conduit, no matter how small, is not acceptable. The number of bends between pull boxes or between pull box and foundations shall not contain more than equivalent of two quarter bends (180 degrees, total), including the bends at the pull boxes or foundations, unless authorized by the Engineer.

Conduit entering a pull box or foundation shall be fitted with a factory made 90-degree elbow with a minimum sweep radius per the table below:

Conduit Size	Sweep Radius
2 inches	15 inches
2 ½ inches	18 inches
3 inches	21 inches

Conduit entering pull boxes shall terminate a minimum of 3” inside the box wall. The conduit shall be between 2” and 4” above the bottom. Conduit entering through the bottom of a pull box shall be located near the sides and ends and extend no more than 4” above the bottom of the pull box including the length of the conduit bell end in order to leave the major interior portion clear. At all outlets, conduits shall enter from the direction of the run and allow for expansion and contraction.

Conduit for future use shall have a detectable mule tape. All conduits shall have a No. 10 AWG bare copper wire installed that extends 36 inches beyond each end of the PVC conduit run between pull boxes and foundations. The pull rope, if needed, and bond wire shall be coiled and inserted into the conduit so as to be easily recovered from either end. Conduit ends shall be capped with conduit end cap fittings after the pull rope is installed. Conduit end cap shall remain in place until wiring is started. When end caps are removed, PVC ends shall be provided with an approved conduit end bell. End bells shall be installed prior to the installation of the conductors. Approved insulated grounding bushings shall be used on steel conduit ends.

The Contractor shall place a warning tape in all open trenches in which conduit is placed. All warning tape shall be buried at a depth of 6" to 8" below final grade.

Where conduit is to be installed under existing roadway pavement by jacking or drilling methods, the jacking and/or drilling pits shall be kept 2 feet clear of the edge of the pavement.

Conduit stub-outs under curbs or roadway edges for loop detection lead-in conductors shall conform to the requirements of COP Standard Details

Installation of conduit for underground electrical service shall be in accordance with the Standard Details, as shown on the Approved Traffic Signal Plan and in accordance with the requirements of the utility company providing electrical service. Conduit installed in railroad right-of-way shall be installed in accordance with the requirements of the railroad company.

471.3.2 Conduit Depth Requirements: Conduits installed in protected areas such as behind curbs, under sidewalks, etc. that are not subject to any vehicular traffic shall be at a minimum depth of 24 inches below final grade. Conduits installed under roadways, driveways, or any open area where there is the possibility of vehicular traffic, shall be installed at a minimum depth of 24 inches below final grade. Unless otherwise stated on the plans, conduit depths shall not exceed 40 inches. When conduit cannot be installed at the minimum depth, it shall be completely encased in 4" of class C concrete.

471.3.3 Trenching, Backfilling, and Compaction: Trenches shall not be excavated wider than necessary for the proper placement of conduit and pull boxes. Trenching shall be done in accordance with MAG Section 601. Backfilling, compaction, and bedding of conduit runs shall be in accordance with MAG Section 601.4.9.

Open trench excavation across any existing paved areas, shall have two (2) parallel cuts made at a distance not to exceed 16 inches. All removal and replacement of existing paved areas shall be in accordance with MAG Section 336.

Open trench excavation across an existing Portland concrete area shall have two (2) parallel cuts made at a distance not to exceed 16 inches. All removal and replacement of existing Portland concrete areas shall be done in accordance with MAG Section 336.

After each excavation is complete and materials in place, the Contractor shall notify the Engineer for inspection, and under no circumstances shall any underground material or equipment be covered with fill without proper approval.

471.3.4 Installation of Pull Boxes: Pull boxes of the type specified on the Approved Traffic Signal Plan shall be furnished and installed at the locations shown on the Plan. Pull boxes shall be installed in accordance with COP Traffic Signal Standard Details. All relocation of pull boxes to avoid driveways

and/or other structures shall be approved by the Engineer and documented by the Contractor on the as-built traffic signal plans.

Pull boxes shall be set and adjusted so that they are flush at curb or sidewalk grade. When no grade is established, pull boxes shall be set as requested by the Engineer. All pull box covers shall be secured with the required bolts and washers before final acceptance of the project. All pull boxes shall be left in a clean condition, free of dirt and debris upon completion of the work. Drainage sump 18" required as per COP Traffic Signal Detail Sheet.

SECTION 472

TRAFFIC SIGNAL FOUNDATIONS

472.1 DESCRIPTION:

The work under this section shall consist of furnishing all materials and constructing all traffic signal foundations and other designated pole foundations including signal poles, as well as cabinet and electrical service pedestal foundations for the traffic signals in accordance with the locations and details designated on the Foundation Sheet of the Approved Traffic Signal Plan. Pole foundations shall include all conduits, conduit elbows, anchor bolts, re-bar cages, grounding electrode, and forms required for construction of the foundation. The traffic signal pole foundations shall conform to the requirements of COP Traffic Signal Details or ADOT Standards for ADOT approved poles and related pole foundations.

The controller and power service pedestal cabinet foundations shall conform to the requirements of COP Traffic Signal Details.

472.2 MATERIALS:

472.2.1 Excavation and Backfill: Trenches shall not be excavated wider than necessary for the proper placement of conduit and pull boxes. Trenching, backfilling, and compaction shall be done in accordance with MAG Section 601.

All excavations within the roadway shall be backfilled and compacted in accordance with MAG Section 211.

472.2.2 Concrete: Concrete used for all foundations shall be class 'A', 3000 psi concrete with a 5" slump and shall be in accordance with the requirements of MAG Section 725.

472.2.3 Anchor Bolts: All anchor bolts shall be in accordance with referenced details, for the relevant traffic signal foundations.

All anchor bolts shall be threaded at the top and conform to the plans.

472.2.4 Rebar Cage: All rebar cages shall be in accordance with referenced details.

472.2.5 Electrical Conduit: All electrical conduit and conduit fittings shall be sized as per the plans sheets and in accordance with these specifications. All foundation conduits shall be grey Schedule 40 PVC.

472.2.6 Grounding Electrode: The grounding electrode shall be in accordance with these specifications and COP Traffic Signal Details.

A 25-foot coil of #4 AWG stranded bare copper grounding electrode shall be installed at the base of the signal pole foundations and extend centered, two feet above the top of the foundation.

Traffic signal controller and power service pedestal foundations shall have a 1-inch PVC ground rod sleeve and a 5/8 inch x 8 foot bonded copper grounding rod installed.

472.3 CONSTRUCTION REQUIREMENTS:

The excavations required for the installation of foundations and other items shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping and other improvements. Any damage by the contractor's operation shall be replaced or reconstructed where determined by the Engineer or designee at the expense of the contractor. The trenches shall not be excavated wider than necessary for the proper construction of the foundations and other equipment. Excavation shall not be performed until immediately before construction of foundations. The material from the excavation shall be placed in a position that will minimize obstructions to traffic and interference with surface drainage.

All surplus excavated material shall be removed and properly disposed of within 48 hours by the contractor, as directed by the Engineer or designee. After each excavation is completed, the contractor shall notify the Engineer for inspection. Under no circumstances shall any underground materials or equipment be covered with fill without the approval of the Engineer or designee.

At the end of each working period, all excavations shall be barricaded or covered, or both, to provide safe passage for pedestrian and vehicular traffic.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted at any time, unless otherwise provided in the Special Provisions.

Sidewalk and pavement excavations shall be kept well covered and protected to provide safe passage for pedestrian and vehicular traffic until permanent repairs are made.

The elevation of signal pole foundations shall be set as follows unless otherwise noted within the construction plans or special provisions. Signal pole foundations shall be set flush (+/- ½") with the existing or new sidewalk when sidewalk is present. Where curb exists without sidewalk, the foundations shall be set flush with a surface defined by a 1.5% upward slope from the top of curb (+/- ½"). Where there is no curb or sidewalk pole foundations shall be as shown on the project plans. The dimensions and locations of foundations shall be as specified on the project plans; however, the Engineer or designee may direct that changes be made in locations due to obstructions or other existing conditions. Any change in locations shall be documented by the contractor on as-built traffic signal plans. The contractor shall verify top of foundation elevations with the Engineer or designee prior to foundation construction.

Prior to pouring concrete, the grounding electrode shall be placed at least 6" below the required depth of the foundation and covered with 6" of soil.

Concrete shall be placed in holes which have been augured against undisturbed earth. If the material in the bottom of the hole is not firm and stable, it shall be compacted or treated as directed by the Engineer or designee. The walls and the bottoms of the holes shall be thoroughly moistened prior to placing concrete.

If the soil is not stable, a deeper foundation than specified may be required or forms shall be used as determined by the Engineer or designee. The forms shall be of the proper size and dimensions and shall be rigid and securely braced.

Foundation forming material shall extend no more than 20 inches below the foundation final grade and shall be removed after placement and curing of concrete.

Anchor bolts shall be oriented such that the bolt pattern sides are both parallel and perpendicular to the roadway centerlines unless otherwise specified on the Approved Traffic Signal Plan. A 25-foot coil of No. 4 AWG bare copper conductor shall be installed 4" below the foundation and covered with 4 "of fill

material such that no part of the coils will be in contact with the concrete foundation. An extension of the No. 4 AWG bare copper wire shall extend into the pole. Anchor bolts, conduit, and rebar cage shall be centered within the foundation, set at the specified height and plumb within ±1/2 degree. During placement of concrete, anchor bolts shall be securely held in proper alignment, position, and height with a suitable template.

After excavations are completed and anchor bolts and conduit installed, the Contractor shall notify the Engineer or designee for inspection. Under no Circumstances shall concrete be placed without approval of the Engineer or designee.

The concrete pour shall be continuous and consolidated by means of vibrators. All exposed surfaces of the foundation shall receive a finish that is smooth, level, and free of form marks.

Type 'A' and 'Pedestrian' pole foundations, cabinet foundation, and service pedestal foundation shall set for a minimum of five (5) days prior to installation of poles and/or cabinets. Type ‘LM’, ‘SM’, ‘SR’, ‘SQ’ and standard ADOT pole foundations shall set for ten (10) days prior to installation of poles.

SECTION 473

DETECTORS

473.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing vehicular and pedestrian detectors at the locations and sizes shown on the Approved Traffic Signal Plan and in accordance with the requirements of these specifications and the COP Traffic Signal Details. Shielded Loop Detector Cable shall be installed and paid for under Electrical Conductors.

473.2 MATERIALS:

473.2.1 Loop Detector Sensor Wire: Loop detector sensors shall be of the size and type specified on the Traffic Signal Plan and shall conform to the requirements of COP Traffic Signal Details. Roadway loop detector sensor wire shall conform to IMSA specification 51-5 with orange jacket and installed in accordance with the requirements of these specifications and COP Traffic Signal Details.

473.2.3 Cold Applied Emulsion Sealant: The loop sealant shall be a single component asphaltic emulsion sealant designed to fill and seal inductive loop saw cuts. Loop sealant shall be "Tri-American TA-500" or approved equal.

SPECIFICATIONS

TEST PARAMETER	LIMITS	TEST METHOD
Residue by evaporation, weight percent	70 min	ASTM D 2939
Ash content, weight percent	50 min	ASTM D 2939
Firm set time, hours	4 max	ASTM D 2939
Brookfield viscosity, Poise RVT Spindle #3, 10 RPM at 75 ± 2 º F	50 to 125 °F	
Tensile strength, psi	20 min	ASTM D 2523
Elongation, %	2.0 min	ASTM D 2523
Flexibility	No full depth cracks	ASTM D 2939 SEE NOTE BELOW
Resistance to water	No blistering, re-emulsification or loss of adhesion	ASTM D 2939, Alternative B

NOTE: Flexibility: Except air-dry specimens to constant weight at 75º ± 5º F and 50º ± 10º F relative humidity. Condition the mandrel and specimens for 2 hours at 75º ± 2º F before test.

473.2.4 Pedestrian Detectors (Pedestrian Push Buttons): The standard required pedestrian detector shall be the Accessible Pedestrian Signal Detector as described in Section 473.2.5 unless the plans specify a pedestrian push button. All pedestrian detectors shall be in accordance with the Americans with Disabilities Act Accessibility Guidelines (latest revision). Pedestrian Push buttons shall be installed as per COP Traffic Signal Details, and meet the following specifications:

1. Body and cover shall be cast aluminum using four (4) brass or stainless-steel Phillips head screws, #8 x 32 x 1", for securing the cover to the body.
2. Body and cover must have an industry standard bolt pattern and design to allow for retrofit of existing units in the field.
3. Body shall be without a sign mount and approximately three (3) inches in diameter.
4. Operation button shall be stainless steel two (2) inches in diameter, (large ADA), with a tamper-proof vandal resistant housing.
5. Operating switch shall be mechanical (no exceptions).
6. The switch shall be the phenolic-enclosed SPST-type with momentary contacts.
7. The switch shall operate in the normally open position.
8. The switch shall have screw-type terminals and shall have a rated life of not less than one million operations.
9. The contacts shall be rated at 15 amps and 125 volts AC.
10. Cover and body will be painted black. Powder coated will be accepted.
11. The body of each pedestrian push button assembly shall have a ½" to ¾" hole located in the center of the base assembly. There shall also be two (2) 5/16" holes in the base assembly 1" above and 1" below the center point in the back of the housing.
12. Each base assembly shall have a curved back or be supplied with a "U" channel mounting bracket to facilitate the mounting of the assembly on round pole surfaces.
13. The mounting bracket shall be 2 ½" long and 1 1/8" wide with 3/8" flanges on each side. Each mounting bracket shall have a 7/8" hole in the center of the bracket and 5/16" holes located 1" above and 1" below the center of the 7/8" hole.

473.2.5 Accessible Pedestrian Signal Detector (APS Push Buttons):

A. General:

1. Conform to applicable sections of the current MUTCD Chapter 4E, Pedestrian Control Features as specified herein.
2. All features fully operational when the traffic signal is in stop-and-go mode.
3. All features non-operational when the traffic signal is in flash mode.
4. Interchangeable with a non-accessible type pedestrian pushbutton with no modifications to the Controller Assembly (CA) or Controller Unit.
5. Audible transducer integral with the APS&D housing, adjacent to the pushbutton.

B. Electrical:

1. Metallic components either grounded or insulated to preclude an electrical hazard to pedestrians under all weather conditions.
2. All features powered by the 110VAC Walk signal and the 110VAC Don't Walk signal so that additional conductors from the CA are not needed.

C Audible Pushbutton Locator

1. Frequency: repeating tone at one (1) cycle per second
2. Tone duration: ≤ 0.15 seconds
3. Volume:
   a. Minimum setting of zero
   b. Manually adjustable initial setting
   c. Automatically adjusted after initial setting. Volume increased in response to a temporary increase in ambient noise and subsequently decreased with a decrease in ambient noise.
   d. Maximum volume: 100 dBA which is the approximate sound pressure of a gasoline powered lawn mower nearby.
   e. Automatic volume adjustment independent of other APS&Ds at the intersection.
   f. May be disabled without affecting operation of audible pedestrian signal.
4. Silent only during walk interval. Active all other times.

D. Vibratory Tactile Arrow Pushbutton

1. Pushbutton contained in a circular assembly which fits inside the housing and is attached to the housing with 4 screws.
2. ADA compliant: Size: ≥ 2.0” (50) diameter, Actuation force: ≤ 5 ft-lb (22.2 N)
3. Shape: Circular, raised slightly above housing so that it may be actuated with the back of a hand
4. Tamper-proof, vandal-proof, weatherproof, freeze-proof, impact-resistant design and construction.
5. Actuation method: Piezo technology. Mechanical not allowed.
6. Operation: Vibrates only when walk signal is displayed. Inactive all other times
7. Tactile Arrow:
   a. Attached to surface of the button assembly by a tamperproof method that allows direction of arrow to be field adjusted left or right to be parallel to the corresponding crosswalk.
   b. Raised slightly above surface of pushbutton, minimum 0.125” (0.3).
   c. Size: Length ≥ 1.5” (38), Height ≥ 1.0” (25)
   d. Color: Sharp contrast to background color of pushbutton and housing

E. Audible Walk Interval

General:

1. Operation independent of other APS&Ds at intersection.
2. Active only during the walk interval (when the walk signal is displayed).
3. Volume:
   a. Minimum setting of zero
   b. Manually adjustable initial setting
   c. Automatically adjusted after initial setting. Volume increased in response to a temporary increase in ambient noise and subsequently decreased with a decrease in ambient noise.
   d. Automatic volume adjustment independent of other APS&Ds at the intersection.
   e. Maximum volume: 100 dBA which is the approximate sound pressure of a gasoline powered lawn mower nearby.
4. Duration:
   a. Default method: Automatically set by the duration of the visual walk signal display.
   b. When selected: Manually set when rest-in-walk is used for a concurrent pedestrian movement.
5. Audible sounds that mimic any bird call are not allowed.

F. Type A, Percussive Tone:

1. Repeating tone at eight (8) to ten (10) ticks per second.

2. Tone frequency: Multiple frequencies with a dominant component at 880 Hz which creates a “tick - tick - tick…” sound.

G. Pushbutton Housing/Sign Frame/Sign

1. One-piece die cast aluminum meeting requirements of ASTM B85.
2. Sign frame designed to accept 9" x 12" (230 x 300) four-hole advisory sign.
3. Flat back to facilitate surface mount.
4. Available brackets to either pedestal top-mount or pole side-mount on pole diameter range of 3½" (89) to 15" (380).
5. Available brackets to allow mounting two (2) APS&Ds to the same 3½” (89) pole, facing ≥ 60 degrees apart, at the same height.
6. Wire entrance through the rear.
7. Stainless steel mounting hardware.
8. Color: Dark Green, Federal No 14056, Federal standard No. 595
    a. Finish: Housing/Frame and all mounting brackets either:
        1. Painted with 3 coats of infrared oven-baked paint before assembly.
        2. Primer: Baked iron oxide which meets or exceeds FS TT-P-636.
        3. Second coat: Exterior-baking enamel, light gray, which meets or exceeds FS TT-E-527.
        4. Third coat: Exterior-baking enamel, which meets or exceeds FS TT-E-489.
        5. Electrostatic powder coated after chemically cleaned.
9. Sign: CT DOT Sign No. 31-0845

473.2.6 Non-Intrusive Detection System: Each intersection shall be equipped with a “non-intrusive” detection system installed in accordance with the manufacturer’s installation instructions and requirements of these specifications. “Non-intrusive” is defined as having no devices embedded in the roadway surface or subsurface. These include video, radar, and thermal imaging detection systems.

A. As a minimum, a single detector shall be capable of capturing vehicles and bicycles in each lane up to four vehicle lanes and one bicycle lane per approach at the stop bar.

B. Provide vehicular detection zone(s) to extend a minimum of 60 feet from the stop bar.

C. An optional feature would be to distinguish bicycles from vehicles at the stop bar.

D. When specified, provide advance vehicular detection at a maximum distance of 400 feet from the stop bar.

E. The detection system shall be capable of emulating the current third car detection system used by Phoenix in signalized left turn lanes. This requires independent multiple detection zones within a single lane.

F. If detection processor cards are used, no more than four (4) detection processor cards shall be required for a standard 4-legged intersection.

G. No more than 4 detector slots shall be used for a standard 4-legged intersection.

H. Detection cards where used shall be compatible with NEMA TS/2 Cabinets, Econolite ASC/2, ASC/3, Cobalt Classic, and ATC controllers.

I. The manufacturer shall have the capability of providing a conversion kit for use in a TS/1 cabinet.

J. Detection equipment and power supplies shall be rated to operate properly at minimum between -34°C and +74°C, (-30°F and +165°F). Power requirements shall be compatible within a TS/1 and TS/2 cabinet.

K. Camera detection systems shall have the ability to transmit MPEG4, MJPEG or H.264 video compression over TCP/IP network. The TMC client software shall have the ability to configure detection zones within the selected camera view and have the ability to upload /download the current configuration to the camera detector processor.

L. Camera detection shall have the ability to detect and ignore vehicle shadows traversing the detection zones.

M. Image detection systems shall have the ability to stream images from all cameras at the intersection simultaneously without adverse effects to the detection or the image stream.

Network Communication Requirements

A. The detection equipment shall be compatible with standard TCP/IP Ethernet communication protocols and have the ability to be configured remotely from the Traffic Management Center (TMC). It shall be compatible with Tropos Communications routers and be able to transmit data through a Tropos Mesh network, fiber communications network and P2P wireless radios.

B. The detection processor(s) shall have an Ethernet RJ45 interface and have the ability to be configured locally and remotely via web interface or client software. Client software shall be compatible with Win7 to the current Windows operating systems and Firefox, Internet Explorer and Chrome latest version browsers.

C. The detection processor shall be capable of remote access for all of the detectors attached to that processor at the same time.

D. Detection systems shall have the ability to transmit broadband communication over TCP/IP network.

E. The TMC client software shall have the ability to configure detection zones within the selected detector view, and have the ability to upload /download the current configuration to the detector processor.

F. The manufacturer shall have the capability to remotely record detection operation (images and detection zones) through the RJ45 connection.

G. The manufacturer shall have the capability to save configurations by time- of-day.

H. Client software and detection firmware updates shall be provided and have the ability to be upgraded by the City of Phoenix signal technician staff at no cost to the City.

I. Non-intrusive Detection equipment shall be an Aldis GridSmart System, Econolite Camera Detection System, Flir Thermal Imaging Camera System, ITS +++ Camera Detection System, Wavetronix, meeting the above requirements; or approved equal.

473.3 CONSTRUCTION REQUIREMENTS:

473.3.1 Vehicular/Bike Loop Detector Sensors:

473.3.1.1 General: Vehicular loop detector sensors of the size and type specified on the Approved Traffic Signal Plan shall be installed in accordance with the locations shown on the Approved Traffic Signal Plan and the requirements of these specifications. Any change in loop detector sensor location or deviation in loop detector sensor installation not in accordance with these specifications must be approved by the Engineer or designee and documented by the Contractor on as-built signal plans. The installation of the detectors shall be such that the operation shall not be affected by temperature changes, water, ice, rain, snow, chemicals, or electromagnetic noise.

473.3.1.2 Loop Detector Sensor Conductor Installation:

1. Loop placement will be as shown on the plans. The Contractor will mark loops in the field and the locations approved in writing by the COP before work on the loop may begin.

2. Slots and cores are to be saw cut and drilled into the final asphalt/concrete base course lift as shown in the COP Traffic Signal Standard Details.

3. To ensure that all saw cuts are true and straight a loop sensor layout shall first be made on the pavement surface.

4. Slots are to be ½" (one-half inch) wide and of sufficient depth to allow 2" (two inches) of sealant coverage.

5. Drill cores, located in corners and ends of center cuts, are to be 2 ½" (two and one-half inches) in diameter and 2 ½" (two and one-half inches) deep.

6. The sawed slot shall extend to the curbside PVC conduit for each loop sensor.

7. Separate lead-in sawed slots extending from the loop to the stub-out conduit shall be cut for each loop sensor.

8. Slots are to be blown out and dried before installation of wires.

9. Loop conductors are to be installed ONLY in the presence of the COP's representative.

10. Loop detector conductors will not be spliced.

11. Each loop is to be wound in the direction and number of turns indicated on the City of Phoenix Traffic Signal Details.

12. Loop lead-ins from the loop to the junction box are to be wound at three turns per foot. Twisted pairs will be taped full length from the exit of the sawed loop slot in the roadway to the connection with the shielded loop detector cable in the junction box.

13. The beginning conductor will be banded in the junction with the symbol “S”, and the loop identified by a number of taped rings as shown on the Plans.

14. Each loop will be provided with a minimum of 6’ (six feet) of slack in the twisted pair of conductors at the junction box when measured from the top of the junction box.

15. Loops are to be sealed only after completion of successful testing.

16. Testing may be conducted ONLY in the presence of the COP’s representative. Tests are to include the following:
    a. Meggar Test – A 600-volt meggar test will show not less than 10 (ten) megohms resistance to ground.
    b. Continuity – Loop circuit resistance is not to exceed 2 (two) ohms.

17. Successful completion of tests will be documented in writing by the COP.

18. After completion of successful testing, the loops are to be sealed.

19. Sealant is to be poured into the slots and drill cores and struck flush with the roadway surface. Excess sealant will be removed from the surface of the roadway.

20. The conduit entrance to the roadway will be sealed in accordance with the COP Traffic Signal Details.

473.3.1.3 Sawcut Sealant: The loop sensor conductors shall be permanently anchored in the sawed slot using the cold applied single component emulsion sealant as specified. The sealant shall completely surround the loop sensor conductors and fill the sawed slot to within 1/8 inch of the pavement surface. Surplus sealant shall be removed from the road surface without the use of solvents. Traffic lane closure shall remain in place until the sealant is set up; Contractor shall cleanup sealant tracking problems at no additional cost to the City.

The emulsion sealant shall be thoroughly mixed per the manufacturer’s recommendations. The emulsion sealant may be poured directly from container or any other suitable applicator, applied into saw cuts.

473.3.1.4 Loop Detector Sensor Connection: Each pair of loop sensor conductors entering the curb-side pull box shall be identified as to which loop it represents (i.e. inside lane, outside lane, through lane, or left turn lane) as per COP Traffic Signal Standard Details. Each conductor pair shall also be marked to signify its winding direction, "S" for start and "F" for finish.

Up to three loop detector sensors can be connected to one shielded loop detector cable per curb-side pull box at a corner of an intersection. Shielded loop detector cable shall run continuous and unspliced from curb-side pull box to the controller cabinet. The loop sensor conductors shall be spliced to the shielded loop detector cables in the adjacent curb-side pull box with each loop having its own splice to an individual twisted pair in the shielded loop detector cable. Shielded Loop Detector Cable is paid for under separate item.

473.3.2 Pedestrian Push Button: Drill appropriate size hole for wire entrance and tap screws as provided by manufacturer's installation instructions at the appropriate height. Mount push buttons to the pole using the hardware as specified by the manufacturer.

Pedestrian push buttons will be wired from the terminal block in the push button to the point of connection in the hand hole at the base of the traffic signal pole plus an additional 16 inches beyond the hand hole with continuous lengths of single conductor wire of the appropriate color. Pedestrian push button wires will not be taped together except at the hand hole in the pole base as shown on the Plans and through drilled pole wire entrance as described herein.

473.3.3 APS Push Button: Drill appropriate size hole for wire entrance and tap screws as provided by manufacturer's installation instructions at the appropriate height. Mount APS push buttons to the pole using the hardware as specified by the manufacturer. Install APS controller unit in the appropriate pedestrian signal head.

APS Pedestrian push buttons will be wired from the terminal block in the push button to the point of connection in the hand hole at the base of the traffic signal pole plus an additional 16 inches beyond the hand hole with continuous lengths of single conductor wire of the appropriate color. Pedestrian push button wires will not be taped together except at the hand hole in the pole base as shown on the Plans and through drilled pole wire entrance as described herein. APS push buttons have a four conductor cable that is to be installed in the pole to connect with the APS Controller Unit. If the cable provided is of insufficient length, splice a four conductor cable with the same color conductors as recommended by the manufacturer to complete the circuit.

473.3.4 Non-Intrusive Detection System: Mount the detector to the pole or mast arm using the hardware and installation instructions as specified by the manufacturer. Provide and run the manufacturer's specified wire from the non-intrusive detector from the mount through the mast arm or pole at the point of attachment down the pole, through the conduit and junction boxes to the signal control cabinet. Install the Non-Intrusive detection processor in the signal control cabinet, connect lead-ins from detector. A Traffic Signal Inspector must be present when working on or in traffic signal equipment including poles, mast arms, cabinets, conduits, and junction boxes. Work within the cabinet will require coordination with the Traffic Signal Shop and at least a 48 hour notice to have a technician open the cabinet and be present while the cabinet is open. Call can be made to City of Phoenix Traffic Signal Supervisor (602) 262-6733 to make arrangements for both the inspector and technician.

The traffic signal technician will install the processor within the cabinet. The contractor shall make the termination of the field wires to the detection processor. The traffic signal technician will make any additional connections needed in the cabinet between the detection processor and any existing equipment within the cabinet required by the manufacturer.

SECTION 474

TRAFFIC SIGNAL POLES AND ACCESSORIES

474.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing traffic signal poles, extensions, and mast arms in accordance with the Equipment Sheet of the Approved Traffic Signal Plans, the COP Traffic Signal Standard Details, and ADOT Standards.

Poles shall include a shaft, mast arms (if required), extensions and hardware required to construct an integral shaft and mast arm(s) and attach it to the base.

474.2 GENERAL STANDARD:

Steel poles for traffic signals and lighting shall include pole shafts, mast arms, and extension. Materials supplied shall conform to the requirements of the COP Standard Details.

474.3 TYPES OF POLES:

Types of poles to be furnished are as follows:

1. Type 'A'
2. Type 'PB'
3. Type 'LM'
4. Type 'SM'
5. Type 'SR'
6. Type 'SQ'
7. ADOT Type 'J','K';'R',and 'Q' – uses a Type 'SR' foundation
8. ADOT Type 'V' and 'W' – uses foundation as shown on ADOT Drawing TS4-18&19

474.3.1 Pole Shafts: Pole shafts shall be fabricated according to the requirements shown on the COP Traffic Signal Standard Details for Types 1 through 6 and ADOT Standards for Type 7 and 8. An 'LM' pole shall come with a 5' extension unless otherwise noted to come with a longer extension (paid for separately). Types 4 through 6 shall be supplied with a 5' extension unless noted on the plans to exclude the extension. A blank plate shall be required when riser is excluded on the plans.

Hand holes in the base of the poles shall conform to the details shown on the Traffic Signal Standard Details. All welds shall be continuous and any exposed welds, except fillet welds, shall be ground flush with the base metal.

A metal tag shall be permanently attached to the pole above the hand hole stating the manufacturer's name, pole type per the Department's approved traffic signal plan, pole drawing number, shaft length, and inches of material thickness.

474.3.2 Mast Arms: Mast arms shall be fabricated according to the requirements shown on the COP Traffic Signal Standard Details for Types 4 through 6 and on ADOT Standards for Type 7 and 8.

474.3.3 Luminaire Mast Arms: The mast arms for the luminaires shall be fabricated as per COP Traffic Signal Standard Details for Types 4 through 6. All bolts, washers, and nuts for luminaire mast arms Types 4 through 6 shall conform to the requirements of the COP Traffic Signal Standard Details. For ADOT Type 7 and 8, the mast arms for the luminaires shall be fabricated as per ADOT Standards. All bolts, washers, and nuts for luminaire mast arms for Type 7 and 8 shall conform to the requirements of ADOT Standards.

474.3.4 10' and 20' Extensions: The extensions for the LM pole shaft to accommodate luminaire mast arms, LED illuminated street signs, wireless mesh radios, CCTV, or devices shall be fabricated as per COP Traffic Signal Standard Details. All hardware to attach the extensions to the pole shafts shall conform to the requirements of the COP Traffic Signal Standard Details.

474.3.5 Finish: Pole shafts, mast arms, extensions, and luminaire mast arms shall be finished with a 2.5 mil powder coat (color will be confirmed by the Traffic Signal Shop). The visual appearance of the finish shall be uniform. Discoloration of the finish such as dark areas, dark streaks, dark rings, or transportation handling marks, which are considered excessive by the Engineer or designee, shall not be allowed. Pole shafts, mast arms, and luminaire mast arms that have a finish unacceptable to the Engineer or designee shall either be repaired or replaced to the satisfaction of the Engineer or designee at no additional cost to the Department.

474.4 CONSTRUCTION REQUIREMENTS:

474.4.1 Base Plates and Poles: High strength bolts, nuts, and washers for bases shall be assembled as specified in the COP Traffic Signal Standard Details and shall be torqued as required by the COP Traffic Signal Standard Details. Anchor bolts, washers, and nuts required for relocating existing poles shall be furnished by the contractor.

Poles shall be drilled and tapped for mounting hardware as shown on the COP Traffic Signal Standard Details.

Poles will be installed and assembled in accordance with the manufacturer's specifications and as show on the Equipment Sheet of the Approved Traffic Signal plans and COP Traffic Signal Standard Details.

All scratches, mars, or abrasions to the finish of poles and mast arms will be repaired satisfactory to the COP Traffic Signal Engineer or designee prior to acceptance.

After erection and wiring, all of the pole types will be grouted to seal the gap between the pole base and the foundation or sidewalk. Grout material will be 12:1 sand /cement mix.

Sidewalks, curbs, gutters, pavement, base material, lawns, plants, and any other improvements removed, broken, or damaged by the contractor's operations shall be replaced or reconstructed with materials in accordance with these specifications. The replaced or reconstructed improvements shall be left in a serviceable condition satisfactory to the Engineer or designee, and conform to these specifications where applicable.

Where existing pole installations are to be modified, materials and equipment shall be used, salvaged, or disposed of as specified in MAG Section 479 or as directed by the Engineer or designee.

If any poles are damaged by the contractor's operations, such repairs or replacements shall be at no additional cost to the Department.

New poles that are damaged by improper drilling of holes will be rejected.

474.4.2 Signal Poles and Mast Arms: Poles, mast arms, extensions and luminaire mast arms shall be of the type shown on the Equipment Sheet of the Approved Traffic Signal Plan and shall be installed in accordance with the COP Traffic Signal Standard Details for types 1 through 6, ADOT Standards for Type 7 and 8, and these specifications.

All poles shall be plumbed to the vertical with all mast arms, signal heads, extensions, luminaires, and other devices indicated on the plans to be on the pole have been installed. When mast arms are bolted to the pole shaft, the mast arm end over the roadway shall adjust to the horizontal.

Poles shall be drilled and tapped for mounting of signal equipment. The use of a welding torch is not authorized.

474.4.3 Drilling of Poles:

474.4.3.1 Wire entrance holes may be drilled for pole-mounted signals when a coupling is not available.

474.4.3.2 Wire entrance holes will be drilled to provide connection to the traffic signal head through the lower bracket arm.

474.4.3.3 Where drilling is required, the hole will be angled downward in poles.

474.4.3.4 Drilled holes will be de-burred and all sharp edges removed.

SECTION 475

ELECTRICAL POWER SERVICE AND CONTROLLER CABINET

475.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing electrical power service pedestal and controller cabinets in accordance with the location and details on the Equipment Sheet of the Approved Traffic Signal Plan, COP Traffic Signal Standard Details, the requirements of these specifications, and the specifications of the utility company serving the location.

475.2 MATERIALS:

475.2.1 Electrical Power Service Pedestal: Each electrical power service pedestal system consists of the service pedestal cabinet, electrical service equipment, wiring, and wiring devices.

475.2.1.1 Service Pedestal Cabinet: The electrical service meter pedestal cabinet shall consist of the meter socket, circuit breaker panel, test bypass facilities, pedestal locking device, ground mount enclosure, and necessary fittings all of which shall conform to the requirements of COP Traffic Signal Standard Details, the Approved Traffic Signal Plans, and the project Special Provisions listed below.

475.2.1.2 Service Pedestal Cabinet Assembly: Provide tamperproof cabinets to provide 120/240 VAC 60-hertz electrical service.

1. Fabricate the cabinet from 12-gauge steel with piano hinged doors and provisions for padlocks.

2. Equip the rear of the cabinet with a removable utility access cover with provisions for a padlock.

3. Provide the cabinet with a standard 4-jaw meter socket.

4. Provide 200 amp utility landing lugs in the utility section.

5. Provide a 100 amp 10K AIC main breaker in the user section of the distribution panel.

6. Provide for up to 6 copper bussed and fully wired circuits.

7. Provide the following circuits in the distribution panel:
    a. 15-amp, single pole breaker for the traffic signal.
    b. 15-amp, single pole breaker for the luminaire.
    c. 15-amp, single pole breaker for the “Smart Sign”

8. Finish: Fully coat the cabinet inside and out with a primer/paint system powder coat

9. Color: Light green

475.2.1.3 Electrical Service Equipment and Wiring: Electrical service equipment, wiring, and wiring devices shall be in conformance with NEMA, the NEC, COP Details, and the specifications of the utility company providing electrical service.

1. Breakers: All circuit breakers shall have an interruption capacity of 10,000 amperes and supplied as indicated in the wiring schematic diagram.

2. Meter Loop Assembly: The meter loop assembly shall be bonded and grounded in accordance with the requirements of these specifications.

3. Conductors: Conductor size and color shall be as specified on the Traffic Signal Plan conductor schedule and in accordance with the requirements of these specifications. All electrical apparatuses shall be UL listed.

4. Ground rods for the Service Pedestal Cabinets are to be copper clad steel, a minimum of 5/8 inch by 8 feet long.

475.2.2 Controller Cabinet Assembly: Cabinet types and configurations shall be supplied as specified on the Approved Traffic Signal Plans, COP Traffic Signal Standard Details, and in accordance with these specifications.

The Contractor shall supply the following traffic signal controller:

Econolite Controller and Integrated Ancillary Equipment:

1. Cobalt Classic NEMA Controller (Includes Ethernet Module & USB port)

2. TS2/Type 1 "P" Plug-N-Go Cabinet 8 phase Cabinet with two fans (Includes flasher, flash transfer relay, jumpers, detectors and all necessary equipment). The exterior of the cabinet shall be finished with a 2.5 mil high gloss white powder coating.

3. EDI Bus Interface Unit - Part # - EDI-BIU700 (3 per cabinet)

4. EDI Malfunction Management Unit Smart Monitor
Part # - EDI-MMU16LEip (1 per cabinet)

5. Ruggedcom RS900-HI-D-TX-TX-TX Non-Fiber Network Switch - Switch must be a “Managed” switch, At least three levels of security, has to be IP addressable, minimum of (9) Ethernet ports, must have serial and Ethernet interface access ports, must be AC+ powered, and must meet the same temperature specs as the controller 160 degree operating range.

   For reference purposes only, our local representative for the above cabinet and integrated equipment is Lori MacIntyre, Cell – (714)-392-2318, e-mail: lmacintyre@econolite.com.

The Contractor shall deliver the signal controller and controller cabinet assembly to Traffic Signal Shop, 2141 E. Jefferson Street for final configuration testing and programming. The Contractor shall coordinate the proposed delivery date and time with the Traffic Signal Warehouse (602) 495-2083 at least 3 weeks prior to the Contractor’s anticipated installation date.

A 12” high cabinet extension ring shall be provided for each cabinet. Extension ring shall be bolted to the cabinet during installation in the field. The ring shall be made of 10 Ga. aluminum sheeting and finished with a 2.5 mil high gloss white powder coating.

475.3 CONSTRUCTION REQUIREMENTS:

475.3.1 Electrical Power Service Pedestal:

Power Service Pedestal System: The electrical power service pedestal shall be assembled and installed on a concrete foundation at the location shown on the Approved Traffic Signal Plan and in accordance with COP Traffic Signal Standard Details. Concrete foundation is a separate pay item.

1. Provide Electrical Service

    a. The contractor is responsible to obtain the electrical service provider's connection point (Power Source). Plans indicate the desired location of the Power Service Pedestal based on the best information available at the time plans were completed. The CONTRACTOR will affirm and accommodate the point of connection.

    b. At notice to proceed, the City of Phoenix Traffic Signal Supervisor will furnish the Contractor with address numbers for all new electrical service pedestal points in the City of Phoenix.

    c. The Contractor shall be responsible for contacting the appropriate electrical service provider, arranging, scheduling, signing, and paying for agreements, line extensions and any other fees and arrangements necessary to energize the intersection traffic signal system or other controls in accordance with the plans.

    d. In addition to the requirements of these Specifications, the Contractor shall comply with all construction requirements of the electrical service provider regarding materials, inspection or other constructions, fees or scheduling necessary to energize the devices included in the plans.

    e. Upon final acceptance, the Contractor shall arrange for the transfer for all electrical service to the entity identified by the City of Phoenix.

2. Connect grounding buss bar to the cabinet foundation grounding rod using a bare #4 AWG solid copper wire. Attach the grounding wire to the ground rod with an appropriate connector.

3. Seal the service pedestal cabinet bases to the foundation using a commercial grade clear silicone sealer.

4. For power pedestal cabinet foundations, use anchor bolts as required by the manufacturer of the cabinet, at least 5/8 inch in diameter by 18 inches long.

5. For service pedestal foundations, anchor bolts will extend four (4) inches above the finished grade of the foundation.

6. Minimum cabinet foundation curing times (NO EXCEPTIONS) before loading is seven (7) days.

475.3.2 Controller Cabinet Assembly: The Contractor is only responsible to deliver the controller cabinet and all related electronics to the City as noted above.

The contractor shall adhere to the minimum cabinet foundation curing times (NO EXCEPTIONS) of seven (7) days when installing the controller cabinet extension ring and scheduling the City to install the controller cabinet.

Controller cabinet extension rings will be secured to the foundation with ½"-13 x 5" masonry stud anchors at a minimum. Masonry stud anchors are to be installed in accordance with the product manufacturer's instructions. Three inches of threaded stud will extend above the finished grade of the Controller Cabinet foundation.

City of Phoenix shall install the controller cabinet to the controller cabinet extension ring previously installed by the contractor to the cabinet foundation. City of Phoenix will terminate field wiring after all field circuits have been proofed for proper operation.

SECTION 477

INTERSECTION LIGHTING

477.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing LED luminaires for intersection lighting in accordance with the location shown on the Equipment Sheet of the Approved Traffic Signal Plan and the requirements of these specifications.

477.2 MATERIALS:

477.2.1 General: Intersection lighting materials shall conform to the type and location of the luminaire as indicated on the Equipment Sheet of the Approved Traffic Signal Plan. All luminaires shall be supplied with an individual photoelectric cell.

The luminaire shall be LED, and shall be capable of operating on primary voltages of 120 to 277 volts, 60 Hz AC. The luminaire shall be of the horizontal cut-off type and gray in color unless otherwise specified on the plans. The light distribution pattern shall be Type 3 Medium with a 2,700K color temp with lumen output to match ANSI/IES RP-8-14 to properly light the roadway.

Each luminaire shall be furnished with an instruction sheet which clearly shows installation procedures.

477.2.2 Luminaire Housing: The luminaire housing shall be fabricated from a corrosive resistant metal material and have a baked-on enamel finish.

477.2.6 Photo Electric Control:

PEC: The photo electric control (PEC) shall be rated at 105-305volt, 60 Hz AC 1,800 volt-ampere. The operating temperature range shall be from -40º F to +158º F and 100 percent relative humidity. The PEC shall be a conventional glass-faced hermetically sealed ½" cell. A 3-5 second time delay shall be incorporated into the PEC circuit to prevent cycling at night by transient lights which might be focused on the PEC.

The PEC shall turn-on at 1.5 ±0.2 foot candles and turn-off at 1.5.1 +\- .25 foot candles. The PEC shall be UL listed for rain-tight applications. A built-in 40,000 Amp surge protector shall be provided to protect the PEC from lightning induced and line voltage transients.

The PEC incorporates a twist lock mount with a Neoprene gasket meeting ASTM D 1056 specifications. The control shall have an operating life of 20 years.

The cover shall be of a green color and be made of Polypropylene with UV inhibitors.

477.2.6 Luminaire Wire:

Contractor shall provide an IMSA 19-1 Cable, 3 conductor, #16 solid or stranded with a PVC outer jacket from the luminaire to the point of connection in the junction box. Cable to be identified and wired as shown conductor table.

477.3 CONSTRUCTION REQUIREMENTS:

Luminaires of the size specified shall be furnished and installed at the locations shown on the Approved Traffic Signal Plan and COP Traffic Signal Standard Details. Unless otherwise specified the luminaire shall be adjusted to the horizontal. All wiring shall be in compliance with the NEC, the requirements of COP Traffic Signal Standard Detail Sheets and as shown on the plans. The intersection lighting circuit shall not be connected to the same service leg to which the controller cabinet assembly is connected.

SECTION 478

ELECTRICAL CONDUCTORS

478.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing electrical conductors for traffic signals and intersection lighting in accordance with the Equipment Sheet of the Approved Traffic Signal Plan and requirements of these specifications.

478.2 MATERIALS:

478.2.1 Electrical Conductors: The wire shall be annealed copper and shall be uncoated unless otherwise specified. Unless otherwise indicated, the wire shall be solid for number 10, 12, 14, and 16 AWG and smaller diameter wire, conforming to the latest requirements of ASTM B 3 for annealed bare copper wire. Conductors for sizes number 8 AWG and larger diameter wire shall be stranded and shall conform to ASTM B 8 for Class B stranding, unless otherwise specified, the conductors shall be insulated with THW grade thermoplastic compound and shall meet the requirements of UL 83. Insulation colors shall be permanent and an integral part of the insulation and shall not be applied as a surface treatment of coating. The insulation thickness shall conform to the requirements of the NEC. Conductor insulation shall be a solid color unless otherwise specified. The color shall be continuous over the entire length of the conductor.

Wire and cable shall be UL listed and rated at 600 volts unless otherwise specified. The UL label shall be present on each reel, coil, or container of wire or cable. When requested, the Contractor shall submit to the Engineer or designee the manufacturer's written certification that the product conforms to the requirements of these specifications.

Conductor colors and sizes for use in traffic signal and intersection lighting shall be as specified on the Wiring Sheet of the Approved Traffic Signal Plan, and the COP Traffic Signal Standard Details.

Wire Tagging: Individual conductors for each vehicular and pedestrian phase group shall be secured together by two layers of plastic electrical tape and tagged with an approved wire I.D. marker as shown on the COP Traffic Signal Standard Details. Cables for each vehicular and pedestrian phase group shall be wrapped with two layers of plastic electrical tape and tagged with an approved wire I.D. marker as shown on the COP Traffic Signal Standard Details. Wires and cables shall be individually marked in all cabinets, pole hand holes and in pull boxes as per COP Traffic Signal Standard Details.

Shielded Loop Detector Cables: Loop detector lead-in shielded cables shall be six conductor A.W.G. #18, stranded, twisted, three pair, tinned copper, polyethylene insulated cable with a polyethylene jacket, rated at 600 volts and 140 degrees Fahrenheit and shall be in conformance with IMSA Specification 50-2.

IMSA Cables: IMSA cable shall be used when specified on the plans. IMSA cables shall be polyethylene insulated copper conductors, polyvinyl chloride jacketed, rated at 600 volts for use in underground conduit or as aerial cable conforming to IMSA

Specification 19-1. Wire insulation color assignment shall be in accordance with COP Traffic Signal Standard Details.

The IMSA 19-1 cable shall be provided with the number and size of conductors as specified on the plans. All cable with less than 42 conductors shall be solid or stranded copper as specified on the plans. All 42 conductor IMSA Spec 19-1 cable shall be constructed as follows: Two (2) layers of 21 conductors A.W.G. #16 stranded. Each layer will contain 21 color conductors per IMSA Spec 19-1, Table 5.1 and separated by a clear Mylar tape. The colors and tracers shall be permanent and an integral part of the insulation and shall not be painted, surface coated, or adhered to surface. Ink strips are unacceptable. Conductor insulation colors shall be standard IMSA colors (as shown by the following table). Cable conductor color, phase, and interval assignments shall be in accordance with COP Traffic Signal Standard Details.

Conductor Number	Insulation Color	Stripe Color	Conductor Number	Insulation Color	Stripe Color
1	Black	---	11	Blue	Black
2	White	---	12	Black	White
3	Red	---	13	Red	White
4	Green	---	14	Green	White
5	Orange	---	15	Blue	White
6	Blue	---	16	Black	Red
7	White	Black	17	White	Red
8	Red	Black	18	Orange	Red
9	Green	Black	19	Blue	Red
10	Orange	Black	20	Red	Green
			21	Orange	Green

Note: Only first 20 are used in a 20 Conductor cable. Conductor color schedule will repeat for the second set of 21 conductors in an IMSA 42 conductor cable.

Single Conductor Wire: Wire under this specification shall be composed of a solid or stranded copper conductor as noted above and insulated by a polyvinyl chloride compound. The insulated conductor shall be completely enclosed in a nylon jacket. The conductor shall be copper and shall, before insulating, conform to the requirements of ASTM B-3, latest revision. Stranded conductors may be either concentric or bunch stranding and shall conform to the circular mil area and physical requirements specified in ASTM Designation B-8, latest revision, for concentric stranding or ASTM Designation B-174, latest revision, for bunch stranding. The insulating compound shall be polyvinyl chloride. The insulation shall be applied concentrically about the conductor. The thickness of the insulation shall not be less than specified in Table 1. The method of measurement for thickness and the apparatus used shall be in accordance with Underwriters Laboratory, Inc. Standard UL 62 (ANSI C33.1).

TABLE 1 INSULATION THICKNESS		
Conductor Size, AWG	Minimum Acceptable Average Thickness	Minimum Acceptable Thickness at any Point
20-12	15 mils	13 mils
10	20 mils	18 mils
8	30 mils	27 mils

The insulation after application to the conductor shall comply with the requirements specified in accordance with Underwriters Laboratory, Inc. Standard UL 62 (ANSI C33.1). The insulation of the finished conductor before the jacket is applied shall withstand, without breakdown, the application of a 60 Hertz or 3,000 Hertz, 7,500 volt essentially sinusoidal spark test potential (RMS) in accordance with the method and using equipment specified in Underwriters Laboratory, Inc. Standard UL 83 (ANSI C33.8). The insulation color shall be specified by COP Traffic Signal Standard Details. A tight-fitting nylon compound jacket shall be applied over the conductor and comply with the requirements specified in ASTM D-4066, latest revision. The thickness of the jacket shall be as specified in Table 2. The method of measurement for thickness and apparatus used shall be in accordance with Underwriters Laboratory, Inc. Standard UL 62 (ANSI C33.1).

TABLE 2 INSULATION JACKET THICKNESS		
Conductor Size, AWG	Minimum Acceptable Average Thickness	Minimum Acceptable Thickness at any Point
20-10	0.004 inches	0.003 inches

All single conductors shall have plain, distinctive, and permanent markings on the outer surface throughout their entire length showing the manufacturer's name or trademark, insulation type, conductor size, voltage rating and the number of conductors in the cable. Insulation colors shall be permanent and an integral part of the insulation and shall not be applied as a surface treatment coating.

EVP Detector Cable: The EVP Detector Cable shall be a three conductor A.W.G. #20 stranded, tinned copper insulated wires with an A.W.G. #20 tinned copper uninsulated drain wire. The insulation for the three wires shall be PVC, of the following colors, blue, orange and yellow. The cable shall have a black PVC outer jacket rated for 600 Volts.

EVP Confirmation Light Cable: The EVP Confirmation Light Cable shall be a two conductor A.W.G. #18 stranded, tinned copper insulated wires. The insulation for the two wires shall be color coded PVC. The cable shall have a gray PVC outer jacket rated for 300 Volts.

478.3. WIRING PROCEDURES:

478.3.1 General Requirements: All wiring shall be in conformance with the NEC and the requirements of these specifications. All wire nuts and other wiring devices shall be UL listed. Conductor sizes and colors shall be as specified on the Wiring Sheet of the Approved Traffic Signal Plan. Conductors shall be pulled into runs in a smooth continuous manner, avoiding contact with sharp objects that might damage the insulation. Approved lubricants shall be used for inserting conductors in conduit. Before installation, conductors' ends shall be taped for moisture protection until connections are made. Approved splices are permitted in pull boxes, pedestals, pole hand holes, and cabinets.

Conductors shall have a minimum of 36 inches of slack above the top of the pull box.

All phase wiring shall be boxed at the intersection, terminated and spliced in the junction boxes.

478.3.2 Conductor Splices: Splices shall be made utilizing wire nut connectors (Ideal underground model numbers 60, 64, and 66, or approved equal). Wire nut shall be pre-filled with Silicone-based sealants for moisture and corrosion, UL listed to 486D for direct burial, and a shell rated for 105 C. Wire stripping length and wire size combinations shall be in accordance with the manufacturer's instructions supplied with the wire nut connector. Soldered connections will not be permitted. All phases shall be spliced in all pull boxes and unused phase wiring shall be covered with insulating tape.

478.3.3 Bonding and Grounding: All metallic enclosures such as cabinets, pedestals, poles, conduit, and cable sheaths shall be bonded to form a continuous grounded system. Non-metallic portions of the system, such as PVC conduit, shall have a No. 10 AWG bare solid copper bond wire installed with suitable connections to form a continuous grounded system.

At each service disconnect, cabinet foundation, or where otherwise specified, an approved copper-plated ground rod shall be installed. Each ground rod shall be a one-piece solid rod of the copper weld type or approved equal and shall be a minimum of 5/8 inch in diameter and 8.0 feet long. The rod shall be driven vertically into the ground to a minimum 7.5 feet below the surface. If the rod cannot be driven vertically, it shall be installed in accordance with article 250-83 of the NEC. The ground rod may be located in a pull box. The service equipment neutral (grounded conductor) and the system grounding conductor (No. 10 AWG bond, solid) shall be connected to the ground rod with a copper-plated bolt or a brass bolt on the ground clamp.

The grounding electrode system shall be in accordance with articles 250-81 and 250-83 of the NEC.

Pole foundations shall have 25 feet of number 4 AWG bare copper conductor coiled and placed at the bottom of the excavation before concrete is poured. Pole foundation grounding electrodes shall be connected to the pole grounding screw in the hand hole with an approved lug connector.

A ground resistance test shall be performed for each installed ground rod prior to final connection of the utility service. Pole foundation coil grounds shall be tested as determined by the Engineer or designee in the field.

The ground resistance shall be measured with a three terminal, fall of potential, direct reading, battery powered earth tester with a 0.50 to 500-ohm scale or digital read-out. The 25-ohm reading shall be approximately at mid-scale.

The test shall be performed according to the manufacturer's instructions and OSHA requirements. Two auxiliary copper clad ground rods shall be driven into the ground a minimum of 3 feet. The lateral spacing

for each test rod shall be given in writing on the test report form and the spacing shall be approved by the Engineer or designee.

All tests shall be performed in the presence of the Engineer or designee and the test results shall be written down, dated, and given to the Engineer or designee for approval.

Each ground rod or foundation ground shall be isolated with the bond wires disconnected when the test is being performed. The resistance to ground shall be 25 ohms or less. If it is not, additional ground rods shall be installed as required at least 15 feet from the original ground and shall be bonded to it. The test shall then be repeated for multiple grounds as necessary to achieve proper grounding below 25 ohms. As many additional ground rods shall be installed as is necessary to achieve proper grounding of 25 ohms or less.

The test shall be performed when the soil is dry. The contractor shall not add any chemical or salt solutions to any portion of the grounding system. All grounding rods and foundation grounds to be tested shall be installed a minimum of ten days prior to testing unless otherwise determined by the Engineer or designee in the field.

SECTION 479

REMOVAL AND SALVAGE OF EXISTING TRAFFIC RELATED FACILITIES

479.1 DESCRIPTION:

It is the purpose of this section to provide information necessary for completion of the removal and disposal of traffic signal equipment and materials as shown on the Approved Traffic Signal Plan to be removed.

479.2 REMOVAL AND SALVAGE OF EXISTING TRAFFIC RELATED FACILITIES:

479.2.1 General: All removals shall be done in accordance with MAG Section 350, as shown on the Approved Traffic Signal Plan, and as detailed below. Any item noted on the Approved Traffic Signal Plan or these Specifications to be salvaged shall be delivered to the COP Traffic Signal Shop or as directed by the Engineer or designee. Delivery to the Traffic Signal warehouse shall include unloading the salvaged materials at a designated warehouse location by the Contractor using the Contractor's own equipment. Two working days (forty-eight hours minimum) in advance of the intended date of delivery, the Contractor shall coordinate the proposed date, time, and items to be delivered with the COP Traffic Signal Supervisor (602) 262-6733. Warehouse hours for receiving deliveries are 8:00 am – 2:00 pm Monday through Friday. The address for the City warehouse is:

City of Phoenix Traffic Signal Shop

2141 E. Jefferson St.

Phoenix, Arizona 85034

Remove, deliver and unload in good condition any existing equipment identified by the COP as salvageable by to the location designated by the COP. Dispose of all signal hardware identified by the COP as non-salvageable or scrap material. Non-salvageable material becomes the property of the contractor. Cost of providing for its proper storage and ultimate disposal to meet Federal or State requirements is incidental to the payment for the removal of the item.

Deliveries of salvaged or obsolete traffic signal equipment to the location designated by the COP will be done in accordance with a schedule submitted to and approved by the COP no less than 24 hours in advance of the action.

Material will be inventoried upon delivery and identified with the intersection from which the material was removed.

479.2.2 Signal Poles: For signal poles, remove, transport and unload mast arm poles, mast arms, poles and posts identified as salvageable by the COP as described in these Specifications. Disassemble mast arm poles and mast arms before transporting. Leave hand hole covers in place. Remove all signal mounting hardware from poles and mast arms before transporting. Attaching hardware and anchor bolt nuts and washers may be bulk packed for delivery.

479.2.3 Controller Cabinet and Power Pedestal: For controller cabinets including internal electronics and power pedestals identified as salvageable by the COP the field wiring will be disconnected, and all loose electronics in the control cabinet will be removed. Both the controller cabinet and power pedestal

may be ground mounted or pole mounted. The controller cabinet, loose electronic devices, and power pedestals will be transported and unloaded as described in these Specifications.

479.2.4 Foundations: Foundations within the ultimate curb and gutter of the roadway shall be part of roadway plans and removed in accordance with MAG Section 350. The Approved Traffic Signal Plans will identify foundations to be removed in accordance with this section. Existing Type "A" poles, pedestrian push-button poles, power pedestals, and controller cabinets will be removed in their entirety as well as any other foundations less than 42 inches in depth. Deeper foundations such as those for mast arm poles must be removed to a minimum of 10 inches below the finished grade of the sidewalks or landscaping. Voids created by the removal of the foundations will be backfilled with natural material compacted to match the density of the surrounding material.

479.2.5 Incidental Traffic Items: This item provides for the removal of all incidental traffic items some of which will be salvageable such as signal heads, pedestrian heads, luminaires, pedestrian push buttons and non-salvageable such as junctions boxes, conduit, wiring, loops, and loop lead-ins. Prior to removal of any items, the contractor shall meet with COP Traffic Signal Engineer or designee to identify specific salvageable materials which will be transported to the location noted above. Items identified as non-salvageable, shall be become the property of the contractor and disposed of in accordance with applicable State or Federal regulations.

Junction boxes rendered obsolete by the signal construction will be removed and disposed of by the contractor. Conduit runs shallower than 24 inches will be removed. Existing conduit runs with 24 inches or more of cover (when compared to the finished grade) may be abandoned in place. The Contractor will remove all wire and cable from conduits to be abandoned in place. The Contractor will dispose of all conduit, wire, and cable removed. For loops and loop lead-ins in saw cut they are to be abandoned in place. Conduit for twisted pair loop lead-in must be cleared of wire, and may be abandoned in place or removed, at the Contractor's choice. If removed, any damage to existing pavement to remain is to be repaired at the Contractor's expense.

479.3 Measurement: Removal of identified existing facilities specified in Section 474.2.2 (Signal Poles) and 474.2.3 (Cabinets and Power Pedestals) will be measured on each basis by type of facility. The cost of transport for salvaged material or disposal of the removed item is incidental to the payment for removal. The method of measurement for 479.3.4 (Foundations) shall be by cubic yard of material removed. The cost of transport for salvaged material or disposal of the removed item is incidental to the payment for removal. The method of measurement for removal of traffic items specified in 474.2.5 shall be by lump sum for Incidental Traffic Items Removal by intersection. The cost of transport or disposal of the removed items is incidental to the payment for removal

479.4 Payment: Removal of existing facilities by type, measured as provided above, will be paid for at the contract price. Said price shall be full compensation for the removal and delivery of salvaged items or the removal and the disposal of removed items not scheduled to be salvaged as specified and shown on the project plans.

SECTION 900

LED ILLUMINATED STREET SIGNS

900.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing LED illuminated street signs at each signalized intersection per the Approved Traffic Signal Plans. The LED Illuminated street signs must look and operate the same as the existing signs throughout the City. An existing sign is available for the contractor's inspection at the Traffic Signal Shop, 2141 E. Jefferson St., Phoenix. AZ. Arrangements to see the sign can be made by contacting the Traffic Signal Supervisor at 602-262-6733.

900.2 MATERIALS:

An aluminum frame slightly larger than the dimensions for the sign face. The frame shall hold the LED lighting fixtures to produce the light source for the internally illuminated sign. A translucent sign face will be on both sides of the sign structure.

The illuminated face shall be Lexan, 3/16-inch-thick sheet, as a substrate; with a green EC film and Translucent Reflective Sheeting.

LED products shall be compatible with existing signs.

IMSA 19-1 Cable, 3 conductor, #16 stranded with a PVC outer jacket

900.3 CONSTRUCTION REQUIREMENTS:

900.3.1 Size and Style: The actual size of the illuminated sign face is provided in the table below. The sign cabinet will be larger than these dimensions and will include the size(s) of the cabinet lip that is used to hold the sign face in place.

ITEM NO.	SIZE	STYLE
900.1001	20 inches x 8 feet	two illuminated faces, double-sided sign
900.1002	20 inches x 9 feet	two illuminated faces, double-sided sign
900.1003	36 inches x 8 feet	two illuminated faces, double-sided sign

900.3.2 Sign Design: The sign design shall include the street name, block number with direction, and City of Phoenix logo. The City will provide the Contractor with Gerber Omega or Gerber Graphics Advantage files via email. The name of the font to be used is the Clearview One Highway font. The Contractor's computer sign cutter shall be able to use True Type fonts to run this program.

The sign background shall be green with white letters, City logo, and borders. The Contractor shall produce the green background with the green EC film.

900.3.3 Sign Face Fabrication Process: Contractor shall install the sign sheeting to the Lexan substrate and the EC film to the reflective sheeting in accordance with the recommended procedures of the manufacturer.

A hand or motor driven squeeze roll applicator must be used with an application pressure of 60-80 psi. Use of soap and water for the application process will not be acceptable.

900.3.4 Sign Cabinet Fabrication and Wiring Process: Sign cabinet shall be of good workmanship, water resistant with weep-holes to drain condensation. The sign and sign cabinet must be rectangular in shape with a smooth, clean appearance without the presence of ridges or angles other than right angles. Contractor shall provide the proposed sign design shop drawings including mounting details for approval prior to ordering the signs. The shop drawings including the cantilever mounting mechanism shall be approved by an Arizona Licensed Structural Engineer.

To prevent reflection from the street light above the sign, the sign cabinet must be designed to angle slightly down toward the traffic. In addition, the cabinet will also leave a slight overhang to shield the sign face from the street light above. The exact angle and size of the overhang is left up to the Contractor.

The sign cabinet shall be painted with enamel paint to the City of Phoenix green to match the color of the traffic signal poles being supplied under this contract.

The sign cabinet shall be designed for ease of maintenance. The cabinet shall include top-hinged doors on both sides and have two prop rods for each door to stabilize them when open. The doors must open up, not open down or slide down or sideways.

The sign cabinets must include LED lighting assemblies internal to the sign. The LED sign shall operate on a 120 Volt circuit.

Each sign shall be supplied with an individual photo electric switch to provide for dusk to dawn operation. This switch must be placed in the sign housing in such a manner that it will not be influenced by the luminaries located above the sign.

Install an IMSA 19-1 Cable, 3 conductor, #16 stranded with a PVC outer jacket continuous without splice from the sign junction box to the junction box located below traffic signal pole marked and terminated as shown on the Traffic Signal Plans and COP Standard Details.

SECTION 901

WIRELESS NETWORK RADIO

901.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing a wireless network radio at designated signalized intersections as shown on the Equipment Sheet of the Approved Traffic Signal Plans.

901.2 MATERIALS:

Provide Tropos Model 7320 with a weatherized gateway plate. Each radio shall come with a Tropos Control Server License.

CAT 5e Cable:

1. Conductor Material: BC - Bare Copper
2. Insulation Material: PO - Polyolefin
3. Outer Shield Material: Foil
4. Outer Shield Material: Aluminum Foil-Polyester Tape/TC - Tinned Copper
5. TC Braided Stainless Steel Shield
6. Outer Jacket Material: Industrial Grade PVC - Polyvinyl Chloride Plenum (Y/N): N
7. Outer Jacket Color – Teal

Power Connector and Cable:

1. 3-wire, watertight female Remke PVC mini-link plug compatible with male connector on radio
2. IMSA 19-1, 3 conductor #16 cable

901.3 CONSTRUCTION REQUIREMENTS:

Install the wireless mesh radio on the horizontal portion of the luminaire mast arm adjacent to the luminaire. The radio should be installed as level as possible using the leveling instrument on the radio with the antennas in the vertical position. Install female mini-link plug to 3 conductor power cable in accordance with manufacturer requirements to ensure watertight connection, or use manufacturer supplied plug with 3’ cord and provide a weatherproof connection between the supplied 3’ cord and the IMSA 19-1 conductor cable. Connect watertight plug to the radio and install supplied 3 wire power cable continuous without splice from the radio (or weatherproof splice at end of 3’ cord) to the junction box located below traffic signal pole as shown on the Traffic Signal Plans and COP Standard Details. Leave a 5’ coil of spare cable.

Install CAT 5e cable from the radio to the controller cabinet as shown on the Wiring Sheet of the Approved Traffic Signal Plans and COP Traffic Signal Standard Details continuous without splice. On the controller cabinet end, leave a 10’ coil of spare cable.

SECTION 902

PTZ CCTV

902.1 DESCRIPTION:

The work under this section shall consist of furnishing and installing a pan-tilt-zoom (PTZ) Closed Circuit TV (CCTV) at locations specified on the Equipment Sheet of the Approved Traffic Signal Plan

902.2 MATERIALS:

Generic IP, POE Plus, POE Outdoor Network Camera Spec

Camera

Sensor	¼ CMOS or Better
Effective pixels	Meets or Exceeds 1.3 Million pixels
Illumination	Color: 0.5 lx, B/W: 0.06 lx at F1.4 (Shutter: 1/30 s, AGC: High), Color: 0.031 lx, B/W: 0.004 lx at F1.4 (Shutter: 16/30 s, AGC: High)
Scanning mode	Progressive Scan
Scanning area	3.6 mm (H) x 2.7 mm (V) {5/32 inches (H) × 11/100 inches (V)}
Shutter speed	Fix shutter: 1/30 - 1/10000 sec adjustable
Dynamic range	On/Off
Digital noise reduction	High / Low
Video Motion Detection	4 Areas
AGC (Auto Gain) control	On/Off - High/Low
Black and white mode	Auto, On, Off
Digital noise reduction	High/Low
Image stabilizer	On/off
Camera/Image title OSD	20Characters, 4 Fonts Selectable Placement
Privacy Zone	Up to 5 Zones Minimum

LENS

Focal length	3.5mm - 118mm
Zoom Ratio	Minimum 30x Optical
Digital Zoom	12x
Angular Field of View	H: 1.8 Deg (tele) – 63 Deg(wide) V: 1.4 (tele) 47deg (wide)
Focus Range	2.0 m - Infinity
Aperture Range	F 1.5- 22, Close

Pan and Tilt

Pan Range	360deg Continuous

Pan Speed	Manual:approx .03Deg/Sec - 119Deg Sec Preset 360Deg/Sec
Tilt Range	-15 Deg - 180Deg
Tilt Speed	Manual:approx .03Deg/Sec - 119Deg Sec Preset 360Deg/Sec
Number of Preset Positions	100
Auto patrol	Preset Sequence/Auto Track/Patrol/Auto Pan
Return to Home Position	10 Sec to 60 Minutes variable

Browser/GUI Interface

Camera Control	Pan/Tilt Zoom, Focus, Click Centering, Drag Zoom, Iris, Preset Positions, Auto mode
Display Mode	Single or multiple camera display
Camera Title	Minimum 20 Aphanumeric Characters
Clock Display	Time- Date 5 Formats
Alarm Control	Reset
Still Capture	Ability to capture a video still
Audio	Mic (Line) Input: ON / OFF Volume adjustment: Low / Middle / High, Audio Output: ON / OFF Volume adjustment: Low / Middle / High
SD Memory Data Download	Still or motion images recorded in the SDHC/SD memory card can be downloaded.
GUI/Setup Menu Language	English and Multi language support.
System Log	Up to 100 (Internal), Up to 4,000 (SDHC/SD memory when the recording format is set to JPEG.) error logs
Supported OS *1	Microsoft® Windows® 7 Microsoft® Windows Vista® Microsoft® Windows® XP SP3
Supported Browser	Windows® Internet Explorer® 9.0 (32 bit) Windows® Internet Explorer® 8.0 (32 bit) Windows® Internet Explorer® 7.0 (32 bit) Microsoft® Internet Explorer® 6.0 SP3

Network

Network Interface	10Base-T / 100Base-TX, RJ-45 connector
Image and Aspect Ratio 4.3 & 16.9	H.264: 1,280 × 960 / 800 × 600 / VGA (640 × 480) / QVGA (320 × 240), up to 30 fps Resolution [4:3] MPEG-4: VGA (640 × 480) / QVGA (320 × 240), up to 30 fps *2 *3 JPEG (MJPEG): 1,280 × 960 / 800 × 600 / VGA (640 × 480) / QVGA (320 × 240), up to 30 fps
Transmission Mode	Constant bitrate / Framerate priority / Best Quality
Frame rate	1 / 3 / 5 / 7.5 / 10 / 12 / 15 / 20 / 30 fps
Bit Rate/Client	64 / 128 / 256 / 384 / 512 / 768 / 1,024 / 1,536 / 2,048 / 3,072 /

	4,096 / 8,192* kbps / Unlimited * H.264 mode only
Image Quality	LOW / NORMAL / FINE
Refresh Interval	0.2 s / 0.25 s / 0.33 s / 0.5 s / 1 s / 2 s / 3 s / 4 s / 5
Transmission Type	UNICAST / MULTICAST
Audio Compression	G.726 (ADPCM) 32 kbps / 16 kbps, G.711 64 kbps
Audio Mode	OFF / Mic (Line) input / Audio output / Interactive (Half duplex) / Interactive (Full duplex)
Supported Protocol	IPv6: TCP/IP, UDP/IP, HTTP, HTTPS, RTP, FTP, SMTP, DNS, NTP, SNMP, DHCPv6 IPv4: TCP/IP, UDP/IP, HTTP, HTTPS, RTSP, RTP, RTP/RTCP, FTP, SMTP, DHCP, DNS, DDNS, NTP, SNMP, UPnP, NTCIP
FTP	Alarm image transfer, Periodic image transfer (When the FTP periodic transmission is failed, backup on an optional SDHC/SD memory card is available.)
No. of Simultaneous Users	Minimum 10 Users
SDHC/SD Memory Card	H.264 recording: Manual REC / Alarm REC (Pre/Post) / Schedule REC (Option) JPEG recording: Manual REC / Alarm REC (Post) / Backup upon network failure Compatible SD (SDHC) card: 2 GB, 4 GB*, 8 GB*, 16 GB*, 32 GB* model * SDHC card

Alarm

Alarm Actions	SD memory recording, E-mail notification, Indication on browser, Camera positioning, Preset position 1 ~ 64, FTP image transfer, T
Alarm Source	3x Terminal inputs, VMD, Command alarm, Auto track
Input / Monitor Output	Monitor Output 1.0 V [P-P] / 75 , NTSC composite, 1.0 V [P-P] / 75 , PAL composite, Output (for adjustment)
Microphone/Line Input	MIC IN and Line IN are selectable. ø3.5 mm monaural mini jack
Audio Output	ø3.5 mm stereo mini jack (monaural output) Line level

General

Safety/EMC Standard	UL (UL60065-1), FCC (Part15 ClassA), CE C-UL (CAN/CSA C22.2 No.60950-1), (EN55022 ClassB, EN55024) DOC (ICES003 ClassA)
General	Power Source/ 24 V AC (50 Hz / 60 Hz): approx. 40 W Heater ON Consumption PoE Plus: approx. 24.0 W (IEEE802.3at compliant, Class 4 device) Heater ON
Ambient Operating Temperature/Humidity	–50 °C ~ +55 °C (–58 °F ~ 131 °F) (24 V AC) *4, *5 –30 °C ~ +55 °C (–22 °F ~ 131 °F) (PoE Plus), 90 % or less (without condensation)
Weight	Maximum 4.5 kg
Wall mount bracket	12”-17”
Pole Mount Shoe	For pole installations => 5” in Diameter

Included With Camera

Cables	Power Cable/Ground Cable/Ethernet Cat5 Microphone cable, Audio out cable, Coax BNC cable, Alarm Cables
Shields and covers	Sun shields, Dome Covers, Safety wire
Memory card	SDHC/SD memory card slot

RJ45 Female Coupler

Hybrid Cable Strain relief

Hybrid Cable Bus Drop Support Strain relief

- Single weave variable mesh grip
- Galvanized steel for additional holding power in abrasive environments
- Strand equalizers position wires for equal loading
- Single eye
- Safety springs are available to reduce tension and prevent pullouts
- 0.24" – 1.5" cable diameter range

Insulation Displacement Connector,

Gel Filled/ Moisture Resistant,

Connector Type Butt Splice,

Color Red,

Stranded Wire Range 24-18 AWG

Hybrid CCTV Network cable

Hybrid Cable Elements encased in PVC Jacket (For CCTV Network Camera)

Common Outer Jacket with Color Stripe

UL Riser Rated for Permanent Installation

Master Jacket PVC Blue

Overall diameter .467”

UL Type - CL3R, FT-4

Hybrid Cable Must be Composed of the following elements

Category 5e+ 350MHz Element
TIA/EIA Cat5e+ 350MHz Four-pair Network Cable
24 AWG Solid Copper Conductors
Meets or Exceeds TIA/EIA-568-B.2 Standards
UL Rated for Permanent Installation
3 Pairs FEP/ 1 Pair Polyolefin Insulation

PVC Jacket

RG59 COAX CCTV CABLE Element
20 AWG Solid BC
Gas Injected foam PE Insulation
95% BC Braid Shield
PVC Jacket

Power Elements

2x18 AWG (7x26)
Stranded BC, Black & Red
6.4 Ω/Mft

902.3 CONSTRUCTION REQUIREMENTS:

The PTZ CCTV Network camera shall be installed per manufacturer's specifications, using the appropriate camera housing, pole mount shoe, and wall mount bracket and approved banding per City specifications. The CCTV Camera shall be installed at the corner where the Engineer or designee specifies that the vertical extension pole be installed for use by the CCTV camera.

The CCTV Camera shall be configured with the IP and Network parameters provided by the Phoenix Traffic Management Center

A 1" inch hole shall be drilled on extension pole 12" from the top facing the center of the Intersection.

The pole shoe shall be banded around the pole and the Camera shall be installed using the mfg. wall mount facing the center of the intersection.

The hybrid cable shall have a mesh strain relief installed and attached to a screw on the top of the pole.

The Camera Ethernet/power/alarm and coax cables shall be formed into a drip loop outside of the Extension pole and tied together with electrical tape and a wire tie below the level of the 1" hole. The camera wiring harness shall be pulled into the extension pole.

A hole ¼"x20 shall be drilled and tapped into the top of the extension pole so that a 1"x1/4x20 screw could be used to fasten the Hybrid Cable Single weave variable mesh grip which will provide dead weight strain relief for the Hybrid Cable.

The Hybrid Cat5e cable shall be terminated with an RJ45 connector terminated and joined to the Cameras Ethernet cable using an RJ45 coupler.

The power conductors from the hybrid cable shall be spliced to the male 24VAC adapter plug pig tail which must removed from the power supply in the cabinet using a Gel Filled/ Moisture Resistant Insulation Displacement Connector or, if the Camera has a terminal block the power conductors shall be connected to the appropriate voltage input pins.

10' Of the Terminated and tested Hybrid RJ45/Coax/Power cable shall be coiled and left at the Cabinet pedestal.

TP Attachment 700-2 – City of Tempe Traffic Specifications

City of Tempe Traffic Signal & Traffic Signal Interconnect Specifications

1. DESIGN REQUIREMENTS

This section will present the criteria and procedures to be utilized by designers and consultants when performing traffic signal design work in and for the City of Tempe.

1. Traffic signal cabinet and foundation shall be per the requirements of City of Tempe Supplement to MAG and Traffic Engineering Group.

2. Traffic signal conduit and pull boxes shall be installed per the requirements City of Tempe Supplement to MAG and Traffic Engineering Group.

3. For any open trench or horizontal boring across the roadway, the design shall provide two (2) 3" conduits and one (1) 2" ITS conduit with pull boxes interconnecting all approaches of the traffic signal intersection.

4. All underground conduits shall have AWG #12 detectable tracer wire and AWG #22 detectable pull tape unless approved otherwise.

5. Conductor color code shall be per the requirements of City of Tempe Supplement to MAG and Traffic Engineering Group.

6. ITS color code shall be per the requirements of City of Tempe Supplement to MAG and Traffic Engineering Group.

7. Modular poles per the requirements of City of Tempe Supplement to MAG shall be used for all traffic signals except in downtown Tempe unless approved otherwise. Modular poles shall be manufactured by T.A. CAID Industries, Inc and shall include:

    - T.A. CAID A-1 Modular Traffic Signal Pole
    - T.A. CAID A-2 Modular Traffic Signal Pole
    - T.A. CAID Modular Traffic Signal Add-On Structures

8. T.A. CAID Modular Traffic Signal Pole.All signal modular foundations shall be constructed per City of Tempe Supplement to MAG; MAG Standard Details and Specifications and ADA design guidelines per the Proposed Guidelines for Accessible Pedestrian Facilities in the Public Right of Way (PROWAG).

9. Signing and Striping shall be per the requirements of MCDOT standards & manual and City of Tempe Traffic Engineering Group.

10. Emergency Vehicle Pre-Emption shall be Global Traffic Technologies Infrared System (Model 711 Detector, Model 138 Cable, and Model 762 Phase Selector).

11. Video detection shall be Aldis Gridsmart Dual Camera System including GS-3 CAM, GS-3-GS2 Processor, and Cables and most recent requirements & updates as appeared on ADOT Approved Product List (APL).

12. Approval from City of Tempe is required before purchase of any equipment.

2. NO. 7 DEEP PULL BOX

2.1 Description

The work under this item shall consist of furnishing and installing No. 7 Deep Pull Boxes in accordance with the Plans.

2.2 Materials

All No. 7 Deep Pull Boxes and lids shall conform to the applicable ITS Standard Drawings, Plans and Technical Specifications. Pull box lids shall bear the words “CITY OF TEMPE TRAFFIC ENGINEERING” unless otherwise specified on the Plans and in the Technical Specifications. Markings shall be clearly defined and shall be placed parallel to the long side of the cover. Letters shall be a minimum of 2 inches in height.

No. 7 Deep Pull Boxes shall be a precast, polymer concrete, fiberglass reinforced, pull box, conforming to the Plans. A certificate of compliance shall be supplied for structural capabilities and materials used in manufacturer. Concrete pull boxes and lids shall not be used. Contractor shall submit test results to certify that the pull box sidewalls and lids remain intact when subjected to the loading conditions specified.

No. 7 Deep pull boxes shall be 24 inches in depth and consist of a single-piece box unit. Stacked units shall not be used. Chipped, cracked or otherwise damaged pull boxes and lids will not be accepted.

2.3 Construction Requirements

The contractor shall be responsible for restoring the surrounding surface conditions back to their original state, including concrete areas. The compaction around the box shall not damage the pull box. The contractor shall replace pull boxes damaged by compaction at no cost to the City of Tempe.

3. AC POWER RECEPTACLE

3.1 Description

The work under this item shall consist of furnishing and installing the AC Power Receptacle and associated mounting hardware, as required for a fully functional and operational AC Power Receptacle.

The Contractor shall provide all AC Power Receptacles from the same manufacturer. All equipment shall be new and in strict accordance with the details shown herein.

3.2 Material Requirements

The Contractor shall provide a 2-gang double duplex non-GFI protected electrical outlet compatible with a NEMA TS2 Type 1 traffic signal cabinet.

3.3 Construction Requirements

The AC Power Receptacle will connect to cabinet power per the cabinet manufacturer's recommendation. Contractor shall meet all applicable codes and standards requirements for all external wiring to AC Power Receptacle. All wires and cables shall be neatly installed (coiled) and secured with break-away ties per common practices and standards. Final connections shall be made by a licensed electrician.

3.4 Testing Requirements

The Contractor shall demonstrate to the Engineer that all AC Power Receptacles are functioning properly.

4. CAT5E CABLE

4.1 Description

The Contractor shall furnish all CAT5E Cable from the same manufacturer. All CAT5E Cable shall be new and in strict accordance with the following requirements:

4.2 Material Requirements

At a minimum, the CAT5E Cable shall meet the following requirements:

- Shall have a black polyethylene jacket with UV resistance for outdoor installation
- Shall satisfy requirements for Category 5e, per ANSI/TIA 568-C.2
- Shall consist of 4 solid conductor pairs; 24 AWG
- Shall be gel-filled to prevent water infiltration
- Shall have an operating temperature range of -20˚C to +60˚C

4.3 Construction Requirements

The Contractor shall install the CAT5E Cable within the signal poles, conduit, pull boxes and traffic signal cabinet, connecting the associated ITS Device (CCTV Camera or Wireless Radio) to a surge protection device and network switch within the traffic signal cabinet as per the port assignment provided by the City of Tempe. The cable run shall be continuous, with no splices permitted between the ITS Device and traffic signal cabinet.

Where CAT5E Cable is to be installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires and shall install CAT5E Cable within Innerduct. The Contractor shall disconnect, remove, reinstall and reconnect the existing cables

and wires as necessary to facilitate the installation of the new cable. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation. New and existing conductors shall be terminated and labeling reconciled. No additional payment will be made as this work shall be considered incidental to the associated items. Where cables are to be installed in a shared conduit with existing traffic signal wiring, an International Municipal Signal Association (IMSA) Certified Traffic Signal Field Technician – Level II will be required on-site. A Uniformed Police Officer will be required on-site as stated in the City of Tempe Traffic Barricade Manual, latest edition.

After installation, 4 feet of the leading end of the CAT5E Cable shall be cut off to ensure that no water infiltration has occurred. The CAT5E Cable shall be protected from sharp edges when entering/exiting signal pole hand holes and other entry/exit points and shall be neatly coiled and secured with Velcro wraps within the traffic signal cabinet per common practices and standards. The CAT5E Cable shall be terminated as per pinout TIA/EIA-568B, using industry practices and standards.

The Contractor shall label all CAT5E Cables entering the traffic signal cabinet to identify the ITS Device to which it is connected. The Contractor shall use Scotch 33+ vinyl electrical tape to label the CAT5E Cable six (6) inches from the terminated cable end, as follows:

ITS Device	Tape Colors/ Number of Wraps
CCTV Camera	2 Purple
Wireless Radio (facing west)	1 Purple & 1 White
Wireless Radio (facing south)	1 Purple & 1 Green
Wireless Radio (facing east)	1 Purple & 1 Red
Wireless Radio (facing north)	1 Purple & 1 Blue

CAT5E Cables terminated within the traffic signal cabinet will be plugged into an in-line lightning and surge protection device prior to being plugged into the network switch. The surge protection device shall meet the following requirements:

- Shall protect all four Ethernet data pairs
- Shall support IEEE 802.3af PoE
- Shall automatically reset to protect against multiple surges

4.4 Testing Requirements

The Contractor shall perform continuity testing of each installed CAT5E Cable in addition to testing required to ensure connectivity with the associated ITS Device. The length of the installed CAT5E Cable should be recorded and provided to the City of Tempe as part of the project documentation.

5. CCTV CAMERA

5.1 Description

The work under this item shall consist of furnishing, installing, integrating and testing the CCTV Camera, CAT5E cabling, connections, mounting hardware and various accessories as required for a fully functional and operational CCTV Camera.

The Contractor shall provide all CCTV Cameras from the same manufacturer. All equipment shall be new and in strict accordance with the following requirements.

5.2 Technical Requirements

The following CCTV Cameras are acceptable:

- Axis Communications Q6055-E Dome Camera
- Bosch VG5-7230-EPC5 AUTODOME IP 7000HD Dome Camera
- Pelco Spectra Enhanced S6230-EGL1 Dome Camera

5.3 Construction Requirements

The Contractor will install the CCTV Camera on a City of Tempe signal pole, along with required mount and CAT5E cabling, and shall connect the CCTV to a network switch located within the traffic signal cabinet. Required mount, CAT5E cabling and surge protection equipment are considered incidental to the installation of the CCTV Camera.

The Contractor shall install cameras on corner mounts, unless otherwise specified in the Plans. Camera mounts shall be installed by drilling and tapping existing traffic signal poles and all holes will be waterproofed to maintain the integrity of the traffic signal pole. Camera corner mounts should be located as high as possible on the luminaire upright, just beneath the luminaire mast arm, and directed towards the interior of the intersection, unless otherwise specified in the Plans. Where applicable, CCTV Camera mounts and adapters will be painted Tempe Bronze to match the color of the traffic signal pole. No wires, cables, or conductors shall be exposed from the base of the tilt/pan drive. All conductors shall be routed inside the support structure.

The Contractor shall be responsible for configuration and programming of the CCTV Camera and connecting it to the network switch. The City will provide IP addresses, netmasks, gateways, port assignments, NTP server, video stream settings and other required information. The Contractor shall apply all available firmware upgrades to the device.

All wires and cables shall be neatly installed and secured per common practices and standards.

5.4 Testing Requirements

The Contractor shall demonstrate to the City of Tempe that the CCTV Camera is functioning properly and that all video camera controls and video streams are accessible from the Tempe Transportation Management Center.

6. ETHERNET CONVERTER

6.1 Description

The work under this item shall consist of furnishing, installing, integrating and testing the Ethernet Converter and associated mounting hardware, cabling, software, power adapter and various accessories as required for a fully functional and operational Ethernet Converter.

The Contractor shall furnish all Ethernet Converters from the same manufacturer. All equipment shall be new and in strict accordance with the following requirements.

6.2 Material Requirements

The following Ethernet Converters are acceptable:

- Comtrol DeviceMaster RTS 1-Port DB9
- Digi One SP Compact Serial Server
- Moxa NPort 5110-T 1-Port Serial Device Server

6.3 Construction Requirements

Contractor shall meet all applicable codes and standards requirements for all external wiring to the Ethernet Converters. All wires and cables shall be neatly installed (coiled) and secured with Velcro wraps per common practices and standards. The Contractor shall provide a service loop at all connection points. All factory caps and plugs removed from the Ethernet Converter shall be stored safely within the traffic signal cabinet for later use.

Contractor shall provide and install one (1) Category 5e (CAT5E) patch cord (1 meter in length, typically) to connect the Ethernet Converter to the City of Tempe's ITS Network.

The Contractor shall be responsible for programming the Ethernet Converter. The City will provide IP addresses, netmasks, gateways, port assignments, VLAN configuration, NTP server and other required information. The Contractor will apply all available firmware upgrades to the Ethernet Converter.

6.4 Testing Requirements

The Contractor shall ensure that the Ethernet Converter is correctly installed, configured and operational. The Contractor shall demonstrate to the City of Tempe that the Ethernet Converter is functioning properly and that it, and all connected devices, are visible on the ITS Network from the Tempe Transportation Management Center.

7. ETHERNET SWITCH

7.1 Description

The work under this item consist of furnishing, installing, integrating and testing the Ethernet Switch and associated mounting hardware, cabling, software and various accessories as required for a fully functional and operational Ethernet Switch.

The Contractor shall furnish all Ethernet Switches from RuggedCom. All equipment shall be new and in strict accordance with the following requirements.

7.2 Material Requirements

The Contractor shall furnish the following Ethernet Switch:

- RuggedCom RS900-HI-D-TX-TX-TX-XX

7.3 Construction Requirements

Contractor shall meet all applicable codes and standards requirements for all external wiring to the Ethernet Switches. All wires and cables shall be neatly installed (coiled) and secured with Velcro wraps per common practices and standards. The Contractor shall provide a service loop at all connection points. All factory caps and plugs removed from the Ethernet Switch shall be stored safely within the traffic signal cabinet for later use.

Contractor shall provide and install one (1) Category 5e (CAT5E) patch cord (1 meter in length, typically) in each copper port (TX) of the Ethernet Switch, in order to provide connectivity to the City of Tempe's ITS Network.

The Contractor shall be responsible for programming the Ethernet Switch. This includes ensuring that the configuration of each uplink port connecting to neighboring switches is trunked allowing multiple VLANs to pass.

The City will provide IP addresses, netmasks, gateways, port assignments, VLAN configuration, NTP server and other required information. The Contractor will apply all available firmware upgrades to the Ethernet Switch.

The Contractor shall minimize disruption to any existing communications equipment within the traffic signal cabinet and coordinate any equipment switchover with the City of Tempe to ensure the integrity and operational capacity of the City's ITS Network is not reduced.

7.4 Testing Requirements

The Contractor shall ensure that the Ethernet Switch is correctly installed, configured and operational. The Contractor shall demonstrate to the City of Tempe that the Ethernet Switch is functioning properly and that it, and all connected devices, are visible on the ITS Network from the Tempe Transportation Management Center.

8. FIBER OPTIC CABLE

8.1 Description

The work under this item shall consist of furnishing, installing and testing Fiber Optic Cable as required for a fully functional and operational communications network.

The Contractor shall furnish all Fiber Optic Cable from the same manufacturer, which shall be ISO 9001 or 9002 certified. All such cable shall be new and in strict accordance with the following requirements:

8.2 Material Requirements

At a minimum, each Fiber Optic Cable shall meet the following requirements:

- Strand count shall be as specified within the Plans
- 9/125 Single Mode Fiber Optic Cable capable of supporting wavelengths of 1310/1550 nm
- All materials in the cable shall be dielectric.
- Shall be loose tube cable construction with a polyethylene outer jacket
- Shall be in buffer tubes of 12 fibers each, color coded in accordance with EIA-598-A
- Each buffer tube shall utilize a gel-free design that is fully water blocked using materials that are craft friendly, requiring little or no clean up, and allowing easy access to the fiber.
- Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z", stranding process. Filler rods should be used in trunk cable to lend symmetry to the cable section.
- Shall have a central strength member designed to prevent buckling of the cable and dielectric tensile strength members designed to minimize cable elongation due to installation forces and temperature variation.
- Shall be certified for a 20-year life expectancy when installed to manufacturer's specifications
- Shall withstand a 600 lbf maximum installation tensile load and a long-term installed maximum tensile service load of 180 lbf
- Capable of bend radii as small as 20 times the outside cable diameter (under installation load) and 10 times the outside cable diameter (long term load).
- Shall have a storage/operating temperature range of -40°C to +70°C
- Shall have a black outer jacket constructed of a high or medium density polyethylene (HDPE or MDPE) that has been applied directly over the tensile strength members and water-blocking material. The jacket shall have at least one ripcord for easy sheath removal.
- Shall have an outer jacket with sequential length markers, in a contrasting color to the cable jacket, at regular intervals of between 3 and 5 feet (in English units) along the outside of the jacket. Also printed on the jacket shall be the cable code to identify the number and type of fibers, manufacturer's name, manufacturer's part number and the year of manufacture. Jacket markings shall be readable and proportionate in height to the cable and must be permanent and weatherproof.
- Crush Resistance of 220 N/cm, per TIA/EIA-455-41 and IEC 794-1-E3
- Shall have a maximum attenuation of 0.25 dB/km at 1550 nm and 0.35 dB/km at 1310nm

8.3 Construction Requirements

No Fiber Optic Cable shall be installed until the pull boxes, conduit, and cabinets through which fiber cables will pass or terminate have been approved by the City of Tempe for Fiber Optic Cable installation.

All Fiber Optic Cable shall be a continuous cable of sufficient length to satisfy the runs shown in the Plans without additional full cable splices not specified in the Plans. Additional splice locations proposed by the contractor, not indicated on the project plans, are subject to approval by the City of Tempe, and shall be at no cost to the City or Department. The Fiber Optic Cable shall be wound on the reel in such a way as to provide access to both ends for testing while the cable is on the reel.

When Fiber Optic Cable is pulled through a pull box, the Contractor shall ensure that the cable is protected from sharp edges and excessive bends. Each cable will be hand-assisted at each pull box and will be neatly coiled in pull boxes at a minimum radius of 20 times the outer diameter of the cable. Cable will be secured with break-away ties per common practices and standards.

Fiber Optic Cable shall be pulled according to the cable manufacturer's recommended installation procedures. Manufacturer-approved pulling grips, cable guides, feeders, shoes and bushings shall be used to prevent damage to the cable during installation. The Contractor shall use a pre-lubrication or continuous lubrication method. The lubricant used will be compatible with the cable jacket as recommended by the cable manufacturer. Liquid detergent shall not be used. Cable shall not drag on the ground or pavement during installation. The Contractor shall ensure that the tensile load on the cable does not exceed the allowed maximum by using a system that includes a means of alerting the installer when the pulling tension approaches the limit and displays the actual tension on the cable. The Contractor may supplement this procedure with a breakaway tension limiter set below the recommended tensile limit of the cable being pulled.

Where cables are to be installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires and shall install Fiber Optic Cable within Innerduct as specified within the Technical Specifications. The Contractor shall disconnect, remove, reinstall, and reconnect the existing cables and wires as necessary to facilitate the installation of the new cable. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation. New and existing conductors shall be terminated and labeling reconciled. No additional payment will be made as this work shall be considered incidental to the associated items. Where cables are to be installed in a shared conduit with existing traffic signal wiring, an International Municipal Signal Association (IMSA) Certified Traffic Signal Field Technician – Level II will be required on-site. A Uniformed Police Officer will be required on-site as stated in the City of Tempe Traffic Barricade Manual, latest edition.
Fiber Optic Cable shall be spliced only at the pull box locations specified on the Plans. At these designated locations, each single mode fiber shall be fusion spliced according to the splice details in the Plans.

All pull boxes with splice closures shall have 50 feet of Fiber Optic Cable slack provided for all cables entering the pull box, between the splice closure and the point where the cable enters/exits the pull box, allowing the attached splice closure to be removed up to 50 feet from the pull box. All passthrough pull boxes without splice closures shall have 15 feet of Fiber Optic Cable slack coiled in the pull box.

All Fiber Optic Cables shall have permanent identification labels attached, with labels and the method of attachment approved by the City of Tempe. Approved labels shall be installed on each Fiber Optic Cable near the point where it enters/exits the pull box. A cable passing through a pull box, whether spliced or not, shall have two labels, one near each entry/exit point to the

pull box. A typical trunk pull box, with a branch fiber optic cable, would have three labels, two on the trunk fiber optic cable (one on each side of the splice closure) and one on the branch fiber optic cable. All labels shall include “City of Tempe ITS”, the fiber type and strand count, e.g., “SMFO 48”, and the destination, e.g., “Traffic Signal Cabinet” or the terminal point for the fiber optic segment.

All fusion splices and connectors shall be prepared in accordance with the recommendations of cable, splice and connector manufacturers. Fusion splice losses shall not exceed 0.1 dB and connectors shall not introduce a loss exceeding 0.5 dB. If any fiber exceeds maximum allowable attenuation or if fiber properties of the cable have been impaired, take appropriate actions up to and including replacement of the fiber cable. Corrective action will be at no additional cost.

The Contractor shall secure a certification from the cable manufacturer that the cable is in conformance with the Rural Utilities Service (RUS) Bulletin PE-90a (where applicable.

The Contractor shall certify that the installation of all Fiber Optic Cables is in accordance with the cable and splice manufacturer’s recommendations and the Technical Specifications.

8.4 Testing Requirements

All new and existing empty conduit shall be tested for continuity and integrity no more than one week prior to the installation of Fiber Optic Cable. Conduit shall be tested by pulling through a metal-disc mandrel with a diameter 10% less than the conduit’s inside diameter and at least 8 inches long, or brushed or swabbed, as the situation requires. Conduit which is found to not be continuous, missing or broken, or in any other way damaged and unsuitable for Fiber Optic Cable installation, shall be exposed and documented with a detailed description and photographs and the City of Tempe shall be notified. No repair work shall be done.

All Fiber Optic Cable (after installation, before splicing) shall be tested for optical loss at 1310nm and 1550nm using a power meter and light source. Tests shall be done a minimum of 3 times at each wavelength and averaged, with the difference between the power meter reference and the average recorded as the actual dB loss for the installed cable.

All Fiber Optic Cable, inclusive of all jumper cables and patch panels, shall be tested bi-directionally, before and after installation, to verify its integrity and performance.

The Contractor shall conduct power meter tests for each terminated fiber to measure the installed fiber cable attenuation, demonstrate connectivity and correct splicing. The contractor shall perform power meter tests on each fiber strand terminated with connectors utilized in circuits, in accordance with Method A.3 of TIA/EIA-526-7 and submit test results for each fiber to the City of Tempe. Power meter tests shall be conducted after all cable has been installed, all splices have been made and Fiber Optic Patch Panels have been installed. Testing shall be conducted at the cable ends in one direction for all fiber strands using 1310nm wave length. The testing shall include a test summary spreadsheet listing, at a minimum, the parameters for each buffer tube by cable.

The Contractor shall test (at 1310nm and 1550nm) all terminated fibers of each Fiber Optic Cable using an Optical Time Domain Reflectometer (OTDR) in accordance with TIA/EIA-758. Tests should be conducted in compliance with EIA/TIA-526-14, EIA/TIA 526-7 or OFSTP 14, Method B, according to the manufacturer’s instructions for the test set being utilized. Splices

testing 0.1 dB or greater, or connectors testing 0.5 dB or greater, shall be remade. If any fibers are out of specification, the entire Fiber Optic Cable run shall be replaced at no additional cost.

Clearly label each OTDR trace identifying a starting and ending point for all fibers being tested. Record the attenuation level of each fiber and clearly indicate OTDR trace results in report format. OTDR readings must not include any unexpected discontinuities such as would be present if the fiber optic cable was damaged during installation. The dB loss per kilometer shall be less than 1.0 dB in order for the fiber optic cable installation to be acceptable.

Demonstrate that the attenuation for each fiber string, termination, and splice, individually and as a whole, comply with the loss budgets required by the Specifications. Clearly annotate each event (connector, jumper cable, pigtail, splice, etc.) and identify the measured loss.

Following completion of all testing, and approval by the City of Tempe, the Contractor shall compile and submit an organized set of electronic files (PDF) reflecting the post-installation tests. These files shall include a fiber test summary that includes, at a minimum, the OTDR traces of each fiber strand and the power meter test results.

The Contractor shall provide copies of certificates of calibration for Optical Time Domain Reflectometers (OTDRs), fusion splicers and Power Meters issued within the past 12 months and may be asked to verify that applicable components are replaced at the recommended intervals. The Contractor shall observe the manufacturer's recommended testing procedures for each piece of test equipment.

9. FIBER OPTIC PATCH CABLE

9.1 Description

The work under this item shall consist of furnishing, installing and testing Fiber Optic Patch Cables as required for a fully functional and operational communications network.

The Contractor shall furnish all Fiber Optic Patch Cables from the same manufacturer. All equipment shall be new and in strict accordance with the following requirements:

9.2 Material Requirements

At a minimum, each Fiber Optic Patch Cable shall meet the following requirements:

- Duplex 9/125 single mode fiber with wavelength of 1310/1550 nm
- Rugged PVC sheathing
- Factory terminated connectors, with ST on one end; SC on the other
- Both cable ends will be ruggedized for strain relief
- Permanent markings or color identifiers shall permit visual distinction between the two fibers
- Length shall not exceed 2 meters

9.3 Construction Requirements

The Contractor shall install the Fiber Optic Patch Cables within the traffic signal cabinet, connecting the Fiber Optic Patch Panel to the Gigabit/Fiber Switch as per the port assignment

provided by the City of Tempe. Cables shall be neatly installed (coiled) and secured with Velcro wraps per common practices and standards and all manufacturer recommended installation and minimum bend radius requirements shall be met. All factory caps and plugs removed from the Fiber Optic Patch Cables shall be stored safely within the traffic signal cabinet for later use.

9.4 Testing Requirements

The Contractor shall furnish the manufacturer's test results of each Fiber Optic Patch Cable to the City of Tempe and shall include installed Fiber Optic Patch Cables in all fiber optic test results conducted, as specified within the Technical Specifications. All Fiber Optic Patch Cables with a connector loss greater than 0.5 dB shall not be accepted and must be replaced at no additional cost.

10. FIBER OPTIC PATCH PANEL

10.1 Description

The work under this item shall consist of furnishing, installing, integrating, and testing the Fiber Optic Patch Panel, and associated mounting hardware, cabling, and various accessories, as required for a fully functional and operational unit.

The Fiber Optic Patch Panel, in conjunction with an integrated drop cable, serves as the attachment point from the traffic signal cabinet to the trunk fiber optic cable. All Fiber Optic Patch Panels shall be field measured before ordering, with applicable slack requirements added to the field measured length before ordering.

The Contractor shall furnish all Fiber Optic Patch Panels from the same manufacturer. All equipment shall be new and in strict accordance with the following requirements.

10.2 Material Requirements

At a minimum, each Fiber Optic Patch Panel shall meet the following requirements:

- Shall be comprised of a factory terminated 4-strand SMFO drop cable integrated into a protective housing and a custom length of loose tube drop cable.
- Shall have ST standard connectors, with all connectors sealed by manufacturer-supplied plugs/caps.
- Shall be black in color, constructed of polycarbonate material, with integrated mounting notches for field mounting within the traffic signal cabinet.
- Shall have pairs of couplers arrayed at a 45˚ angle along the length of the housing in a stair-stepped arrangement to facilitate easy access to each coupler pair. Each coupler port shall have a permanent label/identifier clearly visible to designate the port number.
- Shall incorporate a strain relief boot around the exiting drop cable to provide bend radius protection and short-term cable retention of at least 200lbf.
- Shall have fiber optic connectors constructed with all ceramic ferrules. The fiber shall be secured into the ferrule using a heat cured epoxy and shall be factory terminated and polished.

- Shall be filled with an environmentally stable epoxy to permanently secure the connectors and protect the internal components from vibration and shock. The epoxy shall be thermally stable from -40˚C to +54˚C.

10.3 Construction Requirements

No Fiber Optic Patch Panel shall be installed until the pull boxes, conduit, and cabinets through which fiber cables will pass or terminate have been approved by the City of Tempe for Fiber Optic Patch Panel installation.

The Fiber Optic Patch Panel shall be installed on the lower left side of the traffic signal cabinet, near the rear wall, according to the manufacturer's recommended installation procedures.

All wires and cables shall be neatly installed (coiled) and secured with Velcro wraps per common practices and standards.

The Contractor shall provide slack at all connection points, with 50 feet of slack at all fiber splice locations,15 feet at all passthrough pull boxes and 15 feet at the traffic signal cabinet, with all slack provided after splices have been made.

Where cables are to be installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires and shall install Fiber Optic Patch Panel drop cable within Innerduct. The Contractor shall disconnect, remove, reinstall, and reconnect the existing cables and wires as necessary to facilitate the installation of the new cable. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation. New and existing conductors shall be terminated and labeling reconciled. No additional payment will be made as this work shall be considered incidental to the associated items. Where cables are to be installed in a shared conduit with existing traffic signal wiring, an International Municipal Signal Association (IMSA) Certified Traffic Signal Technician – Level II will be required on-site. A Uniformed Police Officer will be required on-site as stated in the City of Tempe Traffic Barricade Manual, latest edition.

All Fiber Optic Patch Panel drop cables shall have permanent identification labels attached, with labels and the method of attachment approved by the City of Tempe. Approved labels shall be installed on each Fiber Optic Patch Panel drop cable near the point where it enters/exits the pull box. A typical trunk pull box, with a Fiber Optic Patch Panel drop cable, would have three labels, two on the trunk fiber optic cable (one on each side of the splice closure) and one on the Fiber Optic Patch Panel drop cable. All cables shall include "City of Tempe ITS", the fiber type and strand count, e.g., "SMFO 48", and the destination, e.g., "Traffic Signal Cabinet" or the terminal point for the fiber optic segment.

Pulling of the fiber optic drop cable shall comply with requirements specified within the Technical Specifications.

The Fiber Optic Patch Panel drop cable shall be detectable through the installation of a separate #14 green tracer wire alongside the drop cable within the conduit.

10.4 Testing Requirements

Fiber terminations shall be visually and optically tested as specified within the Technical Specifications.

The Contractor shall provide factory test results for reflectance and insertion loss for each Fiber Optic Patch Panel. This test report shall reference the serial number of the patch panel installed and be provided to the City of Tempe after installation.

11. FIBER OPTIC SPLICE CLOSURE

11.1 Description

The work under this item shall consist of furnishing and installing Fiber Optic Splice Closures, including sufficient splice trays to accommodate all fiber optic strands within the trunk cable, in pull boxes and as shown on the plans. The Contractor shall furnish and install cable splice closures including fiber optic splices in accordance with the splice details on the plans. The Contractor shall place splice closures in No. 7 or No. 9 pull boxes by a method described below or as approved by the City of Tempe. The Contractor shall furnish all Fiber Optic Splice Closures from the same manufacturer. All equipment shall be new and in strict accordance with the following requirements.

11.2 Material Requirements

At a minimum, each Fiber Optic Splice Closure shall meet the following requirements:

- Cylindrical butt-end style that is corrosion resistant, watertight and meets the requirements of Bellcore GR-771-CORE and GR-769-CORE.
- Base and dome shall be sealed with a clamp and O-ring system
- Four (4) round cable ports shall be provided in a wraparound block with pre-installed gel profile for cable sealing.
- Block shall be capable of being opened and closed repeatedly without the need to remove or replace gel.
- Splice trays shall be hinged for access to any splice without disturbing other trays.
- Splice trays shall meet ANSI/EIT/TIA-568-C and 606 and be compatible with the fiber to be installed.

11.3 Construction Requirements

The Contractor shall install the splice closure in No. 7 or No. 9 pull boxes as shown on the plans and in accordance to the manufacturer's recommended installation procedures.

All fibers shall be fusion spliced according to the splice details and Plan notes including fibers designated to be coupled with fibers from a drop cable assembly and cut fibers designated to pass through the splice closure. Unused cable ports not utilized shall be plugged.

Fiber Optic Splice Closures shall be installed so that the two trunk cable entries are on the same side of the end cap so that if other branch fiber cables are installed at a later date, the two existing seals remain undisturbed. All Fiber Optic Cables entering the Fiber Optic Splice Closure shall have permanent identification labels attached, with labels and the method of attachment approved by the City of Tempe. All labels shall include "City of Tempe ITS", the fiber type and strand count, e.g., "SMFO 48", and the destination, e.g., "Traffic Signal Cabinet" or the terminal point for the fiber optic segment.

After the Fiber Optic Splice Closure is sealed for the final time, after all splicing and testing is completed, a seal leak test shall be performed, following the manufacturer's recommendations, to verify that the Fiber Optic Splice Closure was installed properly.

12. FIBER SWITCH

12.1 Description

The work under this item shall consist of furnishing, installing, integrating and testing the Fiber Switch and associated mounting hardware, cabling, software and various accessories as required for a fully functional and operational Fiber Switch.

The Contractor shall furnish all Fiber Switches from RuggedCom. All equipment shall be new and in strict accordance with the following requirements.

12.2 Material Requirements

The Contractor shall furnish the following Fiber Switch:

- RuggedCom RS900G-HI-D-2SC25-XX

12.3 Construction Requirements

Contractor shall meet all applicable codes and standards requirements for all external wiring to the Fiber Switches. All wires and cables shall be neatly installed (coiled) and secured with Velcro wraps per common practices and standards. The Contractor shall provide a service loop at all connection points. All factory caps and plugs removed from the Fiber Switch shall be stored safely within the traffic signal cabinet for later use.

Contractor shall provide and install one (1) Category 5e (CAT5E) patch cord (1 meter in length, typically) in each copper port (TX) of the Fiber Switch, in order to provide connectivity to the City of Tempe's ITS Network.

The Contractor shall be responsible for programming the Fiber Switch. This includes ensuring that the configuration of each uplink port connecting to neighboring switches is trunked allowing multiple VLANs to pass.

The City will provide IP addresses, netmasks, gateways, port assignments, VLAN configuration, NTP server and other required information. The Contractor will apply all available firmware upgrades to the Fiber Switch.

The Contractor shall minimize disruption to any existing communications equipment within the traffic signal cabinet and coordinate any equipment switchover with the City of Tempe to ensure the integrity and operational capacity of the City's ITS Network is not reduced.

12.4 Testing Requirements

The Contractor shall ensure that the Fiber Switch is correctly installed, configured and operational. The Contractor shall demonstrate to the City of Tempe that the Fiber Switch is functioning properly and that it, and all connected devices, are visible on the ITS Network from the Tempe Transportation Management Center.

13. GIGABIT FIBER SWITCH

13.1 Description

The work under this item shall consist of furnishing, installing, integrating and testing the Gigabit Fiber Switch and associated mounting hardware, cabling, software and various accessories as required for a fully functional and operational Gigabit Fiber Switch.

The Contractor shall furnish all Gigabit Fiber Switches from RuggedCom. All equipment shall be new and in strict accordance with the following requirements.

13.2 Material Requirements

The Contractor shall furnish the following Gigabit Fiber Switch:

- RuggedCom RS940G-HI-D-2SC25-XX

13.3 Construction Requirements

Contractor shall meet all applicable codes and standards requirements for all external wiring to the Gigabit Fiber Switches. All wires and cables shall be neatly installed (coiled) and secured with Velcro wraps per common practices and standards. The Contractor shall provide a service loop at all connection points. All factory caps and plugs removed from the Gigabit Fiber Switch shall be stored safely within the traffic signal cabinet for later use.

Contractor shall provide and install one (1) Category 5e (CAT5E) patch cord (1 meter in length, typically) in each copper port (TX) of the Gigabit Fiber Switch in order to provide connectivity to the City of Tempe's ITS Network.

The Contractor shall be responsible for programming the Gigabit Fiber Switch. This includes ensuring that the configuration of each uplink port connecting to neighboring switches is trunked allowing multiple VLANs to pass.

The City will provide IP addresses, netmasks, gateways, port assignments, VLAN configuration, NTP server and other required information. The Contractor will apply all available firmware upgrades to the Gigabit Fiber Switch.

The Contractor shall minimize disruption to any existing communications equipment within the traffic signal cabinet and coordinate any equipment switchover with the City of Tempe to ensure the integrity and operational capacity of the City's ITS Network is not reduced.

13.4 Testing Requirements

The Contractor shall ensure that the Gigabit Fiber Switch is correctly installed, configured and operational. The Contractor shall demonstrate to the City of Tempe that the Gigabit Fiber Switch is functioning properly and that it, and all connected devices, are visible on the ITS Network from the Tempe Transportation Management Center.

14. INNERDUCT

14.1 Description

The work under this item shall consist of furnishing, installing and testing the Innerduct as required for a fully functional and operational system.

The Contractor shall provide all Innerduct from the same manufacturer. All items shall be new and in strict accordance with the details shown herein.

14.2 Material Requirements

At a minimum, the Innerduct shall be constructed of a flexible fabric, not HDPE, to minimize space usage within the shared traffic signal conduit and should be pre-lubricated for installation. The Innerduct shall be comprised of a single cell and shall be supplied with standard 1250lb color-coded pull tape.

14.3 Construction Requirements

The Contractor shall install the Innerduct according to the manufacturer's recommended installation procedures.

The Innerduct will be installed in a shared conduit with existing traffic signal wiring. An International Municipal Signal Association (IMSA) Certified Traffic Signal Field Technician – Level II will be required on-site during installation. A Uniformed Police Officer will be required on-site as required by the City of Tempe Traffic Barricade Manual, latest edition.

14.4 Testing Requirements

The Innerduct shall permit the installation and physical separation of communications cables within shared traffic signal conduits and shared communications conduit systems without damage to either while maximizing the availability of space within the conduit systems.

15. POWER-OVER-ETHERNET (POE) EXTENDER

15.1 Description

The work under this item shall consist of furnishing, installing, integrating and testing the PoE Extender and associated hardware, cabling and various accessories as required for a fully functional and operational PoE Extender.

The Contractor shall furnish all PoE Extenders from the same manufacturer. All equipment shall be new and in strict accordance with the following requirements.

15.2 Material Requirements

The Contractor shall furnish a PoE Extender that permits the use of Power-over-Ethernet devices, such as Wireless Radios and CCTV Cameras, beyond the standard limit of 100m/328' with no degradation of functional or operational capacity. The PoE Extender shall be contained within a water resistant, dust proof enclosure and housed completely within the traffic signal

cabinet. The PoE Extender shall not require additional mid-span enclosures or hardware components and be capable of operating between -30˚C and +60˚C. The PoE Extender shall provide a minimum of 24VDC of power to the PoE device.

15.3 Construction Requirements

The Contractor shall install the PoE Extender within the City of Tempe traffic signal cabinet according to the manufacturer's recommendations.

15.4 Testing Requirements

The Contractor shall ensure that the PoE Extender is correctly installed, configured and operational. The Contractor shall demonstrate to the City of Tempe that the PoE Extender is functioning properly, passing power and data through to a connected PoE device, by showing that the PoE device is functioning properly and is visible on the ITS Network from the Tempe Transportation Management Center.

16. WIRELESS RADIO

16.1 Description

The work under this item shall consist of furnishing, installing, integrating and testing the Wireless Radio, CAT5E cabling, connections, mounting hardware and various accessories as required for a fully functional and operational Wireless Radio.

The Contractor shall furnish all Wireless Radios from Simrex. All equipment shall be new and in strict accordance with the following requirements.

16.2 Material Requirements

The Contractor shall furnish one of the following Wireless Radios, per project plans:

- Simrex DataMover WB-K49B
- Simrex DataMover WB-G58AC

16.3 Construction Requirements

The Contractor shall install the Wireless Radio on a City of Tempe signal pole, along with the required mount and CAT5E cabling, and shall connect the Wireless Radio to a network switch located within the traffic signal cabinet. Where applicable, Wireless Radio mounts will be painted Tempe Bronze to match the color of the traffic signal pole. No wires, cables, or conductors shall be exposed beyond the base of the radio mount, with all conductors routed inside the support structure. Required CAT5E cabling and surge protection are considered incidental to the installation of the Wireless Radio; CAT5E cable shall be as specified in these specifications.

Where cables are to be installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires and shall install cabling within Innerduct as specified within the Technical Specifications. The Contractor shall disconnect, remove, reinstall, and reconnect the existing cables and wires as necessary to facilitate the installation

of the new cable. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation. New and existing conductors shall be terminated and labeling reconciled. No additional payment will be made as this work shall be considered incidental to the associated items. Where cables are to be installed in a shared conduit with existing traffic signal wiring, a Uniformed Police Officer will be required on-site as required by the City of Tempe Traffic Barricade Manual, latest edition.

Contractor shall meet all applicable codes and standards requirements for all external wiring to the Wireless Radios. All wires and cables shall be neatly installed (coiled) and secured with break-away ties per common practices and standards. The Contractor shall provide a service loop at all connection points.

The Contractor shall be responsible for programming the Wireless Radio. The City will provide IP addresses, netmasks, gateways, NTP server and other required information. The Contractor will apply all available firmware upgrades to the Wireless Radio.

The Contractor shall install the Wireless Radio according to the manufacturer's recommendations and utilize an aiming tool to ensure that the radio antennas are properly aligned.

The Contractor shall minimize disruption to any existing communications equipment within the traffic signal cabinet and associated intersection and coordinate any equipment switchover with the City of Tempe to ensure the integrity and operational capacity of the City's ITS Network is not reduced.

16.4 Testing Requirements

The Contractor shall ensure that the Wireless Radio is correctly installed, configured and operational. The Contractor shall demonstrate to the City of Tempe that the Wireless Radio is functioning properly and that it, and all connected devices, are visible on the ITS Network from the Tempe Transportation Management Center.

The Contractor shall utilize the manufacturer's wireless management software to evaluate the RSSI, SNR, bandwidth and other wireless parameters to verify the proper configuration and performance of each wireless link. The Contractor shall re-aim the Wireless Radio antenna as needed to obtain an optimal level of performance per the manufacturer's guidelines. Documentation of these wireless performance values for all Wireless Radios shall be provided to the City of Tempe to establish an operational baseline. Utilizing the manufacturer's wireless management software and a Simrex DM-MS-5-POE switch (or equivalent), the Contractor shall perform direct bandwidth tests with the Wireless Radio to demonstrate that the CAT5E cable installation is intact and contains no defects that would affect operational performance.

17. WARRANTY

17.1 Description

All equipment and services shall be warranted for not less than one year following the date of acceptance. If the manufacturer provides a longer warranty period, the Contractor shall provide that warranty to the City of Tempe. The equipment warranty shall provide that in the event of a malfunction during the warranty period, the defective unit or units shall be replaced with a working unit within three working days for use while the warranted unit is being repaired, unless

stated elsewhere in the contract documents. Warranties of fitness and merchantability shall be included.

The Contractor warrants that the materials supplied under this Contract are free of liens and shall remain free of liens.

TP Attachment 700-3 – Uninterruptible Power Supply

Specifications for Uninterruptible Power Supply for Traffic Signals

1 GENERAL

This specification establishes the minimum requirements for a complete emergency battery back-up system for use at traffic signals utilizing light emitting diodes (LED) signals and pedestrian heads. The battery back-up system (BBS) must include, but not be limited to the following:

A. UPS with inverter, charger, tap switching transformer and internal power transfer switch;

B. Automatic/manual bypass transfer switch unit;

C. Batteries;

D. Cabinet;

E. Mounting hardware; and

F. Wiring.

The BBS must provide reliable emergency power to a traffic signal in the event of a power failure or interruption.

2 OPERATION

2.1 General

A. The BBS must provide the following operational modes when operating on battery power:

B. Full operation of all traffic signal devices;

C. Flash operation; and

D. Combination of full and flash operation.

2.2 Run Time

The BBS must provide a minimum of 8.0 hours of full time operation with a 450 watt load. The minimum battery size requirement is listed in section 7.0, Battery Type.

2.3 Compatibility

The BBS must be compatible with Model 332, 336, and 337 cabinets; the ITS cabinet; model 170 and 2070 controllers and any NEMA style cabinet and enclosures; the advanced transportation controller; and all cabinet components for full time operation.

2.4 Output Capacity

The BBS must provide a minimum of 1100W/1100VA at 25°C active output capacity with 83 percent minimum inverter efficiency with 30 percent minimum loading.

2.5 Output Voltage

When operating in backup mode, the BBS output must be 120VAC ± 2 percent, pure sine wave output, ≤ 3 percent THD, 60Hz ± 0.3 Hz.

2.6 DC System Voltage

The BBS DC system voltage shall be 48VDC nominal.

2.7 Transfer Time

The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, must be 5 milliseconds (ms). The same maximum allowable time must also apply when switching from the inverter line voltage to utility-line voltage. Transfers to and from battery operation must not interfere with the operation of the other equipment in the intersection.

2.8 Operating Temperature

The BBS and all components must operate without performance degradation over a temperature range of -40°C to +74°C with a maximum load of 70 percent of rated output of the BBS inverter.

2.9 Feedback Level

The BBS must be tested and certified to Electrical Standards UL 1778 and CSA 107.3.

2.10 Surge Protection

The BBS must have surge protection compliant with IEEE/ANSI C.62.41 Cat. A & B.

2.11 Reliability

The BBS system must have a mean-time-before-failure of 174,955 hours at a temperature of 25 degree C (77 degree F) and 103,030 hours at a temperature of 50 degree C (122 degree F).

2.12 Power and Control Connections

The BBS must be easily installed, replaced, or removed by using easily removable cables for AC input, AC output, DC input, external transfer control/alarm and battery temperature sense.

2.13 AC Connection

The AC input and output must hard wired connections.

2.14 DC Connection

The DC connection must be a recessed one piece Anderson Style connector rated to handle the maximum DC current required by the inverter while running on batteries.

2.15 Temperature Probe Connections

The battery temperature sense inputs shall be panel-mounted Telco style connector.

2.16 Unit Failure

In the event of inverter/charger failure, battery failure or complete battery discharge, the automatic bypass transfer switch shall revert to normally closed (NC) (de-energized) state, where utility line power is connected to the cabinet.

2.17 Overload

The BBS inverter module must be able to shutdown in order to protect against internal damage in the event of an overload at the output. The inverter must support an overload up to 115 percent for 2 minutes and then turn off the inverter output. The fault recovers when the overload is removed and line power returns.

2.18 Schedule

The BBS must provide a time-of-day schedule settings programmable by the user.

The time-of-day schedule must allow the user to program schedule operational modes as required, per intersection.

The BBS time-of-day function when programmed must automatically change operational modes based on the time-of-day schedule. Operational modes must be red flash or full operation.

The BBS must not switch from flash operation to full operation mode when the remaining battery capacity is ≤ 40 percent.

2.19 AC Feedback

The BBS must prevent a malfunction feedback to the cabinet or from feeding back to the utility service.

2.20 BBS Failure Mode

In the event of BBS failure (inverter/charger or battery) or complete battery discharge, the internal power transfer relay must revert to NC (de-energized) state and provide utility power to the intersection when utility line power is available to the cabinet.

2.21 Automatic Shutdown

The BBS must initiate an automatic shutdown when battery output reaches 42.5VDC.

2.22 Destructive Discharge or Overcharge

The BBS must be equipped with an integral system to prevent the battery from destructive discharge or overcharge.

3 AUTOMATIC BYPASS TRANSFER SWITCH

3.1 Rating

The BBS must include an automatic/manual transfer switch rated at 120VAC/30 amps.

3.2 Automatic & Manual Bypass Switch

The automatic bypass transfer switch must be a combination automatic/manual bypass switch. Placing the bypass switch in the “bypass” mode must transfer the intersection load from the UPS output directly to commercial power. AC commercial power must still be available to the UPS input, allowing the UPS to keep the batteries charged. An inverter input breaker must be provided and located on the bypass switch so to shut off commercial power to the UPS input, allowing safely disconnecting and removing the inverter. With the inverter turned off, the batteries can be safely disconnected from the system.

3.3 Indicator Light

The automatic bypass transfer switch must include a bypass indicator light that automatically notifies the user when the manual bypass switch is in bypass position. The indicator light must be illuminated when in UPS mode.

3.4 Status Relay

The automatic transfer switch must have an optional bypass status relay with normally open, dry contacts that automatically close when the manual bypass switch is in bypass position.

3.5 Integrated Switch

The manual bypass switch and the automatic transfer relay must be integrated together within the automatic bypass transfer switch allowing the manual bypass switch to be rated at 15 Amp and to be integrated with the bypass indicator light.

3.6 Terminal Blocks

The automatic bypass transfer switch must have terminal blocks capable of accepting #6 AWG wiring for the AC input and output with #10 AWG from the automatic bypass transfer switch to inverter/charger module.

4 FUNCTIONALITY

4.1 Output Voltage Regulation Mode

The BBS must include auto voltage regulation functionality.

4.1.1 AC Input Voltage Range for Output Regulation

The buck/boost mode must have a minimum range of 88 - 175 VAC.

4.1.2 Transfer Set Points

There must not be any user definable transfer set points for the buck boost mode.

4.1.3 Regulated Voltage

Whenever auto voltage regulation mode is selected the output of the system must be regulated between 108-130VAC. When the output of the system can no longer be maintained with this range, the BBS must transfer to backup mode.

4.2 Circuit Breakers

The BBS must be equipped with an AC Input circuit breaker that protects both the UPS and the loads connected to the output. Should the AC input breaker on the UPS trip, it must allow the UPS to go to inverter mode to power the intersection off of batteries. Should an overload condition still exist when the inverter is energized the inverter must revert to its internal electronic protection, preventing damage to the inverter due to the overload or short circuit condition, on the output. Once this overload condition is cleared the inverter must energize and power the intersection utilizing the available battery power. If the condition does not clear itself, the inverter must stay in the standby mode until manually cleared by a technician.

The BBS must have a flush mounted battery circuit breaker installed on the front panel of the BBS inverter module.

4.3 Line Qualify Time

The BBS must have a user definable line qualify time. The user must be able to select a minimum of six possible settings. The settings must be 3, 10, 20, 30, 40 and 50 seconds. The default line qualify time must be 3 seconds.

4.4 Battery Charger

The BBS must have an integral charger that is compatible with Gel and AGM battery topology. The charger must be an intelligent charger with control systems that automatically incorporates bulk, absorption and float charging modes.

4.4.1 Battery Temperature Compensation

The integral intelligent charger must use temperature compensation. The charging system must compensate over a range of 2.5 - 6.0mV/°C per cell, user adjustable when required.

4.4.2 Battery Temperature Sensor

A temperature probe which plugs into the front panel of the BBS must be used to monitor the internal temperature of the batteries. The temperature sensor must be 2 meter in length, external to the inverter/charger module and taped to the side of a center battery within the battery string.

4.4.3 Battery Temperature Charging

The batteries must not be recharged whenever the battery temperature exceeds 50°C.

4.4.4 Battery Balancing

The BBS must include an external battery balancer to automatically balance the battery charger voltage on all batteries in the string to within +/- 100 mV between any two batteries. The

balancer must allow for any single 12V battery within the battery string to be replaced without replacing all batteries in the string during the battery warranty period.

4.4.5 Recharge Time

The recharge time for the batteries from “protective low-cutoff” to 90 percent or more of full charge capacity must not exceed 12 hours. The BBS charger must be capable of providing 15 amps at 54VDC.

5 USER INTERFACES AND DISPLAYS

5.1 Inverter/Charger Display

The BBS inverter/charger unit must include a backlit LCD display for viewing all status and configuration information. The screen must be easily viewable in both bright sunlight and in darkness.

5.1.1 Screen Size

The screen must be large enough to display the following information with the use of menu scrolling buttons to read required information. All active readings must be real time.

A. Operating mode (line, standby, backup, buck / boost)

B. Utility input voltage

C. BBS output voltage and current

D. Battery temperature

E. Input frequency

F. Output power

G. Battery voltage

H. Charger current

I. Shed timer relays time to activation

J. Ethernet MAC address and IP address

K. Accumulated output power in kW hours

L. Battery runtime remaining

M. Unit serial number

N. Unit firmware version

O. Any alarms and faults

5.1.2 Keypad

The BBS inverter/charger unit must include a keypad for navigating system information.

5.1.3 Web-based Interface

The BBS must be provided with a web-based-interface for user configuration and management through a web browser.

5.1.4 Minimum Capabilities

The BBS must allow the user to do the following through the web browser:

A. View logs;

B. Change modes of operation;

C. Configure email alarms;

D. Adjust line qualify time;

E. Program relay contacts;

F. Configure network parameters;

G. Inverter/charger firmware to be upgradeable remotely via Ethernet; and

H. Communication module firmware upgradeable remotely.

5.1.5 Status LEDs

The BBS must have discrete status LED indications on the front of the inverter/charger.

5.1.6 Green Output LED

This LED must be “on” any time that the output of the BBS is in normal mode. When the BBS output is either in backup mode or auto voltage regulation modes the LED must flash “on” and “off”.

5.1.7 Red Fault LED

This LED must be solid “on” any time that there are any faults in the system.

5.1.8 Red Flashing Alarm LED

This LED must flash “on” and “off” any time that there are any alarms in the system.

5.1.9 Event Log

The BBS must maintain an event log containing a minimum of 200 of the most recent events recorded by the BBS. These events must be down loadable remotely via Ethernet and automatically reported to the central monitoring software. The events log must be date and time stamped.

5.1.10 Events, Alarms and Faults

The BBS must display and log the following events, alarms and faults:

A. Operating mode;

B. Weak battery;

C. Overload;

D. High and low temperatures;

E. User input, S2 is shorted;

F. Line frequency out of specifications;

G. No temperature probe;

H. Low battery;

I. Battery breaker open;

J. BBS is performing a self-test;

K. Fan fail;

L. Incorrect firmware;

M. AC input breaker open;

N. Short circuit;

O. Output voltage high;

P. Output voltage low;

Q. Battery voltage high;

R. Battery voltage low;

S. Isolation relay fail; and

T. Temperature high.

5.1.11 Counters

The BBS must keep track of the following:

A. The number of times that the unit was in backup mode.

B. The accumulated number of hours and minutes that the unit has operated in backup mode since the last reset.

5.1.12 Programmable Relay Contacts

The BBS must provide the user six programmable dry relay contacts and one 48VDC relay contact. As a minimum, the programmable options must be on battery, low battery, timer, alarm, fault, and off. The BBS must also have three input dry relay contacts. BBS self test, user alarm, and BBS shutdown.

5.2 Relay Contact Terminals

The relay contacts must be made available on the front panel of the BBS via 6, 3 position plug-in terminal blocks with screw down wiring connections.

5.2.1 Contacts

Each relay, C-1 through C-5 must have their own common and their own set of normally open (NO) and NC terminals. The terminals for each relay must be oriented as NO-C-NC on the terminal block. C-6 must provide continuous 48 VDC voltage for powering of enclosure DC fan.

5.2.2 Labeling

The contacts on the terminal block must be labeled 1-18, left to right. Additionally, each set of contact must be labeled with the NO-C-NC designation, as well as C1…C6 from left to right. Printed labels noting all alarms and faults must be provided with the BBS inverter/charger to be installed when required.

5.2.3 Rating

The relay contacts must be rated at a minimum of 1 amp at 250 VAC.

5.2.4 On Battery Relay Contact

The dry relay contacts that are configured for “on battery” must only energize when the Inverter is operating in backup mode.

5.2.5 Timer Relay Contacts

The BBS must include a timer that must energize the “timer” configured dry relay contact after the user configured time has elapsed. The timer is started when the BBS enters backup mode. The user must be able to configure the timer to the required time. The format must be hours, minutes, seconds.

5.2.6 Low Battery Relay Contact

The BBS must have an adjustable low battery relay setting. This setting must be adjustable so that the user can set the point at which the low battery relay contact is energized.

6 COMMUNICATIONS

6.1 Serial Interface

The BBS must be equipped with an industry standard RS-232 serial connection for user configuration and management. The serial port must be an EIA-232 (DB9-Female) connector.

6.2 Ethernet Interface

The BBS must have an internal Ethernet communication interface for user configuration and management. The Ethernet port must be an RJ-45, EIA 568B pin out connector.

6.3 Remote Monitoring

The BBS must be include remote monitoring & alarms transmission capabilities through the Ethernet RJ-45 IP addressable port, using simple network management protocol.

6.4 Notification

System must have the capability of notifying operations, maintenance or TMC via e-mail of any alarms, faults or events, user selectable. E-mail set up must allow for different levels of notifications based on the criticalness of the alarms.

6.5 User Configuration Menus

All BBS configuration and system menus must be accessible and programmable from the RS-232 and Ethernet port.

6.6 Communication Protocols

The BBS must support TCP and UDP over IP protocol communications.

6.7 Application Layer Protocols

The BBS must support FTP, Telnet, and HTTP.

6.8 Simple Network Management Protocol

The BBS must be simple network management protocol compliant.

7 BATTERIES

7.1 Battery Type

The battery must be comprised of extreme temperature, float cycle, GEL valve regulated lead acid. Individual batteries must meet the following specifications:

A. Voltage rating: 12V

B. Amp-hour rating: 109 AH, at the 20 hour rate, to 1.75 Volts per cell, minimum battery rating. Larger AH batteries are acceptable providing they do not exceed the group size listed below. (Case 31)

C. Group size: Case 31

D. Batteries must be easily replaced and commercially available off the shelf

E. Batteries must provide 100% runtime capacity out-of-box. Each battery must meet its specification without the requirement of cycling upon initial installation and after the initial 24 hour top off charge.

7.2 Battery String

Batteries used for the BBS must consist of a 4 batteries configured for a 48 VDC battery buss system.

7.3 Operating Temperature

The battery system must consist of one or more strings of extreme temperature; float cycle GEL valve regulated lead acid batteries. Batteries must be certified to operate at extreme temperatures from –40°C to +71°C.

7.4 Construction

7.4.1 Terminals

The batteries must have maintenance-free threaded insert terminals eliminating annual torqueing. Battery terminals that require annual torqueing of each post connection must not permitted.

7.4.2 Ability to Function

An integral lifting handle should be provided on the batteries for ease of removal/installation.

8 CABINET

8.1 General

8.1.1 BBS Cabinet Dimensions

The dimensions for the BBS cabinet must not exceed 50 inches in height, 17 inches in width and 17 inches in depth.

8.1.2 Inverter/Charger Mounting

The inverter/charger unit must be shelf or rack mounted on a standard EIA 19 inch rack.

8.1.3 Automatic Transfer Switch Mounting

The automatic transfer switch must be mounted on EIA 19 inch rail.

8.1.4 Interconnect Wiring

All interconnect wiring must be provided and must be UL Style 1015 CSA TEW.

8.2 BBS Replacement

The BBS equipment and batteries must be easily replaced and must not require any special tools for installation.

8.3 Hot Swappable

The BBS inverter and batteries must be hot swappable. There must be no disruption to the traffic signal when removing the inverter or batteries for maintenance.

8.4 Quick Disconnects

All inverter and battery connections must be of the quick disconnect type for ease of maintenance.

8.5 Ancillary Installation Hardware

All necessary installation hardware (bolts, fasteners, washers, shelves, racks, etc.) must be included.

8.6 Cabinet Sizing

The external cabinet must be capable of housing batteries up to a group 31 size, inverter/charger power module, automatic transfer switch, control panels, wiring, wiring harnesses, and all other, ancillary equipment.

8.7 Cabinet Types

The BBS can be installed either as:

A. Free-standing base-mounted cabinet with optional 8 inch riser for easy cable entrance;

B. Pole-mounted cabinet with optional pole mount bracket kit; or

C. Side-mounted to a traffic controller cabinet with no mounting brackets required.

8.8 Rating

All external cabinets must be NEMA 3R rated. The enclosure must be made of 0.125 (5052-H32) aluminum.

8.9 Ventilation

The external cabinet must be ventilated through the use of louvered vents, filter, and one thermostatically controlled fan. The filter must be the re-usable type and matching the dimensions of the louver with both located on the bottom half of the door.

The cabinet fan must be DC operated for longer reliability.

8.10 Ancillary Hardware

The BBS cabinet must come with all bolts, washers, nuts required to mount it to a controller cabinet.

8.11 Accessibility

All components, terminations, terminal blocks, relays, etc. must be fully accessible.

8.12 Shelves

Battery shelves must be located in the bottom half of the enclosure. All battery shelves must be removable and on ball bearing rollers to slide in and out for easy access for the batteries. Air must be allowed for flow from the bottom of the cabinet and up the back internal wall. Neither the top battery shelf nor the power module shelf must inhibit the airflow to the top of the cabinet.

8.12.1 Locking

The cabinet must include a 3 point locking system, including a Type 2 Corbin lock and utilize a handle with pad locking capability.

8.12.2 Cabinet Options

The following options must be available for the cabinet:

A. On-battery lamp mounted externally on the top of the cabinet that illuminates when the BBS is operating in inverter mode;

B. Battery heater mats to increase battery capacity in cold climates;

C. Receptacle plate assembly that mounts on the transfer switch panel to provide utility power to the battery heater mats;

D. Automatic generator transfer switch that senses a generator is connected and automatically switches to the generator source;

E. Internal lamp with door push-button switch to illuminate the interior of the cabinet; and

F. Status monitoring dry contacts for the automatic transfer switch and the generator transfer switch.

9 MAINTENANCE

9.1 Probe Jacks

The BBS must provide voltmeter standard probe input-jacks (+) and (-) to read the exact battery voltage drop at the inverter input.

9.2 Self-Testing

The BBS inverter module must be programmable to perform automatic self-testing, programmed in weekly intervals and programmed by the user to meet their specific requirements or manufacturer's recommendation. During self-test the BBS inverter module must identify a weak battery or multiple batteries in the string that have reached a weak state and notify maintenance by initiating a weak battery alarm.

10 WARRANTY

10.1 Battery Backup System

The BBS system must include a five-year warranty on parts and labor on the entire BBS system, including batteries, to ADOT when utilizing the BBS Manufacturers own designed enclosure, meeting the above cabinet specifications.

If another enclosure is provided by the BBS manufacturer, the manufacturer must provide a three-year warranty on parts and labor on the BBS inverter module only.

10.2 Batteries

The BBS manufacturer must provide a 5 year unconditional full replacement warranty for every battery with the BBS under this specification. Under the warranty time period, the battery must provide a minimum of 70% of its original capacity.

11 VENDOR SUPPORT

11.1 Technical Support

The BBS manufacturer must provide a toll-free technical support phone number. The toll-free phone number must be included in the BBS manual.

11.2 Documentation

Equipment manuals must be provided for each BBS cabinet. Equipment manuals must include installation, operation, programming, maintenance and troubleshooting.

12 QUALITY ASSURANCE

12.1 Design and Production

Each BBS must be manufactured in accordance with a written manufacturer's Quality Assurance program. The QA program must include, as a minimum, specific design and production QA procedures.

12.2 ISO Certified

The BBS power module manufacturer must be ISO 9001 or ISO 9002 certified.

12.3 Design Qualification Testing

The manufacturer must be certified to carry out the CSA and UL standards testing on the BBS system.

TP Attachment 700-4 – ITS Technical Specifications

SECTION 738 GENERAL REQUIREMENTS:

738-1 Description:

It is the purpose of this section to provide general information necessary for completion of the work on the elements of Intelligent Transportation Systems (ITS) in accordance with the referenced TPs, Standard Drawings, details shown on the RFC plans and requirements of these Specifications.

ITS generally include; dynamic message sign systems, ramp metering/detection systems, closed circuit television camera systems, electronic communications and network infrastructure dedicated to supporting these systems.

All ITS components and appurtenances shall be complete, functional, have successfully passed any specified testing and training procedures, and in operating condition at the time of acceptance.

(A) ITS Material Submittal:

The material submittal shall be clear and contain all items to be supplied on the project by Developer. The material submittal shall contain an index of the items included in the material submittal package. The material submittal shall include adequate details to allow ADOT to procure replacements of materials used on the project. The model, variations, accessories, and options shall be clearly indicated. Material designations used by ADOT shall be noted on the material list. The materials shall be identified by the contract project number, catalog part number, catalog cut, shop drawings for equipment, trade name, and schedules for other pertinent information. The material submittal shall include Certificates of Compliance for all materials conforming to the requirements of Section 106.05 of the TPs.

ADOT approval is required before ordering or installing materials. Developer work schedule shall include at least 10 Days for ADOT inspection and testing.

(B) Access to ADOT Traffic Operations Center (TOC):

Developer shall do no work within the Traffic Operation Center (TOC). All interface cabling (i.e., video or data) that may be required in the TOC will be furnished and installed by ADOT personnel.

(C) ITS Device Staking:

Developer shall survey and stake the locations of the cabinet foundations, DMS structure foundations, CCTV pole, wrong way detection and ramp meter/flasher pole foundations, and on-ramp stop bar locations according to the RFC Plans in the presence ADOT personnel or designated representative. Developer shall give a minimum of 2 Days advanced notice to ADOT prior to staking the locations.

(D) Tracer Wire:

Magnetic Detection for Underground Facilities shall meet the requirements of Store Specifications 104MAGDET.

738-2 Abbreviations:

CCTV	Closed circuit television
dB	Decibels – a logarithmic ratio of input and output power or voltage
DIN	Deutsches Institut für Normung
DMS	Dynamic Message Sign
GIS	Geographic Information System
HDPE	High Density Polyethylene
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers.
ISO	International Standards Organization
ITS	Intelligent Transportation System
kVA	Kilo-Volt-Amperes
LED	Light-emitting diode
mA	Milli-amp, equivalent to 1/1,000 Amp
MOV	Metal oxide varistor
mV	Milli-Volt, equivalent to 1/1,000 of a Volt
NEC	National Electrical Code
NICET	National Institute for Certification in Engineering Technologies
NSPS	National Society of Professional Surveyors
NTCIP	National Transportation Communications for ITS Protocol
NTP	Network Time Protocol
NTSC	National Television Systems Committee
PPI	Plastic Pipe Institute

OTDR	Optical Time-Domain Reflectometer
Ps	Pico-second, equivalent to 1 trillionth of a second
RAM	Random Access Memory
RMS	Root Mean Square
ROM	Read-Only Memory
SAT	System Acceptance Test
SMFO	Single-Mode Fiber-Optic
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SSPC	Society for Protective Coatings
SST	Subsystem Acceptance Test
TIA	Telecommunications Industry Association
TOC	Traffic Operations Center
VAC	Volts, Alternating Current
VDC	Volts, Direct Current

SECTION 739 REMOVAL AND RELOCATION OF ITS EQUIPMENT:

739-1 Description:

The work under this item includes removing loop lead-in cables, removing foundations for sign structure, removal of pull boxes, and removal of conduits. Relocation of ITS Equipment will not be allowed.

739-2 Construction Requirements:

The work shall be in accordance with the requirements of Section 202 of the ADOT Standard Specifications for Road and Bridge Construction (Standard Specifications) as adapted by the Project Special Provisions for Construction with the exception that the concrete foundation shall be removed entirely or to a depth of at least 36 inches below finished subgrade elevation.

Developer shall identify the locations of buried pull boxes. Developer shall remove the pull boxes and replaced with a new No. 9 pull box or connect existing conduit which entered the buried pull box by using new conduit and couplers that match diameter and material of existing conduit. Conduit sweeps into the existing pull box shall be removed. Cables within the affected conduit

and pull boxes shall be removed and replaced. Cables which have an existing splice in the pull box being removed shall be replaced with new continuous cables or new splice enclosure in new No. 9 pull box.

Removal of pull boxes with HDPE-to-PVC coupling shall be per Section 741-3.01 (D).

SECTION 740 STRUCTURAL SUPPORTS AND FOUNDATIONS FOR ITS ELEMENTS:

740-1 Description:

The work under this item includes furnishing equipment, material, labor and accessories needed to furnish and install structural supports and foundations for ITS elements including CCTV, Camera Lowering Systems, ramp meters/flashers, wrong way detection poles and DMS sign structures.

740-2 Materials:

Materials shall be in accordance with the requirements of Subsection 606-2 and Section 609 Drilled Shaft Foundations of the Standard Specifications.

Concrete for the foundations shall conform to the requirements of Section 1006 of the Standard Specifications. Reinforcing steel and wire mesh shall conform to the requirements of Section 1003 of the Standard Specifications and to the requirements of ASTM A 615. Unless otherwise specified, steel bars meeting the requirements of ASTM A 706 may be substituted for ASTM A 615 steel bars. When ASTM A 706 bars are used, tack welding of the reinforcement will not be permitted unless approved in writing by ADOT. Reinforcing steel wire shall conform to the requirements of ASTM A 82.

ITS structural elements and foundations shall conform to the requirements of Section 600 of the TPs.

(A) Shop Drawings:

The shop drawings shall detail connection of the DMS to the support structure and list materials, lengths of support members, flexible conduit routing, catwalk dimensions and connections, handrail, grating, cable connections, and other features required for successful erection, installation, and operation of the DMS. The shop drawings shall specifically identify the bolt torque values. The shop drawing shall show the lane configuration, shoulder width, the location of the DMS and location and elevation of the DMS panel and structural supports in relation to the high point of the roadway including shoulders.

(B) Pole Shafts:

Pole shafts shall be constructed of a uniformly tapered, one or two-piece round tubular pole, conforming to the ITS Standard Drawings. CCTV poles shall provide a means of routing the CCTV cables inside the pole. CCTV poles shall be designed to accommodate a CCTV camera assembly, electrical hardware, mounting hardware, lowering device, pole-mounted cabinet, and

enclosures. Threaded couplings to support pole-mounted equipment shall be factory-installed. Field-modifications to CCTV poles will not be accepted.

CCTV Poles shall be constructed of material conforming to ASTM A595, Grade A or ASTM A572, Grade 55 or better. Drilled shafts shall be used to support CCTV structures. CCTV poles shall be designed for a minimum effective wind area of two square feet for CCTV & Assembly and shall be designed for a one inch maximum deflection at the top of the pole under a 30 mile per hour non-gust wind speed.

The CCTV pole hand hole shall be reinforced with a minimum 2-inch wide hot rolled steel rim. The nominal outside dimension of the hand hole shall be 6 inches x 27 inches. The hand hole shall have a tapped hole for mounting the portable winch for the CCTV lowering system. The hand hole shall be positioned on the CCTV pole so that it is not in conflict with the CCTV pole-mounted cabinet and associated 1-inch mogul elbow. The hand hole shall be positioned so that the CCTV camera is not directly above the user when operating the CCTV lowering system.

Prior to pole fabrication, Developer shall provide the material submittal for each type of pole for approval. The material submittal shall include material specifications and structural calculations showing stresses and deflections in accordance with this TP Attachment 700-4, Section 600 of the TPs, Sections 604 and 731 of the ADOT Standard Specifications, the ITS Standard Drawings, and the RFC Plans. Drawings and calculations shall be prepared, signed and sealed by a Civil or Structural Engineer registered in the State of Arizona.

(C) Base Plates:

Base plates shall be fabricated from structural steel plates conforming to the minimum strength requirements of ASTM A36. Exposed surfaces shall be finished smooth and exposed edges shall be neatly rounded to a 1/8-inch radius. Pole bases shall be galvanized in accordance with ASTM A123.

(D) Non-shrink Grout:

Non-shrink grout shall conform to the requirements of the ADOT Approved Products List.

(E) CCTV Camera Lowering System:

The CCTV camera lowering system shall be compatible with Bosch model MIC-7502-Z30W and orientation of camera, resulting in a correctly-orientated camera image. The CCTV camera lowering system shall not obscure the CCTV cameras range of vision. The CCTV camera lowering system shall be designed to support and lower/raise CCTV camera systems weighing up to 100 pounds. External components shall be made of corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment. Moving parts of the CCTV camera lowering system shall be corrosion resistant, self-lubricating and sealed, rated for a minimum of 10,000 lowering and lifting operations. If offered by the manufacturer, the conductor interface mechanism which receives the movable portion of the lowering device shall be the heavy-duty version.

Developer shall supply and install grommets, connectors, nipples, necessary hardware, a cable from the CCTV cabinet to the lowering device, and a cable from the lowering device to the CCTV camera assembly. Cables shall be outdoor rated, and contain shielded communication conductors and five auxiliary conductors, 14 AWG, or larger. Conductors within the cables shall be stranded.

The CCTV camera lowering system shall be equipped with a self-aligning locking mechanism which securely holds the movable portion of the CCTV camera lowering device when the CCTV camera is in use. When in the locked position, all weight shall be removed from the lowering cable. The locking components shall be made of metal.

The CCTV camera lowering system shall include a junction box between the CCTV camera and the movable portion of the lowering device to facilitate the connection of CCTV camera power, video, and camera control. The junction box shall be water resistant and in accordance with NEMA 3R requirements.

Electrical connections shall be suited for operation at 120 VAC with a current carrying capacity not less than 15 Amperes. The electrical connectors shall contain a minimum of 14 contacts including a ground. Data contacts shall be designed to handle 1V peak to peak NTSC video, RS-232 and RS-485 control, and Ethernet communication signals.

The CCTV camera lowering system shall be operated from the ground by the use of a portable lowering tool. The tool shall consist of a lightweight metal frame and winch assembly operated by a variable speed electric drill motor or hand crank. The CCTV camera lowering system shall include clutches and brakes to prevent the free-fall of the CCTV camera and over tensioning of the lowering device cable. The lowering tool shall have the appropriate gearing to facilitate using a hand crank for lowering and raising the CCTV camera. The CCTV camera lowering system shall incorporate a field adjustable counterweight system to minimize the amount of effort required to raise the CCTV camera. One lowering tool for the project shall be provided to ADOT.

(F) CCTV Pole Foundation:

CCTV Pole Foundations shall be drilled shaft in accordance with Section 600 of the TPs. Excavation and backfill shall conform to the requirements of Subsection 203-5.03 of the Standard Specifications.

Anchor bolts shall conform to the requirements of ASTM F1554 Grade 55. The upper 12 inches of the bolts shall be hot dip galvanized in accordance with ASTM A153. The strength of the nuts shall be equal to or exceed the proof load of the bolts.

Concrete for foundations shall be Class S and shall have a required 28-day compressive strength of 3,500 pounds per square inch.

Developer shall provide the material submittal for each type of foundation including material specifications and reinforcing drawings per ADOT ITS Standard Details or RFC Foundation Details.

740-3 Construction Requirements:

Prior to fabrication of sign structures, Developer shall perform a field survey of the foundation and roadway elevation to determine support structure dimensions to ensure proper mounting height of the DMS and vertical clearance requirements.

ITS structures shall be constructed in accordance with the requirements of Section 600 of the TPs, Subsection 606-3 of the ADOT Standard Specifications and the RFC Plans.

Developer shall form a 1/4-inch weep hole in the grout at the base of the pole which allows drainage of water that may accumulate inside the structure.

(A) Foundations:

ITS structure foundations shall be constructed in accordance with the requirements of Section 600 of the TPs, Subsection 606-3 of the ADOT Standard Specifications and the RFC Plans.

Developer shall use drilled shaft method per Section 609 of the ADOT Standard Specifications.

Excavation shall be performed to avoid damage to pavement, sidewalk, landscaping, irrigation systems, and other improvements. Excavated material shall be placed in a position that will not impact traffic, pedestrians, and drainage. If existing concrete is damaged by Developer, the entire section, between expansion joints, shall be removed and reconstructed.

Surplus excavated material shall be removed and properly disposed of by Developer..

Excavation and backfill shall conform to the requirements of Subsection 203-5 of the ADOT Standard Specifications. At the end of each working period, excavations shall be barricaded or covered, or both, to provide safe passage for pedestrian and vehicular traffic.

Concrete shall be placed in holes which have been augured against undisturbed earth. If the material in the bottom of the hole is not firm and stable, it shall be compacted, or treated as directed by Developer's Geotechnical Engineer. The walls and the bottoms of the hole shall be adequately moistened prior to placing the concrete.

If the soil is not stable and a hole cannot be augured, casings shall be used of the proper size and dimensions, and shall be rigid and securely braced. The casing and the bottom of the hole shall be adequately moistened prior to placing the concrete.

Anchor bolts and conduit stubs shall be placed and held in proper alignment, position, and height during the placing and vibrating of concrete. Foundations shall set for 7 Days prior to pole installation.

DMS support structures shall be bonded to form a continuous grounding system in accordance with Subsection 732-3.03 of the ADOT Standard Specifications. The coil ground shall be covered with native soil prior to placing concrete. A ground resistance test shall be performed in accordance with the ground rod testing method specified in Subsection 732-3.03 of the ADOT Standard Specifications.

Developer shall protect existing lighting poles, conduit, conductors, irrigation, landscape, aesthetic, storm drains, utilities and other elements from damage.

(B) Pole Shafts:

Developer shall bond and ground CCTV poles in accordance with Subsection 732-3.03 of the ADOT Standard Specifications and as shown in the ITS Standard Drawings**.** CCTV poles shall be bonded to form a continuous grounding system.

Poles shall be vertically plumb with camera equipment installed. Once the pole installation is complete, the open space between the base plate and foundation shall be grouted. Grout shall be mixed, handled and placed in accordance with the manufacturer's recommendations.

If field-repair of galvanizing is allowed by ADOT, it shall be by the hot-stick method.

Developer shall obtain an FAA determination for any new CCTV Pole which meet the requirements for construction or alteration requiring notice (77.13) in the Code of Federal Aviation Regulations, part 77. Developer shall not incorporate such new CCTV poles unless and until approved by the FAA.

CCTV camera pole foundations shall be set flush with the existing or new curb and sidewalk or flush with the finished grade where there is no curb or sidewalk, except in sloped areas.

SECTION 741 ELECTRICAL UNDERGROUND EQUIPMENT FOR ITS

741-1 Description:

The work under these items includes furnishing and installing electrical underground equipment including conduit, innerduct and pull boxes for ITS elements, as shown on the RFC Plans and in these Specifications.

The work under this item shall include replacement or adjustment of pull boxes, extensions, lids, conduit sweeps into pull boxes, conduit orientation, conduit alignment, mitigation of unusable conduit, conduit fittings, and other work needed to remedy conditions of existing pull boxes and conduit, as requested by ADOT, within the project limits.

741-2 Materials:

Polyvinyl Chloride (PVC) conduit, Rigid Metallic Conduit (RMC), and Flexible Metal Conduit shall conform to Subsection 732-2.02 of the Standard Specifications. Intermediate Metal Conduit (IMC) is not allowed for ITS applications. Conduit runs which enter pole and cabinet foundations shall consist of PVC.

Conduit bends, fittings, expansion couplings, sweeps, and other accessories shall be of the same material as the conduit.

Conduit elbows for new or future fiber optic cable shall have a minimum radius of 36 inches. Other conduit elbows shall have a minimum radius of 24 inches.

(A) HDPE Conduit:

Developer may propose substituting HDPE conduit which meets these specifications in place of direct-buried PVC conduit.

HDPE conduit and fittings shall comply with ASTM D 2241 and ASTM-F2160-01. HDPE conduit shall have a minimum rating of SDR 11. HDPE innerducts shall have a minimum rating of SDR 13.5. It shall have a cell classification of PE334470C (for black conduit) and PE334470E (for colored conduit) in accordance with ASTM 3350: Standard Specification for Polyethylene Pipe and Fittings Materials. The polyethylene base resin shall meet the density requirement and melt index properties described herein. The density shall not be less than 0.940 and not more than 0.955 g/CM^3 in accordance with ASTM D 1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique. The range for the melt index shall be between 0.05 to 0.5g/10 minutes in accordance with ASTM D 1238: Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer. The HDPE conduit shall have a minimum Flexural Modulus, of 80,000 psi, in accordance with ASTM D 790 and a minimum tensile strength at yield of 3,000 psi, in accordance with ASTM D-638. Additives to the base resin shall be included to provide heat stabilization, oxidation prevention and ultraviolet (UV) protection. It shall utilize carbon black in the range of 2 to 3 percent for long term protection against UV degradation. The minimum protection period shall be one year from date of manufacture in unprotected, outdoor storage in accordance with ASTM D 1603: Standard Test Method for Carbon Black in Olefin Plastics.

Developer shall submit data sheets and a Certificate of Compliance letter from the HDPE conduit manufacturer stating that the product meets these requirements per Section 738-1 of this TP Attachment 700-4.

(B) Innerduct:

Innerduct shall be ribbed HDPE. The number of innerducts per conduit and sizes shall be as called for in the RFC Plans. Innerduct color shall be orange from the factory unless otherwise specified. The innerduct shall be furnished in one continuous length with no factory installed splices or couplings, and of lengths sufficient to complete runs between pull boxes without splicing.

(C) Conduit Warning Tape:

Conduit warning tape shall be a minimum four-mil composite reinforced thermoplastic, with a minimum width of 3 inches and minimum length of 5 feet. Warning tape shall be highly resistant to alkalis, acids, and other destructive agents found in the soil.

Warning tape shall have a continuous printed message warning of the location of underground conduits. The message shall be in permanent ink specifically formulated for prolonged underground use and shall bear the words, “CAUTION - ELECTRIC LINE BURIED BELOW” or “CAUTION – COMMUNICATION CABLE BURIED BELOW” in black letters on a red background for electric conduits or orange background for communication conduits. Where both electric and communications conduits are in a single trench, both warning tapes, as described above, shall be provided.

(D) Detectable Pull Tape:

Detectable pull tape shall be constructed of fiber and have an embedded #22 AWG conductor. The tape shall be low-stretch and moisture-resistant. The tape shall have nominal pull strength of 2,500 pounds. The tape shall include distance markings at intervals not to exceed 2 feet.

(E) No. 7 ITS Pull Boxes:

No. 7 ITS pull boxes shall be precast, polymer concrete, fiberglass reinforced, with ANSI Tier 22 rating for both the box and lid. Concrete pull boxes and lids shall not be used. Steel pull box lids shall not to be used unless H20 traffic loading is required.

No. 7 ITS pull boxes shall be 24 inches in depth and consist of a single-piece box unit. Stacked units shall not be used unless otherwise specified.

Pull box lids shall bear the words “ADOT FMS” unless otherwise specified. Markings shall be clearly defined and placed parallel to the long side of the cover. No. 7 pull boxes letter height shall be a minimum of 1 inch and recessed into the lid.

Pull box lids shall have a locking mechanism approved by ADOT.

Developer shall provide a Certificate of Compliance that the pull boxes furnished and installed are in conformance with this TP Attachment 700-4.

(F) No. 9 Pull Boxes:

No. 9 and No. 9 “split” pull boxes shall be fabricated of concrete and provide conduit access ports on the four sides as shown in the ITS Standard Drawings.

No. 9 pull box lids shall have a square, hinged lid that opens a full 180 degrees. Lid opening shall be spring-assisted from both the open and closed positions using a torsion bar lift system. Lids shall lock down with at least one stainless steel security type penta-head bolt that shall be captive to the lid. Lids shall have padlock cavity with a spring-loaded cover and lock-down bolt that leaves no part of the padlock is exposed.

No. 9 pull boxes shall be furnished with galvanized and slotted C-channel struts embedded in the concrete walls of the pull box, with an 18-hole rack mounted to each slotted C-channel strut, and ½ inch spring nuts and bolts and one cable hook per rack.

Pull box lids shall bear the words “ADOT FMS” unless otherwise specified. Markings shall be clearly defined and placed parallel to the long side of the cover. Letter height for No. 9 pull boxes shall be 4 inches.

Pull box lids shall have a locking mechanism approved by ADOT.

Developer shall provide a Certificate of Compliance that the pull boxes furnished and installed are in conformance with this TP Attachment 700-4.

(G) Retrofit Lids for No. 9 Pull Box:

New lid assemblies retrofitted onto existing No. 9 pull boxes shall match the width and length of the No. 9 pull box. Existing No. 9 pull boxes that do not have existing grounding shall have new a ground rod, grounding conductor and grounding lugs, furnished and installed.

(H) Metal Junction Boxes:

Metal junction boxes and covers installed in concrete structures shall be fabricated from a minimum of 16-gauge type 304 stainless steel. Seams shall be continuously welded and conform to the RFC Details and Project Specifications.

A neoprene gasket with a thickness of 1/8 inch shall fit between the pull box and cover. The cover shall fit securely and be held in place with a minimum of four stainless steel machine screws.

Developer shall furnish materials that meet the requirements of Section 732-2 for conduit and pull boxes, except as modified by this TP Attachment 700-4.

741-3 Construction Requirements:

Construction Requirements shall conform to Section 732, unless otherwise specified in the ITS Standard Drawings, on the project plans, or this TP Attachment 700-4.

741-3.01 Conduit:

Conduit installation shall conform to Subsection 732-3.01 of the Standard Specifications with the following exceptions.

(A) Conduit Routing:

Conduit shown on the plans indicates the intended path and conduit shall be placed in accordance with the lines, grades, details and dimensions shown on the RFC Plans, the ADOT Standard Specifications and this TP Attachment 700-4. The conduit path shall be modified as necessary, to avoid obstacles, conflicts and obstructions, to facilitate future maintenance, or to conform to appropriate codes and specifications. Final conduit locations shall be documented in the record drawings.

The contactor shall restore, repair, or replace, damaged or contaminated vegetation, landscaping features, decomposed granite, irrigation facilities, walkways, utilities, and other items resulting from ITS construction activities.

Developer shall take special precautions prior to work in the vicinity of irrigation lines. Small irrigation lines are typically not Blue Staked, but shall be repaired or replaced if damaged during construction by Developer.

Excavations shall be in accordance with the Project Safety Management Plan.

(B) Conduit Size:

Conduit sizes shall be as indicated on RFC plans and in conformance of the TPs.

(C) Conduit Bend Radius and Deflection:

Except for factory bends, conduit bends shall have a radius of not less than that specified in the NEC. Conduit shall be bent without crimping or flattening, using the longest radius practicable. Communications conduits shall not deflect more than 1 inch per foot (1:12) vertically or horizontally. This is equivalent to a minimum radius of 6 feet. If the 1:12 requirement cannot be achieved, elbow fittings of 11 1/4, 22 1/2, 30 or 45 degrees, with a minimum radius of 12 times the conduit diameter shall be used. If 90-degree cumulative turns are required, they shall be made of individual elbows with a minimum radius of 36 inches for new or future fiber optic cable.

(D) Conduit Fittings:

New runs of conduit shall be continuous from pull box to pull box. HDPE conduit shall not be joined to PVC conduit in the length of the run.

If joining segments of HDPE conduit is called for on the plans, Developer shall utilize non-corrosive, sit-tight, water-tight couplings. Heat fusion, electrofusion fittings and mechanical connections will be permitted if the HDPE conduit and joining device manufacturer's recommendations are followed and the internal diameter of the HDPE conduit is not reduced. Extrusion welding and hot gas welding to join HDPE conduits is not permitted. Upon completion of joining HDPE conduit sections and setting the pull boxes, Developer shall clean the HDPE conduit with compressed air. Developer shall demonstrate that the conduit was not deformed during installation by pulling a cleaning mandrel or ball mandrel with a diameter of 80 percent of the HDPE inside diameter. If the mandrel passes through the HDPE, Developer shall install the pull tape in accordance with Section 732 of the ADOT Standard Specifications. If the mandrel encounters a deformity in the HDPE conduit, Developer shall replace the entire segment of HDPE between pull boxes with new HDPE.

Conduit plugs, caps, or sealing fittings for sealing empty conduit and occupied conduit shall be durable, easily removable, reusable, and produce a watertight seal. Plugs, caps, and sealing fittings shall be designed for the diameter of the conduit and cable, shall cause no damage to the cable when installed, and shall have a rope tie on the inside end for connection of a pull rope. Plugs that seal conduits containing fiber optic cable shall be of the split design to allow installation and removal around in-place cables.

(E) Conduit Depth:

Conduits shall have a minimum cover depth of 30 inches. Backfill compaction shall be in accordance with Subsection 203-5.03 (B) (4) of the ADOT Standard Specifications. When conduit cannot be installed at the required minimum depths, it shall be encased in Class B concrete, in accordance with Section 1006 of the ADOT Standard Specifications.

(F) Conduit in Trenches:

Immediately after conduit work including, installation, mandrelling, or cable or pull tape installations, conduit shall be sealed to prevent the intrusion of water, mud, gravel, vermin, etc. Taping the ends of the conduit is not allowed.

Unoccupied conduits on which work is performed, including those extending beyond the end of capped conduit, shall be sealed with a water-tight, corrosion-proof, removable, reusable, and vermin resistant conduit plug or cap.

Occupied conduits on which work is performed shall be sealed with a conduit cap. The conduit cap shall be water-tight, corrosion-proof, removable, and vermin resistant.

Occupied innerduct on which work is performed extending beyond the end of the capped conduit shall be sealed with an innerduct cap. The innerduct cap shall be water-tight, corrosion-proof, removable, and vermin resistant.

New innerducts and existing empty innerducts to be utilized, shall have a plug pulled through to demonstrate that the innerduct integrity and continuity is appropriate for use with no breaks or debris.

New innerducts and existing empty innerducts to be utilized, shall have a means to secure the ends of the innerduct to prevent the innerduct from retracting into the conduit.

A three inch “Y” shall be cut into the face of the curb directly over conduit located under rolled or vertical curbs.

Developer shall place warning tape in trenches in which new PVC or trenched HDPE conduit is placed. Warning tape is not required in conduit segments where trenchless methods are used for installation. Warning tape shall be buried at a depth of 6 to 8 inches below the finished grade. No compensation will be provided to restore landscape or add decomposed granite of disturbed areas.

(G) Conduit by Trenchless Methods:

New conduit to be installed under existing pavement, curbs and gutters, sidewalks, established landscaping or decomposed granite not otherwise impacted by construction, and at other locations specifically indicated on the RFC Plans, shall be installed by Horizontal Directional Boring (HDB) or Horizontal Directional Drilling (HDD) methods. Open cutting and trenching existing pavement to remain shall not be allowed.

Prior to beginning trenchless installation methods, Developer shall complete the necessary potholing, and submit the proposed profile to the IQF. The profile if installed conduit shall be such that the allowable bend radiuses are not exceeded. Installation shall be performed in accordance with industry standards.

Developer’s installation process shall utilize the “walkover” locating system or other ADOT approved equivalent, for determining the installation profile. The installation equipment shall

register the depth, angle, rotation and directional data. At the surface, equipment shall be used to gather the data and relay the information to the equipment operator.

Excavation and backfill of excavated pits shall be in accordance with the requirements of Subsection 203-5.03 (A) and (B) of the standard specifications.

When enlargement of an installation hole is necessary, the hole shall be at least 25 percent larger than the conduit to be installed. Pulling equipment such as grips, pulling eyes, and other attachment hardware external to the conduit will be permitted as long as a wooden dowel is placed inside the conduit to prevent it from collapsing at the point of attachment when pull tension is at its peak. A swivel shall be used with pulling hardware when pulling back the conduit into the installation path. Drilling fluid shall be pumped down the hole to provide lubrication for the conduit as it is pulled in. The pulling tension for installing conduit into the installation path shall not exceed 75 percent of the conduit manufacturer's tensile strength rating in order to prevent the conduit from "necking down" or deforming.

Final installation profiles shall be submitted to ADOT.

(H) Detectable Pull Tape:

Developer shall install detectable pull tape in new and existing empty conduits and innerducts. Detectable pull tape in conduits shall terminate at the end of the conduit with a minimum of 2 feet of coiled slack in the pull box. Detectable pull tape traveling through conduit that terminates in a pull box, shall have its wire ends connected together to allow for a continuous locating signal to be used for the entire conduit run.

(I) Conduits Embedded in or Attached to Structures:

Attaching or embedding conduit in a structure shall be approved by ADOT and shown on the RFC plans. Conduit within a structural member shall be installed in accordance with the National Electrical Code.

Conduit installed within open bridge cells or attached to structures shall be rigid metal conduit (RMC). RMC shall be painted to match the exterior color of the structure when located on the exterior of the structure. Painting may require pre-treatment of the RMC.

Intermediate junction boxes shall be used in RMC runs over 1,000 feet in length. Intermediate junction boxes shall be evenly spaced at a maximum spacing of 1,000 feet.

Expansion couplings shall be installed in conduit runs which cross an expansion joint in a structure. Expansion couplings shall be as shown in the ITS Standard Drawings or RFC Plans as approved by ADOT. A minimum of 3 feet shall separate a conduit expansion coupling and the pipe sleeve where the conduit enters a structure. Expansion couplings on adjacent conduits shall be staggered to keep conduit runs as straight as possible. Where bonding is not continuous, expansion couplings shall be provided with a #6 AWG bonding jumper conductor with enough slack to accommodate the range of expansion of the coupling.

Where it is not possible to use expansion couplings, sleeves of sufficient size shall be installed to provide a minimum 1/2-inch clearance between the conduit and the inside wall of the sleeve. The sleeve shall be discontinuous at the expansion joints. The coupling sleeve shall not be exposed to the elements and shall be protected by a steel plate recessed within the barrier at the expansion joint.

(J) Conduit Cleaning:

Developer shall clean existing conduit, no more than one week prior to installation of cables or conductors. For PVC conduit, a metal-disc mandrel with an outer diameter not less than 90 percent of the conduit's inside diameter shall be pulled through the conduit. For HDPE conduit, a ball mandrel with an outer diameter not less than 80 percent of the conduit's inside diameter shall be pulled through the conduit. Prior to pulling the mandrel through the conduit, the conduit shall be brushed or swabbed.

(K) Utility Conduits:

Installation of conduit for underground utility service shall conform to the utility company requirements, local codes and TP Attachment 700-4.

(L) Conduit Entering Pull Boxes:

Conduit entering pull boxes shall be installed in accordance with the ITS Standard Drawings. Conduit ends shall be capped with conduit end cap or plug fittings until wiring or cabling is installed. When end caps or plugs are removed, Developer shall install bell end fittings or bell end shape integral to the conduit as approved by ADOT. Bell ends shall be installed prior to the installation of the conductors or cables. Insulated grounding bushings shall be used on steel conduit ends as approved by ADOT.

RMC conduits terminating in a No. 7 ITS Pull Box shall have a coupling to convert to PVC prior to the underground elbow.

New HDPE conduits terminating in a No. 9 pull box shall run directly into the conduit port hole of the pull box wall and be cut flush with the inside face of the pull box. The void between the outside of the conduit and inside of conduit port hole shall be sealed with a sealant as approved by ADOT.

(M) Innerduct:

Innerduct shall be installed in conduit as shown on the plans. Innerduct shall not be pulled dragged on the ground or pavement. Developer shall ensure that the tensile load on the innerduct does not exceed the allowed maximum by using a break-away technique and/or a pulley system with numeric readout which includes a means of alerting the installer when the pulling tension approaches the manufacturer's maximum pulling tension.

Developer shall ensure that the innerduct is protected from sharp edges and excessive bends. Developer shall not cause the innerduct to violate the minimum bending radius for which the

innerduct was designed. Developer shall be responsible for damage of innerduct and shall remove and install new innerduct.

During pulling, the innerduct shall be continuously lubricated as it enters the conduit. Pre-lubrication may be necessary per manufacturers requirements. The lubricant used shall be compatible with the innerduct material. The manufacturer's recommended pulling speed and pulling tension shall not be exceeded.

Innerduct shall be anchored at pull boxes to keep innerduct from retracting into the conduits, beyond the exposed conduit end, in a manner approved by ADOT.

Newly-installed empty innerduct shall contain detectable pull tape from pull box to pull box. Each pull tape shall terminate at the end of the innerduct with a minimum of 2 feet of coiled slack in each pull box.

(N) Cathodic Protection:

Prior to trenching, Developer shall verify the existence of cathodic protection in existing utilities and shall maintain existing cathodic protection and test stations.

(O) Conduit at Removed Pull Boxes:

At pull boxes to be removed, where existing HDPE conduit has a HDPE-to-PVC coupling, a new No. 9 pull box shall be installed in place of the coupling or the coupling and PVC components shall be removed and the conduit shall be spliced with matching HDPE conduit and HDPE-to-HDPE coupling as approved by ADOT, resulting in a continuous all-HDPE segment.

(P) Conduit Reconditioning

Developer shall not recondition existing conduit. Existing damaged conduit intended to remain shall be replaced with new conduit of the same material as the entire conduit run from pull box to pull box.

741-3.02 Pull Boxes

Prior to installation, pull boxes shall be field-located, to avoid drainage swales, slopes steeper than 2:1, maintenance vehicle pathways, utility easements, and other areas of conflict.

Developer shall be responsible for restoring the surrounding surface conditions back to their original condition if not intended to be modified by the Project.

When a new pull box occupies the same location as an existing pull box, the existing bricks, stone sump and felt paper shall be replaced with new. In instances where an existing 12-inch depth pull box is replaced by a 24-inch depth pull box, Developer shall adjust the existing conduits, as necessary, to allow the conduit to enter the bottom of the box in conformance with the ITS Standard Drawings, the project plans and specifications.

Existing flexible delineators for ITS pull boxes within the project limits shall be removed and disposed of by Developer, including delineators for ITS pull boxes that have no other work associated with them.

Compaction around pull boxes shall not cause the sides to deflect or the box or lid to crack or become dented. Developer shall replace cracked, broken, chipped or damaged pull boxes and lids.

Removable caps shall be placed on unused conduits within pull boxes.

(A) No. 9 Pull Boxes:

When installing a No. 9 pull box, Developer shall only lift the pull box and covers using the lifting hardware installed for that purpose. The lid shall be oriented such that the lid hinge lies along the side of the pull box farthest from the roadway.

For “Split No. 9” pull boxes, Developer shall pour the concrete floor of the pull box after the pull box is installed. The concrete shall be Class S with 3,000 psi minimum compressive strength with an integrated 8-inch diameter sump hole for drainage and a ground rod.

Existing “Split No. 9” pull boxes for ITS conduits co-located with lighting conduits, shall have the lighting conductors removed, conduit rerouted around the Split No. 9 pull box, and lighting conductors reinstalled and terminated, matching existing. Lighting conductor splicing shall occur only in a new adjacent lighting pull boxes. No lighting conductors or conduits shall pass through a Split No. 9 pull box to remain.

(B) Retrofit Lids for No. 9 Pull Box:

New lid assemblies retrofitted onto existing No. 9 pull boxes shall be installed in accordance with the manufacturer’s installation procedure and recommended sealant material between the body of the remaining No. 9 pull box and new lid assembly. New lid assemblies retrofitted onto existing No. 9 pull boxes shall be grounded to a ground rod driven into the sump of the pull box. Grounding shall meet the requirements of Subsection 732-3.03 of the Standard Specifications.

(C) Pull Box Reconditioning

Developer shall not recondition existing pull boxes. Existing damaged pull boxes intended to remain shall be replaced with new pull boxes.

Existing No. 9 pull boxes that do not have existing grounding shall have new a ground rod, grounding lugs, and grounding conductor furnished and installed in accordance with the Standard Drawings. Grounding shall meet the requirements of Subsection 732-3.03 of the ADOT Standard Specifications.

Pull box work identified as part of the facilities inventory shall be completed prior to work on fiber optic cable or conductor installation.

SECTION 742 FIBER OPTIC CABLE AND EQUIPMENT

742- 1 Description:

The work under these items includes furnishing and installing fiber optic cables, fiber optic splice closures, Small Form-Factor Pluggable (SFP) transceiver modules with a fiber optic patch cable, rack-mounted fiber optic patch panels and Ethernet switches.

742 - 2 Materials:

(A) Fiber Optic Cable:

Developer shall furnish and install Single Mode Fiber Optic (SMFO) communication cables to provide a communications subsystem.

Fiber optic cable shall be of loose tube construction, filled with a water-blocking material, and constructed by a certified ISO 9001 or 9002 manufacturer. Fiber optic cable shall be dielectric and comply with the requirements of REA PE-90, except as modified by the following requirements:

Cladding diameter:	125 ±1.0 μm
Core-to-cladding offset:	≤0.8 μm
Cladding non-circularity:	≤1.0 percent
Maximum attenuation:	≤0.35 dB/km at 1310 nm, ≤0.25 dB/km at 1550 nm
Microbend attenuation (1 turn, 1.25-inch dia.):	≤0.5 dB at 1550 nm
Microbend attenuation (100 turns, 3’ dia.):	≤0.05 dB at 1310 nm
Mode-field diameter (matched cladding):	9.3 ±0.5 μm at 1310 nm; 10.5 ±1.0 μm at 1550 nm
Maximum chromatic dispersion:	≤3.2 ps/(nm x km) from 1285 nm to 1330 nm and <18 ps/(nm x km) at 1550 nm

Fiber polarization mode dispersion:	≤0.5 ps/(km)1/2
Fiber coating:	Dual layered, UV cured acrylate
Coating diameter:	245 μm ±10 μm
Minimum storage temperature range:	-40 to 158 degrees Fahrenheit
Minimum operating temperature range:	-40 to 158 degrees Fahrenheit

Buffer tubes shall be filled with a dry water-blocking material that provides for an efficient and craft-friendly cable preparation. Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z", stranding process. Filler rods shall be used in the fiber optic cable to lend symmetry to the cable section.

The fiber optic cable shall have a central strength member designed to prevent buckling of the cable.

The fiber optic cable shall utilize a dry water-blocking material to block the migration of moisture in the cable interstices.

The fiber optic cable shall have tensile strength members designed to minimize cable elongation due to installation forces and temperature variation. The fiber optic cable shall withstand a 600 lbf (pound-force) maximum installation tensile load and a long term installed maximum tensile load of 200 lbf.

The fiber optic cable jacket shall be constructed of a high or medium density polyethylene (HDPE or MDPE) jacket that has been applied directly over the tensile strength members and water-blocking material. The jacket shall have at least one ripcord designed for easy sheath removal. The cable shall be wound on the reel in such a manner as to provide access to both ends of the cable to enable testing to be performed while the cable is on the reel.

The cable shall be capable of withstanding total immersion in water with natural mineral and salt contents, and wasp/hornet spray without damage or decrease in function.

Conductor and cable tagging shall conform to the requirements of Subsection 732-2.01 (A) (2) of the Standard Specifications, unless otherwise specified. Tags shall have the capability of being moved along the conductor or cable during future alterations.

Developer shall provide a Certificate of Compliance that the fiber optic cables furnished and installed are in conformance with these Specifications. This certification shall be in two parts:

1. Certificate of Compliance from the fiber optic cable manufacturer that the cable is

in conformance with the Rural Electrification Administration (REA) Bulletin PE-90 (where applicable) and these specifications.

2. Certificate of Compliance from Developer that the communication cable subsystem has been installed and spliced in accordance with the fiber optic cable and fiber optic splice closure manufacturer's recommendations, and the RFC Plans and Project Special Provisions for Construction.

(B) Fiber Optic Splice Closures:

Fiber optic splice closures shall be either shell design or cylindrical, butt-end style, corrosion resistant, watertight, and meet the requirements of CR-771-CORE. Underground splice closures shall seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices.

The splice closure shall provide an internal configuration and end cap with a minimum of two express ports for entry and exit of backbone cable and a minimum of four additional ports for distribution and branch cables.

Splice closures shall be designed to accommodate heat-shrink fusion splice trays in sufficient quantities to perform the required number of splices. At a minimum, the splice closure shall accommodate 144 splices, unless otherwise specified. Splice closures shall be supplied with the maximum number of fusion splice trays.

Splice closures shall have a reliable dual-seal design with both the cable jackets and core tubes sealed, without the use of water-blocking material. The splice closures shall be capable of being opened and completely resealed without loss of performance.

The splice closure minimum dimensions shall be at least 29 inches long by 11 inches wide.

(C) Fiber Optic Patch Panel

The patch panels installed in the field shall be factory terminated and have protective covers for all unused connectors. Patch panels shall be manufactured with LC-type connectors required to match pre-installed connectors on jumper fiber optic cables. Branch 12-SMFO cable shall be pre-installed on the patch panel by manufacturer and have the required length including needed slack to reach each splice location. Branch cable shall be supplied with the splicing end protected by the manufacturer with secure dust-proof cap ready to be spliced into each splice closure.

(D) Fiber Optic Patch and Splice Module

The fiber patch and splice module shall accommodate 12 single-mode fibers with LC type connectors from the patch cables and the branch cable. Patch cables shall be included with the fiber patch panel. The fiber patch panel shall be compatible with plenum-rated loose tube fiber and provide protection of the buffer tube and individual fibers. The panel shall be capable of securing the cable to the housing to prevent any damage due to movement.

(E) SFP Transceiver Module:

The SFP transceiver module and fiber optic patch cable shall be from the same manufacturer. Developer shall ensure compatibility of the SFP with the existing switch. The SFP transceiver module and fiber optic patch cable shall meet the following requirements:

- The characteristics are performed in accordance with Telcordia Specification GR 468-CORE
- Single +3.3V Power Supply
- RoHS Compliant and Lead-free
- AC/AC Differential Electrical Interface
- Eye Safety Designed to meet Laser Class 1 compliant with EN60825-1
- Compliant with Multi-Source Agreement (MSA) Small Form Factor Pluggable (SFP)
- EMC requirement meets FCC in the United States and CENELEC EN55022 (CISPR 22) in Europe
- Operating Temperature: -40 to 85 degrees Celsius / -40 to 185 degrees Fahrenheit
- Distance: as specified in design plans
- Cable Type: 9/125µm/single mode
- Connector Type: Duplex LC
- Wavelength 1310nm
- Link Budget: 20 dBm
- Sensitivity: -23 dBm

(F) Ethernet Switches:

Ethernet switches shall meet the following requirements:

(1) Supported Standards:

- IEEE 802.1d – Spanning Tree Protocol
- IEEE 802.1d – MAC Bridges
- IEEE 802.1p – Class of Service
- IEEE 802.1q – VLAN Tagging
- IEEE 802.1w – Rapid Spanning Tree Protocol
- IEEE 802.1x – Port Based Network Access Control
- IEEE 802.3 – 10BaseT
- IEEE 802.3u – 100BaseTX, 100BaseFX
- IEEE 802.3x – Flow Control
- IEEE 802.3z – 1000BaseLX
- IEEE 802.3ab – 1000BaseTX
- IEEE 802.3ab – Link Aggregation
- IEEE 802.3af – Power over Ethernet (PoE)
- RFC768 – UDP
- RFC783 – TFTP
- RFC791 – IP
- RFC792 – ICMP

- RFC793 – TCP
- RFC826 – ARP
- RFC854 – Telnet
- RFC894 – IP over Ethernet
- RFC1112 – IGMP v1
- RFC1519 – CIDR
- RFC1541 – DHCP (client)
- RFC2030 – SNTP
- RFC2068 – HTTP
- RFC2236 – IGMP v2
- RFC2284 – EAP
- RFC2475 – Differentiated Services
- RFC2865 – Radius
- RFC3414 – SNMPv3-USM
- RFC3415 – SNMPv3-VACM

(2) Packet Processing:

- Processing type: store and forward
- Priority Queues: 4
- Minimum number of VLANS: 64
- VLAN ID Range: 1 TO 4094
- Internet Group Management Protocol (IGMP) multicast groups: 256
- MAC table size: 8192
- Packet Buffer size: 1 Mbit

(3) Network:

- Support Open System Interconnection (OSI) Layer 2 functionality
- Point-to-point, daisy-chain, ring, and mesh topologies for connectivity into new and existing fiber optic and copper based Ethernet networks.
- Broadcast storm frame filtering with user-defined thresholds.

(4) Port Performance:

- 4 SFP ports.
- SFP duplex single-mode fiber that operates at 1,000 Mbps rated for 10 Km or greater as needed.
- Minimum of 12 RJ-45 copper ports with auto-negotiate operation at 10 Mbps, 100 Mbps, and 1,000 Mbps
- Port security to prevent unknown devices from gaining access to the network. Unauthorized attempts to access the network shall result in the port being shut down for a definable period of time along with Simple Network Management Protocol (SNMP) trap and alarm generation
- Ports Individually configurable for port mirroring, speed, duplex, auto-negotiation,

and flow control
- Individual port statistics and full support of Remote Monitoring (RMON) statistics, history, alarms, and event groups

(5) Electrical Service:

- 120 VAC ± 10 percent, 60 ± 3 Hz or 12/24/48/-48 VDC power supply

(6) Enclosure:

- DIN mounting.
- Permanently labeled with name, model, serial number, and other information required for maintenance.
- Operating environmental range of - 40 to + 74 degrees C without fans.

742-3 Construction Requirements:

Construction shall conform to Section 732 of the ADOT Standard Specifications, the ITS Standard Drawings, on the RFC Plans, and these specifications.

(A) Conduit Cleaning:

Developer shall clean new and existing conduits, no more than one week prior to installation of fiber optic cable. Conduit cleaning is not required where existing cables, conductors, or innerducts within a conduit will not be removed.

For PVC conduit, a metal-disc mandrel with an outer diameter not less than 90 percent of the conduit's inside diameter shall be pulled through the conduit. For HDPE conduit, a ball mandrel with an outer diameter not less than 80 percent of the conduit's inside diameter shall be pulled through the conduit. Prior to pulling the mandrel through the conduit, the conduit shall be brushed or swabbed.

(B) Fiber Optic Cable Installation:

Developer shall visually inspect fiber optic cable upon delivery and prior to installation. Prior to installation, damaged cable shall successfully pass OTDR testing, as specified herein. Damaged cable shall be replaced by Developer.

No fiber optic cable shall be installed until the conduit, pull boxes, and cabinets through which fiber optic cables will pass or terminate have been approved for fiber optic cable installation.

Developer shall not cause the cable to violate the minimum bending radius specified by the cable manufacturer. In the event Developer violates the minimum bending radius, the entire length of cable from the previous splice point shall be removed from the project and a new cable shall be installed.

Developer shall ensure that the cable is protected from dragging or scraping. Cable shall not drag on the ground or pavement and shall be guided into conduits or innerduct to avoid contact

with sharp edges. Fiber optic cables shall be pulled through conduit or innerduct with a device designed to provide a firm hold on the exterior covering and the central strength member of the cable.

Developer shall supply documentation identifying the manufacturer's recommendation for maximum pulling tension and speed, and these values shall not be exceeded. Developer shall have this documentation on site during each fiber optic cable installation pull. Developer shall use a break-away tension limiter set below the tensile load limit of the cable and a system that provides a means of alerting the installer when the tension approaches the tensile load limit.

During pulling, the cable shall be lubricated at each pull box. The lubricant used shall be compatible with the cable jacket and meet the cable manufacturer's recommendations. Liquid detergent shall not be used. Developer shall use a pre-lubrication or continuous lubrication method. Lubricant quantity for each pull shall be as follows:

$$Q = 0.0008 \times D \times L$$

Where:

Q = is the lubricant quantity, in gallons
D = is the conduit diameter, in inches
L = is the length of the pull, in feet

Developer shall record the "foot marking" of installed fiber optic cable at the entrance and exit point of No. 9 pull boxes in a Fiber-Optic Cable Installation Sequential Report. The report shall be provided to ADOT in electronic spreadsheet format prior to final acceptance.

(C) Fiber Optic Patch Panel:

The factory terminated patch panels shall be mounted on the cabinet walls. They will be secured to controller cabinets so as to avoid water, dust entry or accidental damage to the branch fiber optic cable. Branch fiber optic cable shall directly connect into patch panels inside controller cabinets, and shall be factory installed on the patch panel. Patch panel shall be installed first in controller cabinet followed by pulling and splicing of the branch fiber optic cable. All connectors on patch panels shall be factory tested and labeled to insure proper installation. All unused connectors shall be sealed by the manufacturer supplied plugs. Pulling of the cable shall comply with general requirements for pulling fiber optic cable in conduits according to this TP Attachment 700-4.

Cables shall be routed to the panel to prevent damage. Developer shall install ultra-polished LC connectors with metal inserts in a composite housing on each branch cable fiber and connect fibers to the panel in the fiber order. The LC connectors for the cable may be fusion pre-polished pigtails or hot melt field-polished connectors. No dry crimp connectors will be acceptable.

(D) Fiber Optic Patch and Splice Module:

The fiber optic patch and splice module shall be mounted vertically on the DIN rail, near the right end. Space for air circulation shall be provided for adjacent equipment also mounted on the DIN

rail. Cables shall be routed to the panel to prevent damage. Developer shall install ultra-polished LC connectors with metal inserts in a composite housing on each branch cable fiber and connect fibers to the panel in the fiber order. The LC connectors for the cable may be fusion pre-polished pigtails or hot melt field-polished connectors. No dry crimp connectors will be acceptable.

(E) Occupied Conduit:

Where fiber optic cables are installed in conduit with existing cables or conductors, Developer shall not damage the existing cables or conductors.

Where fiber optic cables are to be installed within a conduit or innerduct containing existing loop lead-in cables, Developer shall disconnect, remove, reinstall, and test the loop lead-in cables. Developer shall be responsible for damage to existing loop lead-in cables caused by this operation.

Existing fiber optic cables that are required to be removed shall be disconnected, removed, and re-pulled at the same time as the new fiber optic cable and other cables and conductors. The existing fiber optic cable shall be reconnected in the same manner as it was in its original condition and tested in accordance with these specifications.

At least 10 days prior to disconnecting existing conductors or cables, Developer shall submit a schedule for disconnection and reconnection of existing cables for the ADOT TOC for approval. Additionally, Developer shall contact MAG for identification of RCN fibers along the ADOT trunk line 10 days prior to disconnecting existing RCN fibers.

(F) Cable Slack & Coiling:

Unless a greater distance is specified, No. 9 pull boxes with splice closures shall have 50 feet of cable slack provided between the splice closure and the wall of the pull box where the cable enters/exits the pull box, allowing the splice closure to be removed up to 50 feet from the pull box. No. 9 pull boxes without splice closures shall provide a minimum of 100 feet of slack in each cable passing through the pull box, unless otherwise specified.

Cable slack shall be loosely coiled into a circular shape and attached to the rack and hook system integral to the wall of the No. 9 pull box with industry standard nylon cable ties. Cables shall be coiled independently from one another and secured with separate cable ties for each coil. Cable ties shall be tightened to prevent cable slippage, but shall not deform or damage the cable sheath.

(G) Splices:

Developer shall perform fusion splicing of fiber optic cable at the locations shown in the project plans. Splices shall be prepared in accordance with the manufacturer's recommendations. Splicing shall be conducted only at node buildings, specified pull boxes, and connector housing units as shown on the RFC Plans and described in the Project Special Provisions for Construction. Fiber optic cable shall be continuous between splice points.

Developer shall install splice closures in a manner such that trunk line cable entries on the same side of the end cap allowing future branch fiber optic cables to be installed without disturbing the trunk line seals.

Where Developer is splicing to existing fiber optic cable, Developer shall take care not to disturb existing splices. Existing splices that are damaged shall be repaired immediately by Developer.

(H) Connectors:

Branch fiber optic cables, typically between a cabinet and a splice closure on the trunk line, shall be connectorized in accordance with the manufacturer's recommendations. Connectors shall be installed to meet requirements of the ITS Design Guide, ITS Standard Drawings, as indicated on the RFC Plans, and in these specifications.

Trunk line fiber optic cables shall not be connectorized.

(I) Tagging:

Tags shall be installed on conductors and cables inside pull boxes near the pull box entrance and exit, and inside cabinets. Tags shall be labeled with the following fields, as applicable:

Field 1: Responsible Agency (applicable only if agency is other than ADOT)

Example Legends	Application
MCDOT	Maricopa County Department of Transportation
Tempe	City of Tempe

Field 2: Description

Example Legends	Application
SMFO144	144-strand single mode fiber optic cable
SMFO12	12-strand single mode fiber optic cable
AWG6	American Wire Gauge 6

IMSA7	IMSA 19-1, 7-Conductor
LOOP 1U	lane 1 upstream loop detector (other loop designations per Standard Drawing FM-5.01)
CCTV	CCTV device cable
DMS	DMS device cable

Field 3: Termination

Example Legends	Application
TO NODE 12	fiber optic trunk line or power to a node
TO EB TRUNK LINE	fiber optic branch to Eastbound trunk line
TO CAB 3118253	fiber optic or power to a cabinet
TO LC 3118256	power to a load center
TO SIGNAL	fiber optic or power to a signal cabinet
TO EB DMS	Power or control cable to eastbound DMS

A continuous cable passing through a pull box shall have two tags which will be the same except with different Termination descriptions. A pull box with a trunk line fiber optic cable spliced with a branch fiber optic cable shall have three tags, two on the trunk line fiber optic cable and one on the branch fiber optic cable. Multiple power conductors that go to one load center shall be bundled together and have one tag that indicates the load center cabinet number in the Termination field. Multiple power conductors that go to different cabinets shall be bundled and tagged in conductor pairs according to the cabinet they go to.

Tagging shall be recorded by Developer in a Record Drawing Cable Schedule and include the distance marking on the fiber optic cable at the entrance to a pull box, cabinet, or other termination point. The as-built Cable Schedules within the ITS Plans shall be provided to ADOT

with the Final Complied Documentation.

(J) Test Requirements:

Fiber optic cable shall successfully pass the following tests, demonstrating acceptable attenuation and connectivity. Developer shall make corrective actions for unacceptable. Failed splices and connections shall be remade and re-tested for compliance. Developer shall replace cable in its entirety that is not compliant with these specifications.

Each fiber optic strand shall introduce less than 0.35 dB/km of attenuation at 1310 nm and 0.25 dB/km of attenuation at 1550 nm.

Each splice between two new fibers shall introduce less than 0.1 dB of attenuation. Each splice between one new and one existing, or two existing fibers, shall introduce less than 0.3 dB of attenuation.

Each fiber connector shall introduce less than 0.5 dB of attenuation. Connectors exceeding this limit shall be replaced until this requirement is met.

(1) Power Meter Test:

Power meter tests shall be conducted by Developer after installation of the fiber optic cable, splicing, and installation of fiber optic pigtails and break-outs.

Power Meter Tests shall be performed on each fiber strand terminated with connectors utilized in circuits, in accordance with Method A.3 of TIA/EIA-526-7 – “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.” Testing shall be conducted at the cable ends in one direction using 1310 nm wave length.

Developer shall use the Power Meter Test Form provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to ADOT.

(2) OTDR Test:

OTDR testing shall be conducted by Developer after successful completion of the power meter test.

OTDR tests shall be performed in accordance with EIA/TIA-455-8 for all fibers, including new fibers, dark fibers, and existing fibers in splice enclosures that Developer works in. Developer shall test each fiber in both directions at 1310 nm and 1550 nm using a launch cable of a length recommended by the OTDR manufacturer.

Developer shall use the OTDR Test Form provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to ADOT.

Developer shall submit OTDR traces which clearly annotate the location of each loss event and identify the allowable loss and measured loss.

Developer shall coordinate with ADOT to install the SFP module and fiber optic patch cable and reconfigure the existing switches to accommodate the new fiber optic communications channels being established for this project.

The Fiber Patch Panel shall be rack mounted at a location designated ADOT. Cables shall be routed to the panel to prevent damage. Developer shall install ultra-polished LC connectors with metal inserts in a composite housing on all 144 fibers and connect fibers to the panel in the fiber order. The LC connectors for the cable may be fusion pre-polished pigtails or hot melt field-polished connectors. No dry crimp connectors will be accepted.

Minimum qualifications for Developer personnel performing installation and testing of the Ethernet Switches shall be:

- Three years' experience in installation, testing and maintenance of Ethernet network equipment.
- Performed two installations where Ethernet Switches were deployed and the network has remained in continuous satisfactory operation for at least two years.

Developer shall provide documentation indicating the names of the individuals performing the work, company they work for, contact information, relevant experience and the amount of time spent on each project, and any other supporting information to ADOT for approval at least 60 Days prior to the start of Ethernet switch installation.

Developer shall request the IP address, VLANs, host name, and other configuration settings from ADOT at least 30 Days prior to installing the Ethernet Switches. The host name shall include the cabinet ID number, device type (DMS, CCTV, Ramp Meter), and location description.

Ethernet switches shall be physically labeled with the IP address, device type (DMS, CCTV, Ramp Meter), and location description.

Ethernet switches shall be mounted vertically, in the middle of the DIN rail. The power supply shall be mounted to the left of the Ethernet switch leaving space for air circulation.

Wires and cables shall be neatly installed and secured using common practices and standards. Developer shall provide service loops at connection points. Components shall be installed in a manner where parts are readily accessible for inspection and maintenance.

SECTION 743 CONTROL CABINET ASSEMBLIES AND FOUNDATION

743-1 Description:

The work under this item includes furnishing and installing control cabinets, as shown on the plans and in these Specifications.

The work under these items includes furnishing and installing control cabinet foundations, as shown on the plans and in this TP Attachment 700-4.

The work under this item includes furnishing and installing transformer cabinet foundations, as shown on the plans and in this TP Attachment 700-4.

743-2 Materials:

The ITS cabinets shall be the type indicated on the RFC Plans. Overall appearance and dimensions shall be as shown in the ITS Standard Drawings unless otherwise specified.

Developer shall provide complete wiring diagrams and schematics for ITS cabinet assemblies for ADOT testing. The diagram shall show the specific loop detector field wire terminals for each loop detector. An electronic copy and one set of 11” x 17” prints shall be provided with each ITS cabinet assembly. The wiring diagram shall illustrate circuits and components in detail. Components shall be identified by name or number so as to be clearly noted in the drawings. Material submittals shall conform to the general requirements of this TP Attachment 700-4 and Section 116 of the TPs.

743-2.01 Standard Equipment:

ITS Cabinets Assemblies shall be furnished with the following items.

(A) General:

Bolts, nuts, washers, screws, hinges, and hinge pins shall be stainless steel, unless otherwise specified.

Units of equipment shall be enclosed in a sheet metal case with a protective finish. The case shall be designed to provide convenient access to the entire interior assembly and permit the removal of printed circuit boards or modules without the use of special tools.

Module and printed circuit assemblies shall incorporate plug-in techniques and be easily replaceable. A guide or track shall be provided for each module and assembly. Assemblies shall be mechanically secured so as to retain the assemblies in their proper position under conditions of shock and vibration when the unit is mounted in a roadside cabinet.

Assemblies shall be provided with two guides for each plug-in printed circuit board. The guides shall extend to within 0.75 inch from the face of either the socket or connector. Connectors and printed circuit cards shall be keyed to prevent accidental insertion of the wrong connector or card.

The manufacturer’s model number, serial number, functional variation circuit issue or revision number, and date of shipment (month and year) shall appear in an easily visible location on each equipment unit and module supplied.

Units having the same model number shall be electrically and mechanically interchangeable.

(B) Cabinet Housing:

Cabinet housings shall be ventilated NEMA 3 weather resistant with the top of the enclosure crowned, to prevent standing water. Overall appearance and dimensions shall be as shown on the RFC Plans and conform to the ITS Standard Drawings. The outside surface of the cabinet shall have a smooth, uniform, natural, unpainted aluminum finish.

The enclosure, doors, two lifting eyes, gasket channels and supports welded to the enclosure and doors shall be fabricated of 0.125-inch minimum thickness 5052-H32 sheet aluminum. Bolted-on supports shall be either the same material and thickness as the enclosure, or shall be 0.105-inch thick (minimum) steel. The side panels and filter shell shall be fabricated of 0.080-inch minimum thickness sheet aluminum.

Each cabinet shall be provided with two lifting eyes. Each lifting eye opening shall have a minimum diameter of 0.75 inch. Each lifting eye shall be able to support a load of 1,000 pounds.

Exterior seams for the enclosure and doors shall be continuously welded. Welds shall be neatly formed and free of cracks, blow holes, and other irregularities. Edges shall be filed to a minimum radius of 0.03125 inch. Exterior cabinet welds shall be accomplished by the gas Tungsten arc Tungsten Inert Gas (TIG) process only. For the TIG process, the ER5356 (AIMg-5) 5% Magnesium, Aluminum alloy welding rod, conforming to AWS A5.10 requirements shall be used for welding on aluminum. Procedures, welders, and welding operators shall conform to the requirements and practices in AWS B3.0 and C5.6 for aluminum. Internal cabinet welds shall be done by either the gas metal arc Metal Inert Gas MIG (also known as Gas Metal Arc Welding (GMAW) or the gas tungsten arc TIG process.

An anodic coating shall be applied to aluminum surfaces after the surface has been cleaned and etched. The cleaning and etching procedure shall be to immerse in inhibited alkaline cleaner at 159.8 degrees Fahrenheit for 5 minutes (in a mix of 6 to 8 ounces per gallon to distilled water) then rinsed in cold water and etched in a sodium solution at 150.8 degrees Fahrenheit for 5 minutes (0.5 ounce sodium fluoride, plus five ounces of sodium hydroxide mix per gallon to distilled water). The surface shall again be rinsed in cold water and then degreased in a 50 percent, by volume, nitric acid solution at 68 degrees Fahrenheit for 2 minutes. Finally, the surface shall be rinsed in cold water.

The anodic coating shall conform to MIL-A-8625F (Anodic Coatings for Aluminum and Aluminum Alloys) for Type II, Class I Coating except the outer housing surface coating shall have a 0.0007-inch minimum thickness and a 0.952 ounces per square inch minimum coating weight. The anodic coating shall be sealed in a 5 percent aqueous solution of nickel acetate (pH 5.0 to 6.5) for 15 minutes at 210.2 degrees Fahrenheit.

The enclosure door frames shall be double-flanged on all four sides, and shall have strikers to hold tension on and form a firm seal between the door gasket and the frame. The dimension between the door edge and the enclosure external surface when the door is closed and locked shall be 0.156 $\pm$ 0.08 inch.

Gaskets shall be provided on door openings and shall be dust-tight. Gaskets shall be 0.25-inch minimum thickness, closed-cell neoprene or silicone, and shall be permanently bonded to the

metal. If neoprene is used, the mating surface of the gasket shall be covered with a silicone lubricant to prevent sticking to the mating metal surface. A gasket top channel shall be provided to support the top gasket on the door to prevent gasket gravitational fatigue.

No bolts shall protrude through the cabinet top or walls. Inside and outside edges of the cabinet shall be free of burrs.

Cabinet housing shall have single front and rear doors, each equipped with a lock. The handles shall have provisions for padlocking in the closed position. Each handle shall be 0.75-inch minimum diameter stainless steel with a minimum 0.50-inch shank. The padlocking attachment shall be placed at 4 inches from the handle shank center to clear the lock and key. An additional 4-inch minimum gripping length shall be provided.

The latching mechanism shall be a 3-point draw-roller type. The center catches and push-rods shall be cadmium plated, Type II Class 1. Rollers shall have a minimum diameter of 0.75 inch with nylon wheels and steel ball bearings. The push rods shall be turned edgewise at the outward supports and have a cross-section of 0.25-inch thick by 0.75 inch wide, minimum. The center catch shall be fabricated from 0.140-inch steel, minimum.

When the door is closed and latched, the door shall be locked. The lock and lock support shall be rigidly mounted on the door. In the locked position, the bolt throw shall extend a minimum of 0.25 inch into the latch-cam area. A seal shall be provided to prevent dust or water entry through the lock opening.

Locks shall be consistent and compatible with current ADOT ITS cabinet maintenance keys. The key shall be removable only in the locked position. One key shall be furnished with each lock. All parts of the locking mechanism shall be stainless steel. Locks shall have rectangular spring-loaded bolts. Bolts shall have a 0.281-inch throw and shall be 0.75 inches wide by 0.75 inches thick (tolerance is +/- 0.035 inches).

The rear door shall be provided with louvered vents. The louvered vent depth shall be a maximum of 0.25 inch. A removable, reusable air filter shall be housed behind the door vents. The filter shall cover the vent opening area. A filter shell that fits over the filter and provides mechanical support for the filter shall be furnished. The shell shall be louvered to direct the incoming air downward. The shell sides and top shall be bent a minimum of 0.25 inch to contain the filter. The filter resident in its shell shall be held firmly in place with a bottom bracket and a spring loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside of the housing. The filter shall be 16 inches wide x 12 inches high x 0.875-inch thick, and compatible with the cabinet the filter is serving. The intake (including filter with shell) and exhaust areas shall pass a minimum of 100 cubic feet of air per minute.

Two-bolts per leaf hinge shall be provided to bolt the enclosure to the door. The housing shall have 4 hinges. Each hinge shall be 3.5-inch minimum length and have a fixed pin. The pin ends shall be welded to the hinge and ground smooth. The pins and bolts shall be covered by the door edge and not accessible when the door is closed.

Front and rear doors shall be provided with catches to hold the doors open at both 90 and 180 ± 10 degrees. The catch minimum diameter shall be either 0.375 inch for plated steel or aluminum rods or 0.25 inch for stainless steel. The catches shall hold the door open at 90 degrees in a 60 mile per hour wind acting at an angle perpendicular to the plane of the door.

Developer shall furnish and install pressure-sensitive, permanent identification decals on load center cabinets, as shown in the ITS Standard Drawings. The decals shall be 3- inch tall, Series C, Gothic letters and shall be top-grade, glass-beaded, reflective black letters on a silver or chrome background.

(C) Cage Support Assembly:

A standard EIA 19-inch rack cage shall be installed inside the housing for mounting of the controller unit and cabinet accessories.

The EIA rack portion of the cage shall consist of two pairs of continuous, adjustable equipment mounting angles. The angle nominal thickness shall be either 0.1345-inch plated steel or 0.105 stainless steel. The angles shall be tapped with holes having 10-32 threads with EIA universal spacing.

The angle shall comply with standard EIA RS-310-D and shall be supported at the top and bottom by either welded or bolted support angles to form a cage.

The cage bottom support mounting angles shall be provided on either side, level with the bottom edge of the door opening for horizontal support and bolt attachment. Side cage supports shall be provided for the upper cage bolt attachments. Spacer brackets between the side cage supports and the cage shall be either 0.188-inch aluminum or 0.105-inch steel.

Clearance between angles for mounting assemblies shall be 17.75 inches.

Two steel supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be a minimum 3 inches wide. The angles shall be vertically adjustable.

As part of the controller support brackets, a 1.5-inch rack mounted drawer shall be provided within a 1.75-inch space. The rack mounted drawer shall have a hinged top cover. The drawer shall store documents and miscellaneous equipment up to 50 pounds in weight when extended out from the cage. When fully extended, the drawer shall lock in place and shall require manual release of spring pins on each of two sides to allow the drawer to be retracted into the cage.

The cage shall be bolted to the cabinet at four points on both top and bottom, using the housing cage supports and associated spacer brackets, and shall be centered within the cabinet.

Aluminum side panels shall be provided in the cabinet as shown in the ADOT ITS Standard Drawings. They shall be bolted to the support cage.

(D) Electrical Requirements:

Circuits shall be functionally operational with regard to the following parameters:

Power source frequency:	60 ± 3 Hz
Applied Line Voltage:	90 to 135 VAC, single-phase
Ambient temperature:	-35 to +165 degrees Fahrenheit
Humidity:	5 to 95 percent, non-condensing

The surfaces of circuit boards shall be sealed to protect against moisture.

Circuits shall commence operation at or below 90 VAC, as the applied voltage is increased at a rate of 2 ± 0.5 VAC per second.

Equipment shall be unaffected by transient voltages normally experienced in commercial power lines.

Equipment shall be capable of normal operation following opening and closing of contacts in series with the applied voltage at a rate of 30 openings and closings per minute for a period of 2 minutes.

Live electrical circuitry shall be isolated by a dead front panel fabricated from 14-gage sheet steel. The dead front panels shall be hinged on one side and securely fastened on the other with bolts. Switches, breakers and other components shall have openings to operate from the front of the panel.

(E) Cabinet Wiring:

Conductors used in cabinet wiring shall terminate with properly sized non-insulated (if used for DC logic only) or clear insulated spring-spade type terminals except when soldered to a through-panel solder lug on the rear side of the terminal block or as specified otherwise. Crimp-style connectors shall be applied with a power tool that prevents opening of the handles until the crimp is completed.

Cable connectors shall have cable hoods or shields and strain relief clamps.

Pin and socket connectors shall use identical contact insertion tools, contact extraction tools, and contact crimping tools. Pin diameter shall be 0.062 inches.

Conductors between the service terminal AC- and Equipment Ground, and their associated bus, the equipment ground bus conductor to Power Distribution Assembly, and cage rail, AC- Bus to Power Distribution Assembly shall be 8 AWG or larger.

Conductors, unless otherwise specified, shall be 22 AWG or larger, with a minimum of 19 copper strands. Conductors shall conform to Military Specification MIL-W-16878D, Type B, or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl

chloride, except that conductors 14 AWG and larger may have Type THHN insulation (without nylon jacket), and shall be stranded with minimum of seven copper strands.

Field conductors shall be tagged in the control cabinet in accordance with these Specifications. Conductors shall conform to the following color-code requirements:

The grounded conductors of AC circuits shall be identified by a solid white or solid gray color;

The equipment grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes;

The DC logic ground conductors shall be identified by a continuous white color with a red stripe;

The ungrounded AC+ conductors shall be identified by a solid black or continuous black with colored stripe; and

The logic ungrounded conductors shall be identified by a color not specified above.

Wiring harnesses shall be routed to minimize crosstalk and electrical interference.

The C1 connector wire harness shall be a minimum of 4 feet in length and shall have adequate length to allow the C1P connector to properly connect the controller unit to the cabinet while the unit is mounted in the cabinet and while the unit is sitting on the cabinet drawer.

Wiring containing AC shall be routed and bundled separately or shielded separately from logic voltage control circuits.

Cabling shall be routed to prevent conductors from being in contact with metal edges.

Cabling shall be arranged so that removable assemblies can be removed without disturbing conductors not associated with that assembly.

The DC logic ground shall be electrically isolated within the cabinet from the AC neutral and the equipment ground by at least 500 Megohms at 250 VDC.

The cabinet power supply DC ground shall be connected to the DC logic ground bus using a No. 14 AWG or larger stranded copper wire.

With the power line surge protector disconnected, the AC neutral and the equipment ground shall be electrically isolated by at least 500 Megohms at 250 VDC.

(F) Circuit Breakers:

Circuit breakers shall be trip-free type with medium trip delay characteristics. Multi-pole circuit breakers shall be the common-trip type. Circuit breakers shall be UL 489 approved. The trip and frame size shall be plainly marked on the breaker by the manufacturer, and the Amperes rating shall be marked and visible from the front of the breaker. Breakers shall be quick-make, quick-

break on either manual or automatic operation. Contacts shall be silver alloy enclosed in an arc quenching chamber. Overload tripping shall not be influenced by an ambient temperature range of from 0.4 to 122 degrees Fahrenheit. Minimum interrupting capacity shall be 5,000 Amperes RMS when the breaker is secondary to a UL approved fuse or primary circuit breaker, and both breakers in concert provide the rated capacity. For circuit breakers 80 Amperes and above, the minimum interrupting capacity shall be 10,000 Amperes RMS.

(G) Fuses:

Fuses shall be 3AG Slow Blow type, and reside in a fuse holder. Fuse size rating shall be labeled on the chassis or beside the holder. Fuses shall be easily accessible and removable without the use of tools.

(H) Power Line Surge Protector:

A power line surge protector shall be furnished and installed as part of the cabinet. The power line surge protector shall consist of a hardware base and replaceable protection module with LED failure indicators, conforming to the following requirements:

Operating Voltage	120 VAC
Clamping Voltage	340 VAC
Operating Current	15 Amps
Peak Surge Current	32.5 kA/Phase, 45.5 kA/Total
Operating Frequency	60 ± 3 Hz
EMI Attenuation	50 dB Typ.
Modes of Protection Status Indicators Temperature range: Maximum Dimensions:	L-N, L-G, N-G Power On, MOVs Functional -40 to + 185 degrees Fahrenheit 3.125 inches wide x 7.125 inches long x 3.5 inches high

Typical radio interference noise suppression shall be 10 dB at 10kHz, 50 dB at 100kHz, and 90 dB at 1 MHz.

Power line surge protection shall be provided to enable equipment to withstand (non-disruptive) and operate normally following the discharge of a 25 microfarad capacitor charged to ± 2,000 Volts, applied directly across the incoming AC line at a rate of once every 10 seconds, for a maximum of 50 occurrences, with the equipment operating between 27 to 109 degrees Fahrenheit and at 108 to 132 VAC.

Equipment shall withstand (non-disruptive) and operate normally when one discharge pulse of ± 300 Volts is synchronously added to its incoming AC power line and moved uniformly over the full wave across 360 degrees or stay at any point of line cycle once every second, with the equipment operating between 27 to 109 degrees Fahrenheit and at 108 to 132 VAC. Peak noise power shall be 5 kilowatts with a pulse rise time of 500 nanoseconds.

(I) DIN Rail Shelf:

A 4U DIN rail shelf shall be included and capable of supporting power supplies, an Ethernet Switch, a patch and splice module, power supplies, and other cabinet accessories.

(J) Ventilation Fan:

Cabinets shall be equipped with two electric fans with ball or roller bearings and each with capacity of 100 cubic feet of free air flow per minute. Fans shall be mounted within the interior of the cabinet and vented.

Fans shall be thermostatically controlled and shall be manually adjustable to turn on between 32- and 140-degrees Fahrenheit, with a differential between automatic turn on and off of not more than 20 degrees Fahrenheit. It shall be possible to manually adjust the on/off temperature set point in 20-degree Fahrenheit increments. Each fan circuit shall be protected at 125 percent of the fan motor current rating.

(K) Lighting:

The cabinets shall contain two LED light fixtures. The fixtures shall be mounted on the inside top of the cabinet near the front edge and rear edge of the roof so that the front or rear of the control equipment will be illuminated when the corresponding door is open. A door-actuated, refrigerator-type, normally-closed, durable push-button type switch shall automatically turn the appropriate light fixture on and off when the front or rear door is opened and closed.

743-2.02 Cabinet Accessories:

ITS Cabinet Assemblies shall be provided with the cabinet accessories as required.

(A) Model 2070 Controllers

Controllers shall be Intelight model 2070LC, model number INT YCT-2070LC(S), and shall include Intelight Maxtime ramp metering software and licensing, model INT YSW-RAMPMT,

factory-loaded onto the controller. Each controller shall also be provided with one Intelight Maxview central system license, model number INT YSW-MV-LICENSE. The Maxview licenses shall be provided to ADOT in the form of one license key from Intelight for the project by email to systemstechnologygroup@azdot.gov. The Developer shall submit the Purchase Order (PO) to ADOT indication the location for each Intelight controller.

(B) Inductive Loop Detector Cards:

Detector cards shall provide two inductive loop detector channels for detecting vehicles and actuating Model 2070 controllers. Control buttons and channel indicators shall be mounted on the front panel. Detector cards shall have a front panel indicator to provide visual indication of detection strength for each channel. The detector card front panel shall be provided with a handle to facilitate insertion and removal. Detector cards of the same type shall be interchangeable. Detector cards shall be in full compliance with the environmental requirements of the most current NEMA standard.

Indicator lights and character displays shall have a 45-degree cone of visibility from an axis perpendicular to the front panel. They shall be readily visible at a radius of up to 4 feet within the cone of visibility when they are subjected to 9,000 foot-candles of white light (equivalent to bright sunlight) at 45 degrees to the front panel. The front panel shall provide a separate indicator for Detect and Fault for each channel.

Detector cards shall mate and be fully functional with the input file via a 44 terminal, double row, edge connector having terminal spacing of 0.156 inch.

Detector cards shall draw no more than 100 mA from the + 24 ± 6 VDC cabinet power supply and shall be insensitive to 700 mV RMS ripple on the incoming + 24 VDC line.

Detector card outputs shall be opto-isolated, open collector, NPN transistor and shall sink up to 50 mA at 30 VDC. The output shall be compatible with the controller unit's inputs.

Component parts and test points shall be clearly identified by permanent marking of circuit references on the printed circuit board.

Each loop input channel shall be galvanically isolated, through the use of separate isolation-transformers, from each other and the internal circuitry of the detector.

Detector channels shall function properly with an external surge protector installed on the loop circuit.

Internal surge protection, provided on loop detector input terminals, shall enable the detector to withstand a discharge of a 10 microfarad capacitor charged to ± 1,000 Volts directly across the loop detector input pins with no loop load present and enable the detector to withstand a discharge of a 10 microfarad capacitor charged to ± 2,000 Volts directly across either the detector input pins or from loop input pins to equipment ground. The detector input pins shall have a dummy resistive load attached equal to 5.0 Ohms for test purposes.

Optically-isolated solid state output devices shall be rated to hold off 50 VDC at 20 mA ON current with a maximum 1.5-Volt drop across the output terminals. Isolation shall be at least 1,000 VAC RMS.

Detector cards shall have a remote reset circuit which, when activated by an external ground level signal greater than 15 microseconds, shall cause presence detections to be reset.

Detector channels shall be sequentially scanned to eliminate crosstalk between loops connected to the same unit.

Detector channels shall automatically self-tune to any loop system inductance from 20 to 500 microhenries within 1 second after application or interruption of voltage.

At a minimum, each channel shall include the modes “PRESENCE,” “PULSE,” and “OFF”. “OFF” shall disable the output and indicator, and shall disable the channel excitation circuit to assist in determining the offending channel when crosstalk is present.

“PULSE” shall provide a single 125 ± 25 ms output pulse in response to all types of licensed motor vehicles when traveling over a 6 x 6-foot rectangular loop at 10 miles per hour and shall detect successive vehicles traveling over the same rectangular loop at speeds of 10 to 60 miles per hour with a minimum 1-second headway. Selection of pulse mode shall clear the presence indication on the associated channel.

“PRESENSE” shall output a pulse that is directly related to the duration that a vehicle is detected by the loop system. In presence mode, the detector channel shall be capable of detecting a motorcycle and hold the output for at least 4 minutes when the motorcycle is stopped over one loop of a series-connected loop system having four 6 x 6-foot loops with 1,000 feet of lead-in and a Q factor greater than 5. The detector channel shall hold the output for at least 15 minutes when the test is repeated using a standard automobile on the same loop system configuration.

The time delay between a vehicle entering the detection zone and the occurrence of the detection output shall be 10 ms or less at the midpoint sensitivity setting. The time delay between a vehicle leaving the detection zone and the detection output turning off shall be 10 ms or less at the midpoint sensitivity setting.

For test purposes, a negative inductance change shall be applied for a minimum of 100 ms and a maximum of 600 ms. When the difference in the durations of the inductance change and the corresponding ground true output are averaged over 10 trials, the average difference (algebraic) shall not exceed the specified threshold.

To test for vehicle presence, the delay time between when an inductance change is applied and the time it takes for the output to respond, averaged over 10 trials, shall not exceed the specified threshold.

To test for vehicle absence, the delay time between when an inductance change is removed and the time it takes for the output to respond, averaged over 10 trials, shall not exceed the specified threshold.

To test recovery time, the above two tests shall be repeated in sequence 10 times with a delay of not more than 100 ms between the beginning of each two-stage sequence.

Detector channels shall have a range of selectable sensitivities that ensures detection of all types of licensed motor vehicles (including motorcycles) without detecting moving or stopped vehicles further than 36 inches away from a three-turn, 6 x 6-foot loop with 50 feet, 500 feet, and 1,000 feet of lead-in cable.

Detector channels shall be continuously monitored for open circuit, short circuit, and changes in inductance indicating a loop fault condition. A loop fault of one channel shall have no adverse effect on the operation of the other channel. Specific fault conditions shall be indicated by a unique sequence of flashes by the fault indicator light. The fault indicator light shall display a previous fault condition. Detector channels shall re-tune instantly and resume detection following a momentary open circuit condition. During an open circuit condition, the channel shall provide a continuous output that is not resettable as long as the open circuit exists, except when the channel is off.

(C) Loop Detector Surge Protectors:

Loop detector surge protectors shall be provided in existing and new cabinets with new loop terminations. Loop detector surge protectors shall have three spade lugs for connection to a terminal strip, with 7/16-inch spacing, and conform to the following minimum performance requirements:

(1) Peak Surge Current:

a. 8 x 20 µsec Differential Mode: 400 A

b. 8 x 20 µsec Common Mode: 1,000 A

(2) Life Expectancy (Occurrences):

a. 8 x 20 µsec (200A): 500

b. 10 x 700 µsec (100A): 100

(3) Response Time: Less than 5 ns

(4) Input Capacitance: 35 pF

(5) Clamping Voltage (After Breakover): 150 V

(6) Operating Temperature: Up to 185 degrees Fahrenheit

(D) Power Distribution Assembly No. 4:

The power distribution assembly No. 4 (PDA4) shall perform the following functions:

Receive the 120 VAC power source and distribute it to the various cabinet functions through separate circuit breakers.

Provide, via the Model 206 power supply module, a + 24 VDC power source for the operation of various cabinet accessories.

Provide, via a Model 204 flasher unit, a means of flashing external signal indications.

Provide a switch pack load bay with inputs from the controller and outputs to field circuits.

The PDA4 shall include four 15 Amp circuit breakers. The rating of each breaker shall be shown on the face of the breaker or handle. Breaker function (EQPT, CCTV, SIG GATES, REC) shall be labeled on the front panel as shown on the ITS Standard Drawings.

The PDA4 shall have three duplex receptacles. Each receptacle shall accept both standard two-prong non-grounded and standard three-prong grounded plugs.

Receptacle No. 1 (REC1) and receptacle No. 2 (REC2) shall have ground-fault circuit interruption, as defined in the NEC. Circuit interruption shall occur in the presence of 6 mA or more ground-fault current and shall not occur on less than 4 mA ground-fault current.

The 120 VAC supplies to the two outlets of receptacle No. 3 (REC3A and REC3B) shall be separate. The rear panel of the PDA shall be etched to label REC3A as “CONTROLLER” and REC3B as “AUX”.

Terminal blocks shall have 10-32 thread terminal screws.

The PDA4 shall provide for the mounting and connection of four Model 200 switch packs.

The PDA4 shall have a maximum depth of 10.5-inches.

(E) Model 206 Power Supply Module:

The Model 206 Power Supply Module shall supply + 24 VDC to the input files and other devices in the cabinet. It shall be furnished as a part of the PDA4.

The power supply shall be of ferro-resonant design, having no active components, and conforming to the following requirements:

Line regulation shall be 2 percent from 90 to 135 VAC at 60 Hz, plus an additional 1.6 percent for each 1.0 percent of frequency deviation.

Load regulation shall be 5 percent from 1 to 5 Amperes, with a maximum temperature rise of 86 degrees Fahrenheit, above ambient.

Design voltage shall be + 24 ± 0.5 VDC at full load, 86 degrees Fahrenheit, 115 VAC incoming voltage.

Full load current shall be 5 Amperes, minimum.

Ripple noise shall be no greater than 2 Volts peak-to-peak and 500 mV RMS at full load.

Power source shall be 90 to 135 VAC.

Efficiency, at full load, shall be 80 percent, minimum.

Circuit capacitors shall be rated for 40 Volts, minimum.

The front panel shall include AC and DC fuses, power ON light, and test points for monitoring the output voltages.

The assembly, including terminals, shall be protected to prevent accidental contact with energized parts.

The module chassis shall be vented. Its top and sides shall be open. When resident in the power distribution assembly, the module shall be held firmly in place by a stud screw, an assembly connector support panel, and a wing-nut.

Two 0.5 Ohm, 10-Watt (minimum) wire-wound power resistors, each with a 0.2 microhenry maximum inductance, shall be provided; one on the AC+ power line and one on the AC- line.

Three MOV surge arrestors rated for 20 Joules minimum, shall be supplied between AC+ and equipment ground, AC- and equipment ground, and between AC+ and AC-. A 0.68-microFarad capacitor shall be placed across AC+ and AC- between the two power resistors and the MOVs.

(F) Input File:

Developer shall furnish and install input files for cabinets used for detection applications, as shown in the ADOT ITS Standard Drawings. The input file racks shall provide card slots for the loop detector cards. Each input file rack shall have a maximum depth of 8.5 inches and shall mate with and support up to 14 two-channel detector sensor or isolator cards. The file shall provide a PCB 22/44S connector centered vertically for each two-channel card slot. The input file shall be provided with labels identifying the detectors associated with each slot. Terminal blocks shall be provided with a terminal screw size of 8-32 with locking star washers.

(G) Switch Packs & Flasher Units

The unit chassis shall be made of metal suitable to meet rigid support and meet the ambient temperature and humidity requirements in Section 743-2.01 (d).

The unit control circuitry and switches shall be readily accessible using either a screwdriver or wrench. Only one type of screw head end (Slotted or Phillips) shall be used.

The unit shall be constructed so no live voltage is exposed. A handle shall be attached to the front panel for insertion or removal from the unit mating connector.

The unit shall be constructed so its lower surface is no more than 2.06 inches below the centerline of the connector and no part shall extend more than 0.9 inches to the left or 1.1 inches to the right of the connector centerline.

Continuous edge guides shall be provided on the unit.

Each switch shall be capable of switching any current from 0.050 to 10.0 Amperes (AC) load with a power factor of 0.85 or higher.

Each switch shall be designed for a minimum of 300 Million operations while switching a tungsten load of 1,000 Watts at 158 degrees Fahrenheit. Switch isolation between DC input and AC output circuit shall be at least 10,000 Mega Ohms at 2,000 VDC.

Each switch shall turn ON within ± 5 degrees of the zero-voltage point of the AC sinusoidal line, and shall turn OFF within ± 5 degrees of the zero-current point of the alternating current sinusoidal line. After power restoration, the zero voltage turn ON may be within ± 10 degrees of the zero voltage point only during the first half cycle of line voltage during which an input signal is applied. Turn ON and OFF shall be within 8.33 ms following application or removal of the logic signal, respectively.

(1) Model 200 Switch Packs:

The Model 200 Switch Pack unit shall be a modular plug-in device containing three solid-state switches. Each switch shall open or close a connection between applied power and external load.

A Ground True Controller Unit Input (0 to 6 VDC) shall cause the switch to energize and a Ground False (16 VDC or more) shall cause it to de-energize. State transition shall occur between 6 and 16 VDC. The input shall not sink more than 20 milliamps or be subjected to more than 30 VDC. The input shall have reverse polarity protection.

With all switches on, the unit shall not draw more than 60 milliamps at +16 VDC or more from the +24 VDC cabinet supply.

Each switch shall have an OFF state dV/dt rating of at least 100 Volts per microsecond. Each switch shall be isolated so that line transients or switch failure shall not alter the controller unit.

The unit front panel shall have an indicator on the input to each switch. The indicator shall be labeled or color-coded “Red”-top switch, “Yellow”-middle switch, and “Green”-bottom switch. The middle switch indicator shall be vertically centered on the unit front panel with the other indicators positioned 1 inch above and below.

The resistance between the AC+ input terminal and the AC+ output terminal of each switch shall be a minimum of 15 kiloohms when the switch is in the open state. When the switch is in off state, the output current through the load shall not exceed 10 milliamps, peak.

(2) Model 204 Flasher Unit:

The Model 204 Flasher Unit shall be a modular plug-in device containing a flasher control circuit and two solid-state switches. The unit's function is to alternatively open and close connections between applied power and external load.

The unit shall generate its own internal DC power from the AC line.

The unit shall commence flashing operation when AC power is applied providing 50 to 60 flashes per minute, per switch, with a 50 percent duty cycle.

Each switch shall have an OFF state dV/dt rating of at least 200 Volts per microsecond.

An indicator showing the switch's output state shall be provided. The two indicators shall be centered with 1 inch minimum spacing.

Each circuit shall be designed to operate in an open-circuit condition without load for 10 years minimum.

A surge arrestor shall be provided between AC (pin 11) and Flasher Output (pins 7 & 8).

The arrestor shall meet the following requirements:

Recurrent Peak Voltage	212 Volts
Maximum Energy Rating	50 Joules
Average Power Dissipation	0.85 Watts

(H) Remote Management Power Strip:

A remote management power strip shall be included in the cabinets.

The remote management power strip shall be a non-surge protected power strip rated for an operating temperature range of -34 to 74 degrees Celsius (-30 to165 degrees Fahrenheit) and an operating current of 15 Amps. The power strip shall have a minimum of 4 NEMA 5-20R power outlets, and be rack-mounted with a recess for plug and cord clearance. The power strip shall provide IP network accessibility and support NTP, SNMP, and SMTP protocols. A web interface shall provide status and control of each of the receptacles separately. The system shall be capable of providing email alerts, event log, and scheduling with momentary power cycling.

(I) Detection & Ramp Meter Cabinets:

The Detection & Ramp Meter Cabinets shall be furnished and installed in accordance with the ITS Standard Drawings and in these Specifications. At location where the number of lanes exceed that as shown in the ITS Standard Drawings, the Developer shall coordinate with the cabinet manufacturer to ensure the cabinets are pre-wired to accommodate loops and detectors for all lanes of traffic.

Detection and Ramp Meter Cabinets shall be provided with the following cabinet accessories:

Model 2070 Controller

Inductive Loop Detector Cards

Loop Detector Surge Protector

Power Distribution Assembly (PDA) No. 4

Model 206 Power Supply Module

Input Files “I” and “J”

Model 200 Switch Packs

Model 204 Flasher Units

Additional cabinet accessories shall be furnished and installed when specified on the project plans which include a Remote Management Power Strip.

Detection and Ramp Meter Cabinets shall be capable of operating without a conflict monitor.

Locking star washers shall be included on each terminal block mounting screw. Each terminal of each double-sided terminal block shall contain two terminal screws with a removable shorting bar between the terminal screws. The shorting bar shall be suitable for 22 AWG through 14 AWG wire, and PV 18-6F-M lugs. A removable shorting bar shall be installed between the terminal screws. The terminal number assigned to each terminal shall be clearly and permanently indicated on a marking strip placed on or adjacent to the terminal block.

The main circuit breaker box shall contain the following:

120 VAC, 30 Ampere, socket-mounted, double-pole, single-throw heavy duty relay and socket to serve as the signal power interrupt relay

30 Ampere single-pole breaker

Power line surge protection device

The circuit breaker box shall have nominal dimensions of 10 inches high x 8 inches wide x 4 inches deep. The main circuit breaker shall accommodate service wire as large as No. 2 AWG. The electrical service conductors shall be contained in a flexible conduit as described in the NEC. This conduit shall enclose the service from the entrance conduit to the circuit breaker box. It shall be long enough to be dressed neatly and attached to the side panel.

The flexible conduit shall be equipped with a coupling and a reducer, if necessary, to enable its attachment to the service entrance conduit. Conduit shall extend approximately 6 inches into the service entrance conduit.

(J) CCTV Cabinets:

CCTV Cabinets shall be furnished with pole-mounting hardware. CCTV cabinets shall be provided with one exhaust fan. CCTV Cabinet shall be provided with a power distribution panel including the following:

30 Ampere main circuit breaker

20 Ampere circuit breaker for the cabinet equipment receptacle

20 Ampere circuit breakers for GFCI convenience receptacle

One standard three-wire 20 Ampere duplex outlet

One GFCI three-wire 20 Ampere duplex outlet

Power line surge protection device

Additional cabinet accessories shall be furnished and installed when specified on the project plans which include a Remote Management Power Strip.

743-3 Construction Requirements:

Developer shall install wire, cable, connectors, and other incidental materials necessary to connect equipment to be incorporated in, or connected to the work through the foundation, to the cabinet, to form a fully functional system which meets the requirements of Subsection 731-3.01 of the Standard Specifications. Installation shall include:

Grounding the cabinet to the ground system, using bare, solid 8 AWG soft-drawn copper wire;

Grounding the transformer, if it is on the same foundation as the control cabinet;

Connecting the cabinet to the power source;

Completing fiber optic splices and terminations within the cabinet, as required;

Furnishing and installing necessary mounting hardware (pole-mount, if applicable to specific cabinet type and location).

Developer shall supply Certificates of Compliance for each ITS cabinet and each accessory within a control cabinet at the time of delivery of the ITS cabinet assembly for the following:

Acceptance testing of each supplied component

Physical and functional testing of each module

A minimum of 100-hour burn-in of each module

A minimum of 24 hours of operation of each cabinet

743-3.01 Cabinet Foundations

Foundations shall conform to the requirements of Subsection 731-3.01 of the Standard Specifications. Foundations shall include conduit, conduit fittings and elbows, anchor bolts, conductors, connectors, ground rods, grounding conductors, grounding lugs, and other incidental materials necessary to connect equipment incorporated in, or connected through the foundation, to the cabinet, to form a fully functional system.

If the cabinet will be located on a slope steeper than 3:1, the foundation shall be offset from the pull box along the mainline conduit or other structure so that their locations do not lie on a line perpendicular to the roadway.

Foundations shall be monolithic with the exposed surfaces formed and finished to present a neat, smooth appearance. The bottom of each foundation shall rest on undisturbed earth and the top shall be level. Adjacent concrete maintenance pads shall also meet these requirements.

Forms for the concrete shall be rigid and securely braced in place. Templates shall be used to properly position and hold in place conduit, anchor bolts, and the ground rod. Immediately prior to pouring the concrete, both forms and the earth shall be thoroughly moistened. The concrete shall be allowed to cure at least 12 hours and shall be hardened sufficiently to prevent damage before the forms are removed. Developer shall backfill and build slope in accordance with the RFC Plans and restore the landscaping in areas with no new landscaping.

Grounding shall meet the requirements of Subsection 732-3.03 of the Standard Specifications. Cabinet foundations shall have a copper clad steel ground rod with a minimum diameter of 5/8 inch. The ground rod shall be driven into place through a sleeve in the foundation. The ground rod shall be installed so that it extends into the surrounding undisturbed earth a minimum of 9 feet. The ground rod shall extend approximately 3 inches above the foundation. The ground rod shall be connected to the grounding system using ground clamps on the rod and an approved lug connector in the cabinet. The cabinet shall be grounded with an 8 AWG solid copper wire.

If Developer prefers to use an electrolytic grounding system, it shall be 100 percent self-activating, sealed, and maintenance free. The electrolytic grounding system shall be UL listed with a minimum life rating of 30 years. The electrolytic grounding system shall hygroscopically extract moisture from the air to activate the electrolytic process without additions of chemicals or water. The electrolytic grounding system shall not use hazardous material.

Concrete shall be 3,000 pound per square inch Class S concrete conforming to the requirements of Section 1006. Anchor bolts shall conform to the requirements of Section 606-2.05 and 1004-4. Grounding conductors shall conform to the requirements of Subsection 732-2.01.

743-3.02 Cabinets:

Field wires and power service cables shall be wired to the cabinets as shown in the ITS Standard Drawings and on the RFC Plans. Developer shall connect the cabinet and its accessories to the various field devices to be controlled, to form a fully functional system.

Removable caps shall be placed on unused conduits within the cabinet.

Wire and cable terminations shall only be made at recessed-screw barrier type terminal blocks, unless otherwise specifically noted. No in-line or butt splices shall be made other than at terminal blocks.

Control cabinet equipment shall be mounted on the cage mounting rails as shown in the ITS Standard Drawings, unless otherwise specified.

Equipment, housings, metal conduit, and cabinets (exposed metal, non-current carrying parts) shall be grounded and bonded in accordance with Subsection 732-3.03 of the Standard Specifications and NEC Article 250. The cabinet's ground resistance shall be 25 Ohms or less.

Grounding conductors and bonding jumpers shall be connected by exothermic welding, UL listed pressure connectors, UL listed clamps, or other approved UL listed means. Connection devices or fittings that depend solely on soldering shall not be used. Sheet metal screws shall not be used to connect grounding conductors to enclosures.

On two-door cabinets, the DIN rail shall be attached to the vertical rails serving the "back side" of the cabinet. The "front side" of the cabinet is the side from which controller face and keyboard are viewed. On single-door cabinets, the location for mounting the DIN rail shelf will be as specified by ADOT, to meet specific site equipment space requirements.

Developer shall furnish and install silicone caulking, or other sealant as approved by ADOT, around the base of the cabinet to form a watertight and dust-proof seal.

743-3.02 Cabinet Accessories:

Detector cards and switch packs shall be installed in the appropriate slots in the control cabinet.

(A) Model 2070 Controllers:

Developer shall securely mount the controller unit in the cabinet by firmly attaching it to the cabinet rack with screws. After Developer establishes communications to the controller, ADOT will configure the controller software settings. Developer shall allow a minimum of 10 Days for ADOT to configure the controller software settings.

Ramp meter controllers shall be delivered to ADOT TSMO YM PM02 Basement at 2302 W Durango Street, Phoenix, Arizona 85009 for programming and testing of controllers. The Developer shall notify ADOT TSMO at least 2 Business Days prior to the scheduled delivery of the controllers.

(B) Inductive Loop Detector Cards:

Developer shall set the loop detector card to the following parameters:

Mainline Channels:

Mode: Short Presence

Frequency Level (levels 1, 2, 3, and 4 correspond to low, medium low, medium high, and high, respectively):

U: 1	2U: 3	3U: 2	4U: 4	5U: 1	6U: 3	7U: 2	8U: 4
1D: 2	2D: 4	3D: 1	4D: 3	5D: 2	6D: 4	7D: 1	8D: 3

Sensitivity (set to provide the following call strengths observed under normal traffic):

No vehicle: 0

High Vehicles (Semi-truck, 4x4): 4

Mid-sized Vehicles (car, SUV, small pick-up truck): 5

Low Vehicles (sports car): 6

Entrance Ramp Channels:

Mode: Long Presence

Frequency Level (levels 1, 2, 3, and 4 correspond to low, medium low, medium high, and high, respectively):

ELI: 1	ELQ: 1	ERO: 4
ELO: 2	ERI: 3	ERQ: 2

Sensitivity (set to provide the following call strengths observed under normal traffic):

No vehicle: 0

High Vehicles (Semi-truck, 4x4): 4

Mid-sized Vehicles (car, SUV, small pick-up truck): 5

Low Vehicles (sports car): 6

(C) Remote Management Power Strip:

Remote management power strips shall be horizontally rack mounted below the DIN rail shelf, leaving a single space gap between the DIN rail shelf and the remote management power strip.

743-3.03 ITS Cabinet Assembly Testing Requirements:

ITS cabinet assemblies shall successfully pass the following tests, demonstrating that they operate properly when assembled and connected to the equipment they serve. Developer shall make corrective actions for equipment failing a test.

(A) Stand-Alone Test:

Developer shall perform the stand-alone test under normal traffic conditions and after the ITS cabinet assembly is complete and loop lead-in cables have been connected to the loop detector card.

(1) ITS Cabinet Assembly Test

Developer shall use the ITS Cabinet Assembly Test Form provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to ADOT.

(2) Traffic Volume and Speed Test

Developer shall test the accuracy of the volume data collected by the controller for each loop detector. The controller shall provide volumes accurate between 95 to 105 percent. Accuracy shall be evaluated comparing 20-second volume data reported by the controller to a manual vehicle count during a 15-minute period, or 100 vehicles passing over the loop, whichever comes first. Developer shall record 20-second controller volume and 1-minute manual count volume on the Traffic Volume and Speed Test Form provided at: https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to ADOT. ADOT will add Intelight menu commands to see line speeds.

Developer shall perform the following loop detector speed calibration and test for each mainline lane:

1. Set the trap distance to 18 feet in the controller.

2. Determine the actual speed using a certified radar gun or a vehicle with a calibrated speedometer. If using a vehicle, drive the vehicle past the detector station at a constant maximum safe and legal speed and record the Actual Speed. If using radar, collect radar speeds as vehicles pass over the loops. The person collecting the speeds shall be positioned to collect radar speeds as near to head-on as possible, speeds shall not be collected at an angle exceeding 15 degrees from the line of travel of the vehicle.

3. Record the actual speed

4. Record the speed measured by the controller

5. Perform the following calculation:

$$\text{New Trap Distance (ft)} = \text{Current Trap Distance (ft)} \times \frac{\text{Controller Speed (mph)}}{\text{Actual Speed (mph)}}$$

6. Set the trap distance in the controller to the New Trap Distance.

7. Repeat the previous steps as necessary until the controller indicates accurate speeds to ADOT's satisfaction.

8. Record the final calibrated speed trap distance on the Traffic Volume and Speed Test Form provided at:

   https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to ADOT.

(3) Ethernet Switch Test

Developer shall use the Ethernet Switch Test Form provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to ADOT.

(B) Subsystem Test (SST):

ADOT, with the support of Developer, will conduct the subsystem test on the ITS cabinets and communications system to verify that communications circuits (Developer-installed and existing equipment and connections) are properly configured and operate without failure and without adversely affecting the existing system. The SST shall start on a Monday, Tuesday, or Wednesday and shall be conducted for 3 consecutive days.

A communication failure to detection or ramp meter cabinet shall include receiving traffic data for less than 4,104 of the 4,320 (95 percent) 20-second intervals in a day.

Developer shall repair or replace components that fail the SST and the test shall be restarted on a Monday, Tuesday, or Wednesday and be conducted for 3 consecutive days. Developer shall supply test equipment requested by ADOT to troubleshoot the system.

(C) System Acceptance Test (SAT):

Upon successful completion of subsystem testing, the SAT shall be started. The SAT shall consist of a 30 consecutive day period of operation without failure of all Developer-supplied and approved relocated equipment. Developer shall ensure that all equipment is ready for testing prior to submission for ADOT's testing and acceptance.

The SAT shall not start without providing the required ITS documentation and delivering red lines identified in Section 751 of this TP Attachment 700-4 to ADOT. GPS data shall be submitted and

approved by ADOT prior to beginning the SAT for the periods specified in the ITS Record Documentation item.

The purpose of the SAT is to demonstrate that the total system, consisting of hardware, software, communications, materials and construction, is properly installed, is free from defects and problems, exhibits stable and reliable performance, and complies with contract documents.

During the SAT, Developer shall maintain equipment in an operable condition and ADOT personnel shall be provided access to the equipment. Developer shall identify, isolate, diagnose, and troubleshoot system problems and inconsistencies. Developer shall provide test equipment and labor needed to test, isolate and correct equipment deficiencies found during the SAT. Developer technical personnel having industry standard certification in the field of the design and construction of each system component shall be available on site within 48 hours of notification of a problem. Developer, in conjunction with ADOT, shall formulate possible solutions and shall implement corrections required in Developer-supplied equipment.

During the SAT, Developer shall record test failures on the System Acceptance Test Failure Log provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and immediately submit the form to ADOT. After the repair has been completed, an updated form shall be submitted to ADOT. Documentation errors, omissions, and changes occurring prior to, and during, the SAT shall be corrected and resubmitted before the SAT is completed.

(1) SAT Minor Failure

In the event of a minor failure during the SAT, the test clock shall stop until the system is repaired. Upon completion of the repair, testing shall resume with 24 hours added to the remaining test time of the system. The following constitutes a minor failure:

- Failure to communicate to a controller.
- Failure to receive traffic data for less than 4,104 of the 4,320 (95 percent) 20-second intervals in a day.

(2) SAT Major Failure

In the event of a major failure during the SAT, the test clock shall stop until the system is repaired. Upon completion of the repair, testing shall resume with the test clock reset to day zero. The following constitute a major failure:

- Third failure to communicate to an individual controller.
- Third failure to receive traffic data from an individual controller for less than 4,104 of the 4,320 (95 percent) 20-second intervals in a day.
- Failure to correct an issue within 4 hours of being notified by ADOT.

Equipment lists and equipment submittals shall conform to the general requirements of these Specifications.

SECTION 744 LOAD CENTERS, TRANSFORMERS AND FOUNDATION

744-1 Description:

The work under this item includes furnishing and installing load center cabinets, load center cabinet foundations and modifying existing load center cabinets for ITS applications.

744-2 Materials:

Load center cabinets shall meet the requirements of Subsection 736-2.03 of the Standard Specifications as modified by this TP Attachment 700-4. Electrical service risers, riser strapping, meter socket and service-side enclosure shall meet the requirements of the electrical service provider. Electrical components shall be UL listed.

Type II load center cabinets shall conform with ADOT Standard Drawings T.S. 3-1 and FM-3.18. Type IV load center cabinets shall conform with ADOT Standard Drawings FM-3.19 and FM-3.20.

Load center cabinets shall include circuit breakers, internal wiring, meter socket, electrical service riser, transformer, and other incidental materials. Photoelectric lighting controls shall be omitted. There shall be no shelves in the interior of the cabinet.

The cabinet and door shall be constructed from 5052-H32 sheet aluminum alloy with a thickness of 0.125-inches. Welds shall be neatly formed and free of cracks, blow holes, and other irregularities. Inside and outside edges of the cabinet shall be free of burrs. The cabinet shall have a sloped top to prevent the accumulation of water. The outside surface of the cabinet shall have a smooth, uniform, natural, aluminum finish. The doors shall have signs stating "Danger High Voltage".

The door opening(s) shall be double flanged on all four sides to increase strength around openings and keep dirt and liquids from entering the enclosure when the door is opened. A two-position door restraint on each door shall be provided, to hold the door open at 90 degrees in a 60-mph wind acting at an angle perpendicular to the plane of the door. The restraint shall hold the door open at 90 ±10 degrees and at 180 ±10 degrees. The door shall be furnished with a gasket that satisfies the physical properties as found in UL508 Table 21.1 and shall form a weather tight seal between the cabinet and door.

Door hinges shall be continuous and welded to the inside of the door and cabinet and bolted to the outside of the cabinet and door using twenty 0.125-inch stainless steel carriage bolts and nylon insert lock nuts. The hinges shall be made of 0.093-inch thick aluminum and shall have a 3-inch open width with a 0.25-inch diameter stainless steel hinge pin. The hinge pin shall be capped top and bottom by weld to render it tamper proof.

The latching mechanism shall be a 3-point draw roller type. The center catch and push- rods shall be cadmium plated, Type II Class 1. Push-rods shall be turned edgewise at the outward

supports and shall be 0.25-inch by 0.75-inch steel, minimum. Rollers shall have a minimum diameter of 0.75-inches and shall be made of nylon. The center catch shall be fabricated from 0.140-inch steel, minimum.

A stainless-steel handle with a 0.75-inch diameter shank shall be furnished. The latching handle shall have a provision for padlocking in the closed position. The lock shall be consistent and compatible with current ADOT maintenance keys. The key shall be removable only in the locked position. One key shall be furnished with each lock. All parts of the locking mechanism shall be stainless steel. The locks shall have rectangular spring-loaded bolts.

A cabinet exhaust fan meeting the requirements of Subsection 734-2.03 (D) shall be mounted on top.

Load center cabinets shall have a dead front panel to isolate all live electrical circuitry. The panel shall be fabricated from 14-gage sheet steel. The dead front panels shall be hinged on one side and securely fastened on the other with bolts. Switches, breakers and other components shall have openings to operate from the front panel.

All electrical components in the load center assembly shall be UL listed.

Switches, breakers and other components shall have openings to operate from the front panel.

Foundations shall conform to the requirements of Subsection 731-3.01 of the Standard Specifications and this TP Attachment 700-4. Foundations shall include conduit, conduit fittings and elbows, anchor bolts, conductors, connectors, ground rods, grounding conductors, grounding lugs, and other incidental materials necessary to connect equipment incorporated in, or connected through the foundation, to the cabinet, to form a fully functional system.

Concrete shall be 3,000 pound per square inch Class S concrete conforming to the requirements of Section 1006 of the Standard Specifications. Anchor bolts shall conform to the requirements of Section 606-2.05 and 1004-4 of the Standard Specifications. Grounding conductors shall conform to the requirements of Subsection 734-3.03 of the Standard Specifications.

(A) Cabinets:

The enclosure shall be a NEMA 3 single door ventilated cabinet. Overall appearance and dimensions shall be as shown in the ITS Standard Drawings.

Cabinets shall be designed for mounting on a concrete foundation using anchor bolts of size and placement as shown in the ITS Standard Drawings.

The cabinet and door shall be constructed from 5052-H32 sheet aluminum alloy with a thickness of 0.125-inches. All welds shall be neatly formed and free of cracks, blow holes, and other irregularities. All inside and outside edges of the cabinet shall be free of burrs. The cabinet shall be designed with a sloped top to prevent the accumulation of water on its top surface. The outside surface of the cabinet shall have a smooth, uniform, natural, aluminum finish. The doors shall have signs stating "Danger High Voltage".

The door opening shall be double flanged on all four sides to increase strength around openings and keep dirt and liquids from entering the enclosure when the door is opened. A two-position door restraint on each door shall be provided, to hold the door open at 90 degrees in a 60-mph wind acting at an angle perpendicular to the plane of the door. The restraint shall hold the door open at 90 ±10 degrees and at 180 ±10 degrees. The door shall be furnished with a gasket that satisfies the physical properties as found in UL508 Table 21.1 and shall form a weather tight seal between the cabinet and door.

Door hinges shall be continuous and welded to the inside of the door and cabinet and bolted to the outside of the cabinet and door using twenty 0.125-inch stainless steel carriage bolts and nylon insert lock nuts. The hinges shall be made of 0.093-inch thick aluminum and shall have a 3-inch open width with a 0.25-inch diameter stainless steel hinge pin. The hinge pin shall be capped top and bottom by weld to render it tamper proof.

The latching mechanism shall be a 3-point draw roller type. The center catch and push- rods shall be cadmium plated, Type II Class 1. Push-rods shall be turned edgewise at the outward supports and shall be 0.25-inch by 0.75-inch steel, minimum. Rollers shall have a minimum diameter of 0.75-inches and shall be made of nylon. The center catch shall be fabricated from 0.140-inch steel, minimum.

A stainless-steel handle with a 0.75-inch diameter shank shall be furnished. The latching handle shall have a provision for padlocking in the closed position. The lock shall be consistent and compatible with current ADOT maintenance keys. The key shall be removable only in the locked position. One key shall be furnished with each lock. All parts of the locking mechanism shall be stainless steel. The locks shall have rectangular spring-loaded bolts.

Cabinet ventilation shall be provided by louvered vents in the front door with a removable pleated paper air filter. The filter shall cover the vents and shall be held firmly in place with bottom and top brackets and a spring-loaded upper clamp. Exhaust air shall be vented out between the top of the cabinet and the door. The exhaust area shall be screened with a material having a maximum hole diameter of 0.125 inches.

A 12-gauge steel plate or panel board shall be attached with six 3/8-inch mounting studs welded to the back wall of the cabinet for mounting the transformer. Appropriately sized carriage or lag bolts shall be used to attach the transformer at the top and bottom. The transformer shall be mounted 4 inches from the top of the plate and centered from side to side.

(B) Transformer:

Transformers shall be new. Transformers shall conform to paragraphs 2.1.3 and 2.1.5 in Section 2 of the current NEMA Standards Publication TR-1-2013, and to other applicable NEMA standards (i.e., NEMA ST 20), UL (i.e., UL-506), EIA, and ts.

Transformers of the same type shall be identical and interchangeable. The transformer overall dimensions, physical outlines, and mounting hole dimensions shall be shown on the RFC Plans as approved by ADOT. Transformers shall be single-phase, dry type units. The transformer primary and secondary voltages shall be as shown on the project plans. The mass of the transformer shall not exceed 250 pounds and shall be wall mounted. The transformer shall be

labeled either “step-up” or “step-down” and the incoming (primary winding) and outgoing (secondary winding) voltages shall be clearly identified on the exterior. Transformers shall be of low-noise and sound levels shall not exceed 40 dB for transformers rated below 10 kVA, and shall not exceed 45 dB for transformers rated 10 kVA and higher. Transformers shall be provided with two 2 ½ percent taps above nominal voltage (Full Capacity Above Nominal - FCAN) and four 2 ½ percent taps below (Full Capacity Below Nominal - FCBN).

The core volume shall allow operation at 10 percent above rated primary voltage at no load, without exceeding a temperature rise of 207 degrees Fahrenheit. All core laminations shall be oxide or varnish coated, annealed, free of burrs, and properly assembled to reduce noise and ensure efficient operation of the transformer.

Coil conductors shall be continuous with terminations brazed or welded without auxiliary flux material. The entire core and coil assembly shall be impregnated with varnish and cured to seal out moisture. Coils shall be protected with an outer layer of glass tape or similar quality insulation. Coils shall incorporate an electrostatic shield located between primary and secondary windings.

744 - 3 Construction Requirements:

Developer shall coordinate with the electrical service provider, local Governmental Entity and ADOT to identify service locations, determine electrical service addresses, comply with electrical service provider requirements, and verify electrical service provider approval of the load center cabinet equipment and installation methods proposed.

The load center cabinet shall be installed at locations as shown on the RFC Plans.

Removable caps shall be placed on unused conduits within the cabinet.

Developer shall furnish and install silicone caulking, or other approved sealant around the base of the cabinet to form a watertight and dust-proof seal.

Developer shall furnish and install pressure-sensitive, permanent identification decals on load center cabinets, as shown in the ITS Standard Drawings. The decals shall be 3- inch tall, Series C, Gothic letters and shall be engineer-grade, glass-beaded, reflective black letters on a silver or chrome background.

Existing load center cabinets to remain shall remain in service for items and devices served in the existing condition.

Developer shall install wire, cable, connectors, and other incidental materials necessary to connect equipment to be incorporated in, or connected to the work through the foundation, to the cabinet, to form a fully functional system.

If the cabinet will be located on a slope steeper than 3:1, the foundation shall be offset a minimum of 5 feet from the pull box along the mainline conduit or other structure so that their locations do not lie on a line perpendicular to the roadway.

Foundations shall be monolithic with the exposed surfaces formed and finished to present a neat, smooth appearance. The bottom of each foundation shall rest on undisturbed earth and the top shall be level. Adjacent concrete maintenance pads as shown on the ITS Standard Drawings shall also meet these requirements**.**

Forms for the concrete shall be rigid and securely braced in place. Templates shall be used to properly position and hold in place conduit, anchor bolts, and the ground rod. Immediately prior to pouring the concrete, both forms and the earth shall be thoroughly moistened. The concrete shall be allowed to cure at least 12 hours or as specified for class provided, whichever is longer, to prevent damage before the forms are removed. Developer shall backfill and build slope in accordance with the plans and restore the landscaping.

Grounding shall meet the requirements of Subsection 734-3.03 of the Standard Specifications. Cabinet foundations shall have a copper clad steel ground rod with a minimum diameter of 5/8 inch. The ground rod shall be driven into place through a sleeve in the foundation. The ground rod shall be installed so that it extends into the surrounding undisturbed earth a minimum of 9 feet. The ground rod shall extend approximately 3 inches above the foundation. The ground rod shall be connected to the grounding system using ground clamps on the rod and an approved lug connector in the cabinet. The cabinet shall be grounded with a 8 AWG solid copper wire.

If Developer prefers to use an electrolytic grounding system, it shall be 100 percent self-activating, sealed, and maintenance free. The electrolytic grounding system shall be UL listed with a minimum life rating of 30 years. The electrolytic grounding system shall hygroscopically extract moisture from the air to activate the electrolytic process without additions of chemicals or water. The electrolytic grounding system shall not use hazardous material.

The transformer cabinet assembly shall be installed at design locations as shown on the RFC Plans, and as approved by ADOT.

Developer shall measure the secondary voltage after installation. If the secondary voltage is found to be more than 3 percent above or under nominal operating voltage during loaded and unloaded conditions, Developer shall connect to the appropriate taps on the transformer to supply output voltage within 3 percent of nominal voltage under loaded and unloaded conditions.

Removable caps shall be placed on unused conduits within the cabinet.

Developer shall furnish and install silicone caulking, or other approved sealant around the base of the cabinet to form a watertight and dust-proof seal.

SECTION 745 ELECTRICAL CONDUCTORS FOR ITS

745-1 Description:

The work under these items shall consist of furnishing and installing electrical conductors for ITS elements at the locations designated on the RFC Plans and in accordance with the details shown on the RFC Plans and the requirements of this TP Attachment 700-4.

745-2 Materials:

Electrical conductors shall conform to Section 732 of the Standard Specifications, unless otherwise specified. Conductors shall conform to the requirements of the following table, unless otherwise specified.

CONDUCTOR TABLE						
CIRCUIT	FUNCTION	INSULATION		CONDUCTOR		
		COLOR	TYPE	Minimum Thick. (MILS)	Minimum Gauge (AWG)	TYPE
Ramp Meter Signals	Red #1 Red #2 Green #1 Green #2 Common Spare Spare	Red Blue Green Orange White Black White/Blk			#14	IMSA 19-1
Ramp Meter Flashers	Beacon Common Spare Spare	Red White Green Black			#14	IMSA 19-1

CONDUCTOR TABLE						
CIRCUIT	FUNCTION	INSULATION		CONDUCTOR		
		COLOR	TYPE	Minimum Thick. (MILS)	Minimum Gauge (AWG)	TYPE
Common	Common Lead	White	THW	45/60	AS	AS
Spares	Unused Leads	Varies	Varies		AS	AS
Detection	Detector Roadway Loops, Saw Cut	Black, in Orange Tubing	PE in PVC or PE Tubing	15 31	#14 Stranded	IMSA 51-7
Detection	Detector Roadway Loops, Pre-formed	Black, in Orange Tubing	TFFN in PVC or PP Tubing	AS	#16 Stranded	

CONDUCTOR TABLE						
CIRCUIT	FUNCTION	INSULATION		CONDUCTOR		
		COLOR	TYPE	Minimum Thick. (MILS)	Minimum Gauge (AWG)	TYPE
Detection	Loop Detector Lead-In Cable	Black/ Natural	PE Alum/ Mylar Tape Shield		#14	IMSA 50-2
	Service Service Common Bond	Black White Green or Bare	THW THW THW	AS AS AS	AS AS AS	
Legend: AS = As Specified; PP = Polypropylene; STP = Stranded Twisted Pair; S4C = Stranded 4 Conductor						

In ramp meter conduits, the bond conductor shall have green insulation with the insulation removed within pull boxes from the point where it leaves the bell end of the conduit.

Conductor and cable tagging shall conform to the requirements of Subsection 732-2.01 (A) (2) of the Standard Specifications, unless otherwise specified. Tags shall have the capability of being moved along the conductor or cable during future alterations.

745-3 Construction Requirements:

Wiring procedures for conductors and cables shall conform to the requirements of Subsection 732-3.02 of the Standard Specifications, unless otherwise specified.

Electrical conductors that are left un-terminated shall be made waterproof.

Bonding and grounding shall conform to Subsection 734-3.03 of the Standard Specifications and the requirements of the plans and these Specifications.

Metal enclosures, cabinets, pedestals, poles, metal pull box lids, metal conduit, and metal cable sheaths shall be bonded to form a continuously grounded system. Non-metal portions of the system such as PVC or HDPE conduit shall have a bare copper bond wire or a green insulated copper bond wire installed with suitable connections to form a continuously grounded system.

Cables, conductors, pull tape, and innerducts within the same conduit or innerduct shall be installed at the same time.

Where cables or conductors are to be installed in conduit with existing cables or conductors that will remain, Developer shall disconnect, remove, reinstall, reconnect and test the existing cables and conductors in accordance with the testing requirements of the applicable device being connected or as determined by ADOT. Developer shall be responsible for damage to existing cables or conductors caused by this operation. Existing cables or conductors shall be considered in good condition unless Developer demonstrates otherwise to ADOT as part of the ITS Inventory and prior to ITS Work.

Excess cable length within No. 9 pull boxes shall be loosely coiled into a circular shape and attached to the rack and hook system integral to the wall of the No. 9 pull box with industry standard nylon cable ties. Cables shall be coiled independently from one another and secured with separate cable ties for each coil. Cable ties shall be tightened to prevent cable slippage, but shall not deform or damage the cable sheath.

Tags shall be installed on conductors and cables inside pull boxes near the pull box entrance and exit, inside cabinets and enclosures. Tags shall be labeled with the following fields, as applicable:

Tag Field 1: Responsible Agency (use only if agency is not ADOT)

Examples:	Applications:
MCDOT	Maricopa County Department of Transportation

Tempe	City of Tempe

Tag Field 2: Description

Examples:	Applications:
SMFO144 SMFO12	144-strand single mode fiber optic cable 12-strand single mode fiber optic cable
AWG6	American Wire Gauge 6
IMSA7	IMSA 19-1, 7-conductor
LOOP 1U	lane 1 upstream loop detector (other loop designations per Standard Drawing FM-5.01)
CCTV	CCTV cable
DMS	DMS cable

Tag Field 3: Termination

Examples:	Applications:
NODE 12	to node 12
EB TRUNK LINE	fiber optic branch to trunk line on EB side
CAB 3118253	to cabinet #3118253
LC 3118256	to load center #3118256

SIGNAL	to a signal cabinet
EB DMS	to eastbound DMS
LEFT RM	To left side ramp meter pole
WB WW SIGN	To wrong way sign on westbound exit ramp

A continuous cable passing through a pull box shall have two tags which will be the same except with different termination descriptions. Multiple power conductors that go to one load center shall be bundled together and have one tag that indicates the load center cabinet number in the termination field. Multiple power conductors that go to different cabinets shall be bundled and tagged in conductor pairs according to the cabinet they go to.

Tagging shall be recorded by Developer in a Record Drawing Cable Schedule and include the distance marking on the cable at the entrance to a pull box, cabinet, or other termination point. The Record Drawing Cable Schedule shall be provided to ADOT with the ITS Final Compiled Documentation.

Cables and conductors to be removed shall be identified and marked at intermediate pull boxes for ADOT approval prior to removal. After ADOT approval, cables and conductors to be removed shall be cut at intermediate pull boxes prior to removal. Conduits to remain empty for future use shall have detectable pull tape installed.

At least 10 Days prior to disconnecting existing conductors or cables, Developer shall submit a schedule for disconnection, removal, reinstallation, reconnection, and testing for ADOT approval.

SECTION 746 LOOP DETECTION

746-1 Description:

The work under these items includes furnishing, installing and testing loop detectors and loop detector lead in cables, as shown on the RFC Plans and in this TP Attachment 700-4.

746-2 Materials:

All work shall conform to Section 735 of the ADOT Standard Specifications, the ITS Standard Drawings, the RFC Plans, and this TP Attachment 700-4.

Developer shall furnish Certificates of Compliance for loop detector materials which shall include certification that the batches furnished were manufactured under the same conditions as the batches tested.

(A) Loop Wire:

Loop detector lead-in cable shall be 14 AWG conforming to IMSA 50-2. Loop detector wire shall be 14 AWG HDPE polyethylene insulated conductors conforming to IMSA 51-7.

(B) High Temperature Backer Rod:

High Temperature backer rod shall be a round foam material rated to withstand a minimum temperature of 400 degrees Fahrenheit. The diameter of the backer rod shall be sized according to the width of the saw cut as follows:

Saw Cut Width (inches)	Backer Rod Diameter (inches)
1/4	3/8
3/8	1/2
1/2	5/8
3/4	7/8
7/8	1
1	1 1/4
1 1/8	1 1/2
1 5/8	2

(C) Loop Slot Sealant:

Developer shall furnish and install loop slot sealant, depending on the pavement surface to be sealed, to seal the loop slots and surface hole of the home run conduit. Loop slot sealants shall be a flexible encapsulant designed for sealing and protecting loop detector wires installed in saw cuts. Developer shall provide the expiration date of the sealant with the material submittal.

(1) Two-Part Epoxy Filler Sealant:

Two-part epoxy joint filler sealant shall be a 100-percent solids, flexible, two-component, solvent free, epoxy resin/hardener system for use as a saw cut sealant in asphaltic concrete pavements and Portland cement concrete pavements.

Materials shall comply with the requirements of Subsection 1015-1 of the Standard Specifications.

The epoxy system shall be specifically designed for the intended application according to the product literature provided by the manufacturer.

The epoxy system shall be of sufficient strength and hardness to withstand stress and abrasion from vehicular traffic, while remaining flexible enough to provide stress relief under thermal movement and protect the loop wire from moisture penetration. It shall also be moisture insensitive to allow effective application to damp pavements. No standing water is permitted on the surfaces to which the epoxy system is to be applied.

The epoxy system shall be designed to enable vehicular traffic to pass over properly filled saw cuts immediately after installation without tracking or stringing of the material.

Properly installed and cured epoxy systems shall exhibit resistance to the effects of weather, motor oils, gasoline, anti-freeze solution, brake fluid, deicing chemicals, and salt in such a manner that the performance of the loop detector wire is not adversely affected.

The epoxy system shall be designed for roadway installation when the surface temperature is a minimum of 40 degrees F and rising. The cured epoxy system shall be temperature stable and exhibit no degradation in performance throughout the ambient pavement temperature ranges experienced within the State of Arizona.

The components of the epoxy system shall have a minimum shelf life of 12 months in original unopened, undamaged containers, when stored in a cool dry environment, as recommended by the manufacturer.

The epoxy system shall meet the following requirements:

Property	Test Method	Requirements
Mixing Ratio; Part A to Part B	-	1 to 1 by volume
Viscosity, centipoises	ASTM D 2393-86	4000 to 8000
Pot Life, minutes	ASTM C 881	12 to 20

Cure Time, minutes	ASTM C 679	60 maximum, Tack Free
Hardness (Shore D)	ASTM D 2240	35 to 65
Tensile Elongation, percent	ASTM D 638	50 minimum
Water Absorption, percent (24 hrs.)	ASTM D 570	1 maximum
3 percent Salt Water Absorption, percent (24 hrs.)	-	0.03 to 0.20
Oil Absorption, percent (24 hrs.)	ASTM D 471	0.01 to 0.02
Gasoline Absorption, percent (24 hrs.)	-	0.05 to 0.90

(2) One-Part Elastomeric Sealant:

One-part elastomeric sealant may be used to seal saw cuts in Portland cement concrete pavement and lean concrete base.

The sealant shall provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in concrete pavements, while protecting the loop wire from moisture penetration.

The encapsulant shall be a one-part elastomeric compound requiring no mixing, measuring or application of heat prior to or during its installation.

The encapsulant shall, within its stated shelf life in original undamaged packaging, cure only in the presence of moisture. The rate of cure will, therefore, depend upon temperature and relative humidity at the time of installation. Cool dry weather will slow curing whereas warm, humid weather will accelerate curing. The encapsulant shall have a minimum 12-month shelf life in undamaged original containers when stored in a cool, dry environment.

The encapsulant shall form a surface skin allowing exposure to vehicular traffic within 30 minutes at 75 degrees F without tracking or stringing of the material, and completely cure to a tough, rubber-like consistency within 2 to 7 Days after installation.

Properly installed and cured encapsulant shall exhibit resistance to effects of weather, vehicular abrasion, motor oils, gasoline, anti-freeze solution, brake fluid, deicing chemicals and salt

normally encountered, in such a manner that the performance of the loop detector wire is not adversely affected.

The cured encapsulant shall be temperature stable and exhibit no degradation in performance throughout the ambient pavement temperature ranges experienced within the State of Arizona.

The encapsulant shall exhibit minimal shrinkage during or after its installation, and in no manner affect the performance characteristics of the material.

The encapsulant shall be designed to permit clean-up of material and application equipment, prior to curing of the encapsulant, with a suitable non-flammable solvent. Should encapsulant material be allowed to cure in the application nozzle, it shall be able to be pulled out as a solid plug.

The encapsulant shall be designed for roadway installation when the surface temperature is between 40 and 140 degrees F.

The encapsulant shall have the following physical properties in its uncured and cured states.

Uncured (Wet) Encapsulant		
Property	Requirement	Test Procedures
Weight	10.1 ± 0.3 pounds/gallon	A. Weight/Gallon
Total Solids by Weight	75 – 85 percent	B. Determination of Non-Volatile Content
Viscosity	10,000 - 85,000 centipoise	C. Dynamic Viscosity
Drying Time	Touch: 24 hrs. maximum Complete: 30 hrs. maximum	D. Tack-Free Time
Cured Encapsulant		
Property	Requirement	Test Procedure

Hardness (Indentation)	65 – 85	E. Rex hardness
Tensile Strength	500 psi minimum	F. Tensile & Elongation
Elongation	300 percent minimum	

(3) Hot Applied Rubberized Sealant:

Hot applied rubberized sealant may be used to seal saw cuts in asphaltic concrete and in lean concrete base. It shall be suitable for use as a sealant for loop detector saw cuts and be non-tracking under traffic. At application temperatures, the sealant shall be a thin, free flowing fluid which penetrates saw cuts and self-levels permitting uniform application. The sealant shall be melted and applied to pavements using a pressure feed melter unit. Pour pot application is not acceptable. The sealant shall be a relatively stiff sealant but shall remain flexible at low pavement surface temperatures. The test results shall conform to the following specifications for the loop detector sealant.

Test	Specification
Penetration: 125 degrees Fahrenheit, 50g, 5s	50 maximum
Penetration: 77 degrees Fahrenheit, 100g, 5s	10 – 25
Softening Point:	210 degrees Fahrenheit minimum
Ductility: 77 degrees Fahrenheit	15 cm minimum
Mandrel Bend: 0 degrees Fahrenheit, 90 degrees Arc, 10s, 3/4-inch diameter	Pass 2 of 3
Recommended Pour Temp:	380 degrees Fahrenheit
Safe Heating Temp:	420 degrees Fahrenheit

Test	Specification
Brookfield Viscosity: 400 degrees Fahrenheit	7,500 centipoise max.
Unit Weight:	8.5 pounds per gallon
Coverage; 1/2 by 1/2-inch crack	11.0 pounds per 100 feet

Materials shall conform to ADOT Standard Drawings T.S. 6-3 and T.S. 6-4.

746-3 Construction Requirements:

Construction of loop detectors shall conform to the ITS Standard Drawings and project plans. Loop detectors shall not be placed within 6 feet of an adjacent operational loop. The installation of the detectors shall be such that the operation shall not be affected by temperature changes, water, ice, rain, snow, chemicals, or electromagnetic noise. Loop detectors shall be installed prior to chip seal or friction course for asphaltic concrete pavements or Portland cement concrete pavements.

(A) Saw Cut Loops:

Prior to installing the loop wire or lead-in cable, Developer shall saw cut the slots and install associated conduit and pull boxes. New loop detectors shall not be cut in the exact same location as an existing loop detector. Developer shall use clean water to prevent blowing dust while cutting the slots. Developer shall flush the slots, vacuum water out of the slots and from the roadway, and then blow the loop slots with oil free compressed air to dry them and free them from debris, taking necessary safety precautions to avoid flying debris from coming into contact with personnel or vehicles. Debris shall be disposed of in accordance with Section 107.11 of the ADOT Standard Specifications. Developer shall take precautions to keep materials from entering the storm drains. The slots shall be thoroughly cleaned to allow sealant to adhere to the sides of the slot.

Developer shall install the loop wire in the slots without damage to the insulation. Turns of loop wire shall be installed in the same slot. The loop detector wire shall consist of one continuous wire from the pull box, through the loop, and back to the pull box. The top of the upper loop detector wire shall be a minimum of 1 ½ inches below the top of PCCP or Asphalt. Friction course, if present, is not included in the measurement. If the loop detector is installed in reinforced concrete, or is at least 2-inches below the roadway surface, Developer shall install four turns of the loop. The loop detector wire pair shall be twisted together 3 times per foot from the corner of the loop in the roadway to the pull box.

After the loop wire is installed, Developer shall install high temperature backer rod in the saw cut. The backer rod shall be continuous and completely shield the entire length of the loop detector wire from the loop slot sealant.

Developer shall seal the slots with loop slot sealant. Developer shall ensure that the slots are clean and dry with no residue remaining at the time of sealing. Developer shall seal the home run conduit stub out with loop slot sealant. During the sealing operation, the ambient air temperature shall be within the application range specified by the sealant manufacturer. The sealant shall be installed in accordance with the ITS Standard Drawings and in a manner that will fill the slot to its full depth. Developer shall strike off and remove excess sealant and remove it from the site.

(B) Pre-Formed Loops

Pre-formed loops shall be installed in accordance with the ITS Standard Drawings, the RFC Plans and these Specifications.

(C) Lead-in Cable:

Developer shall install lead-in cable between the control cabinet and the nearest pull box adjacent to the loop detector. Developer shall leave 5 feet of coiled slack in the pull box. Lead-in cables shall be unspliced from the loop detector wire to the control cabinet. One lead-in cable shall be provided, per loop, unless otherwise specified. Lead-in cables shall be tagged in the control cabinet and in pull boxes in accordance with this TP Attachment 700-4.

Developer shall solder splice the loop wire to its associated lead-in cable and provide a watertight seal in the pull box. Developer shall connect the lead-in cable to the appropriate loop detector channel in the control cabinet. Spade lugs installed on the loop lead-in cable in the control cabinet shall be crimped and soldered. Solder shall be resin core solder with 60 percent tin and 40 percent lead. Lead-in cables that are not terminated within 1 Day of installation shall have unterminated ends waterproofed.

(D) Loop Detector Test Requirements:

The following tests shall be performed by Developer in the presence of IQF personnel. Developer shall provide traffic control for testing of loop detectors . Developer shall use the Loop Detector Test Form provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to the IQF. The IQF will review the test results and submit the form to ADOT for approval. Developer shall not proceed with other loop detector work until ADOT approves the loop test forms.

(1) Loop Detector Wires Only:

The following tests shall be performed at the pull box on loop detector wire that is disconnected from the loop lead-in cable.

(a) Existing Loop Detectors:

The following tests shall be performed during the facilities inventory on existing loop detectors to be utilized by the project. Testing of existing loop detectors shall be completed prior to other construction activities requiring traffic control. Testing of existing loop detectors shall be accomplished by cutting off the existing lead-in cable splice or waterproofed ends of the loop wire, testing, and resplicing to the existing loop lead-in cable or waterproofing the ends of loop wire of successfully tested loop detectors. Loop detector wire shall not be tested by skinning the insulation. Developer shall install new loop lead-in cable tags where existing tags are missing or do not meet the requirements of these Specifications. Developer shall replace loop detectors and lead-in cables damaged during testing.

Developer shall install new saw cut loop detectors where existing loop detectors to be utilized by the project do not exist or do not pass testing. If a single loop detector within a pair of existing loop detectors (trap) does not pass testing, Developer shall replace both loop detectors.

(b) New Loop Detectors:

The following tests shall be performed twice for each new loop detector, before the loop slot sealant has been poured and after the loop slot sealant has hardened. Developer shall replace or repair loop detector components until the loop detection successfully passes testing.

(i) Resistance to Ground Test:

The resistance to ground shall be measured with a Megohmmeter (Megger) connected between the loop wire and the nearest reliable electrical ground, such as a meter, metal pole, fire hydrant, or to a metal rod driven 3 feet into the ground. The resistance to ground shall be at least 100 megohms at 500 VDC.

(ii) Series Resistance Test:

The series resistance, measured by an ohmmeter, shall be between 0.1 and 0.8 Ohms for a 6 x 6-foot loop, and less than 10 Ohms for other sizes of loops.

(iii) Inductance Test:

The inductance of a loop, measured with an inductance tester, shall be between the following limits:

6' X 6' loop, 3 turns	50 to 100 µH
6' X 6' loop, 4 turns	100 to 155 µH

6 'X 6' loop, 5 turns	200 to 260 µH
6 'X 20' loop, 2 turns	55 to 105 µH
6 'X 20’ loop, 3 turns	125 to 180 µH

(2) Loop Detectors Spliced to Lead-in Cable:

After the preceding tests have been passed, the following tests shall be performed at the control cabinet on the loop lead-in cables. The tests shall be performed with the loop lead-in cable spliced to the loop detector wire and with the with loop lead-in cable disconnected from the loop detector card. The tests shall be performed twice for each loop, once with the splice between the loop detector wire and the loop lead-in cable dry, and once with the splice submerged in water, and has been submerged for at least 1 minute.

(a) Resistance to Ground Test:

Utilizing a Megger, Developer shall verify that the insulation resistance to ground of each lead-in conductor is at least 10 megohms at 500 VDC.

(b) Inductance Test:

The inductance of a loop detector plus the lead-in cable, measured with an inductance tester, shall be between 50 to 490 µH.

Active loop detection within the project limits shall be tested after work is complete which may damage loop detection, such as milling of pavement. Developer shall provide traffic control for testing of loop detectors. Developer shall submit a Loop Detection Test Plan including traffic control plans for review and approval by ADOT. If active loop detection is not shown on the plans, Developer shall coordinate with ADOT to identify active loop detection locations. The test plan shall list active loops to be tested which may include loop detection at entrance ramps, freeway mainline, and in freeway-to-freeway ramps. Inactive loop detection shall not be tested.

Developer shall be accompanied by ADOT personnel during testing.

(3) Loop Detectors Spliced to Lead-in Cable:

The following tests shall be performed by Developer at the control cabinet on the loop lead-in cables in the presence of ADOT personnel. The tests shall be performed with the loop lead-in cable spliced to the loop detector wire and with the with loop lead-in cable disconnected from the loop detector card. After the test is complete, Developer shall reconnect the lead-in cable to return the loop detection system to its previous state.

(a) Inductance Test:

Utilizing a Megger, Developer shall verify that the insulation resistance to ground of each lead-in conductor is at least 10 megohms at 500 VDC.

The inductance of a loop detector plus the lead-in cable, measured with an inductance tester, shall be between 50 to 490 µH.

(4) Loop Detector Wires Only:

The following tests shall be performed if the preceding test failed in order to isolate whether the loop detector or lead-in cable caused the test to fail. The following tests shall be performed at the pull box on loop detector wire that is disconnected from the loop lead-in cable. After the test is complete, Developer shall solder splice the loop wire to its associated lead-in cable and provide a watertight seal using a factory-filled silicon wire nut in the pull box to return the loop detection system to its previous state.

(a) Resistance to Ground Test:

The resistance to ground shall be measured with a Megohmmeter (Megger) connected between the loop wire and the nearest reliable electrical ground, such as a metal pole, fire hydrant, or to a metal rod driven 3 feet into the ground. The resistance to ground shall be at least 100 megohms at 500 VDC.

(b) Series Resistance Test:

The series resistance, measured by an ohmmeter, shall be between 0.1 and 0.8 ohms for a 6’ x 6’ loop, and less than 10 ohms for other sizes of loops.

(c) Inductance Test:

The inductance of a loop, measured with an inductance tester, shall be between the following limits:

6' X 6' loop, 3 turns	50 to 100 µH
6' X 6' loop, 4 turns	100 to 155 µH
6 'X 6' loop, 5 turns	200 to 260 µH
6 'X 20' loop, 2 turns	55 to 105 µH
6 'X 20’ loop, 3 turns	125 to 180 µH

Developer shall prepare a written report detailing the results of the loop detector testing for review by the IQF. The IQF will review the test results and submit the report to ADOT for approval. Developer shall use the Loop Detector Test Form provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to the IQF. Developer shall identify loop detectors failing to pass and the component causing the failure which typically will be the loop detector, splice, or lead-in cable. Repairs identified by Developer are subject to approval by the IQF

Damage to loop detection during construction activities which could have been reasonably avoided by Developer shall be replaced. Developer shall replace loop detectors and lead-in cables damaged during testing.

Developer shall install new loop lead-in cable tags where existing tags are missing or do not meet the requirements of these specifications.

Developer shall install new saw cut loop detectors where existing loop detectors do not pass testing. If a single loop detector within a pair of existing loop detectors (trap) does not pass testing, Developer shall replace both loop detectors. New loop detection shall be tested in accordance with the loop detection specifications.

Developer shall install the new loop at locations designated on the RFC plans. Developer shall maintain a distance of at least 5 feet offset for the new loop from the existing non-functional loop.

SECTION 747 WARNING FLASHER ASSEMBLIES:

747-1 Description:

The work under this item shall include furnishing and installing warning flasher assemblies, as shown on the plans and in this TP Attachment 700-4.

747-2 Materials:

Materials shall comply with Standard Drawing FM 6.01. Materials shall be warranted against all defects in materials and workmanship in accordance with the Contract Documents. Signs shall meet the requirements of Section 608 of the Standard Specifications. Pole foundations shall meet the requirements Section 609 of the Standard Specifications. Poles shall meet the requirements of Section 731 of the Standard Specifications.

Signal indications and mounting assemblies shall meet the requirements of Section 733 of the ADOT Standard Specifications. Signal indications shall be LED modules and meet the requirements of the Institute of Transportation Engineers (ITE), Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement, 2005. The light output of the LED modules shall meet the requirements of Section 4 of the ITE Specification, the 44-point test identified in paragraph 6.4.2.1, and the single point test identified in paragraph 6.4.2.2. LED modules shall include the option listed in Section 5.8 of the ITE Specification and meet the requirements of Technical Note No. 2 of the ITE Specification. LED signal modules shall be a

single, self-contained device with integral power supply and shall be weather tight and fit securely in the housing. LED modules shall not include dimming circuitry. LED modules shall be compatible with Department load switches and conflict monitors. LED signal modules shall be rated for use in the ambient operating temperature range of –40 to +74 degrees C. LED signal modules shall use two color-coded 20 AWG copper wires with 30 mil jacketed insulation rated for 600 Volts AC and 105 degrees C. The wires shall be a minimum of 36-inches long with crimped spade terminal connectors.

The signal indication shall be flashed by the flasher unit supplied in the control cabinet.

747-3 Construction Requirements:

Developer shall connect the warning flasher assembly to the control cabinet in conformance with the RFC Plans to provide a complete and functional ramp meter system. Components shall be supported and installed in accordance with Section 600 of the TPs.

Developer shall test each signal head for accuracy with a IMSA Level II Traffic Signal Field Technician to verify operation before the system is turned over to ADOT for further testing and acceptance. The signal heads shall be bagged until placed into operation.

SECTION 748 RAMP METER SIGNAL ASSEMBLIES:

748-1 Description:

The work under this item shall include furnishing and installing ramp meter signal assemblies, as shown on the plans and in this TP Attachment 700-4.

748-2 Materials:

Materials shall comply with Standard Drawing FM 6.01. Materials shall be warranted against all defects in materials and workmanship in accordance with Contract Documents. Signs shall meet the requirements of Section 608 of the ADOT Standard Specifications. Pole foundations shall meet the requirements Section 609 of the ADOT Specifications. Poles shall meet the requirements of Section 731 of the ADOT Standard Specifications.

Signal indications and mounting assemblies shall meet the requirements of Section 733 of the ADOT Standard Specifications. Signal indications shall be LED modules and meet the requirements of the Institute of Transportation Engineers (ITE), Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement, 2005. The light output of the LED modules shall meet the requirements of Section 4 of the ITE Specification, the 44-point test identified in paragraph 6.4.2.1, and the single point test identified in paragraph 6.4.2.2. LED modules shall include the option listed in Section 5.8 of the ITE Specification and meet the requirements of Technical Note No. 2 of the ITE Specification. LED signal modules shall be a single, self-contained device with integral power supply and shall be weather tight and fit securely in the housing. LED modules shall not include dimming circuitry. LED modules shall be compatible with Department load switches and conflict monitors. LED signal modules shall be rated for use in the ambient operating temperature range of –40 to +74 degrees C. LED signal modules shall use two color-coded 20 AWG copper wires with 30 mil jacketed insulation rated

for 600 Volts AC and 105 degrees C. The wires shall be a minimum of 36-inches long with crimped spade terminal connectors.

748-3 Construction Requirements:

Developer shall connect the ramp meter signal assembly to the control cabinet in conformance with the ITS Standard Drawings, ITS Design Guide and RFC Plans to provide a complete and functional ramp meter system. Components shall be supported and installed to Section 600 of the TPs.

The lower ramp meter head shall be aimed at the location of a driver stopped at the stop bar.

Developer shall test each signal head for accuracy with a IMSA Level II Traffic Signal Field Technician to verify operation before the system is turned over to ADOT for further testing and acceptance. The signal heads shall be bagged until placed into operation.

SECTION 750 CCTV FIELD EQUIPMENT

750-1 Description:

The work under this item shall include furnishing and installing Closed Circuit Television (CCTV) cameras.

750-2 Materials:

CCTV cameras shall be Bosch model MIC-7502-Z30W.

750-3 Construction Requirements:

Developer shall mount the CCTV Camera to the CCTV lowering device in accordance with the requirements of the CCTV camera manufacturer, lowering device manufacturer.

Conductors and cables shall be routed inside the CCTV pole. No cables or conductors shall be exposed, including at the base of the tilt/pan drive and at the entrance to the CCTV cabinet.

Developer shall program the camera with camera ID information, and preset positions. Developer shall coordinate with ADOT to obtain information for programming of the CCTV cameras prior to testing.

750-4 Test Requirements

CCTV camera components will be subject to testing and monitoring to determine conformance with this TP Attachment 700-4 and to ensure proper operation of the equipment and system.

Developer shall provide traffic control for the CCTV testing.

(A) Stand-Alone Tests:

Developer shall test the following stand-alone (non-network) functional operations of the CCTV system:

- Control of focus, optical zoom, digital zoom, iris, pan, and tilt
- Response to automatic preset positioning commands
- Display of Camera ID information
- Presence and quality of video signal during bright sunlight and night conditions
- Lowering device functions properly

For testing purposes, “bright sunlight” conditions shall be defined as occurring between 10:00 AM and 2:00 PM, on a cloudless day. “Night” conditions shall be defined as occurring between one hour after sundown and one hour before sunrise with the moon no more than one-quarter full.

Developer shall use the CCTV Test Form provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and submit a complete and organized set of forms in electronic PDF format to ADOT.

(B) Subsystem Test (SST):

ADOT, with the support of Developer, shall conduct the subsystem test on the CCTV and communications system to verify that communications circuits (Developer installed equipment as well as connections to existing) have been properly configured and operate without failure and without adversely affecting the existing system. The SST shall start on a Monday, Tuesday, or Wednesday and be conducted for 3 consecutive days.

Developer shall replace components that fail the SST and the test shall be restarted on a Monday, Tuesday, or Wednesday and be conducted for 3 consecutive days. Developer shall supply test equipment requested by ADOT for troubleshooting the system.

The CCTV SST test shall verify the following:

- Transmission of high-quality video images to the TOC
- Transmission of control signals to camera
- Positioning of camera from the TOC control panels
- Response to automatic preset positioning commands from the TOC
- Priority and partitioning of commands
- Generation of text, date, and time on monitors

If the video is does not meet the requirements of the test, Developer shall perform video resolution and signal-to-noise ratio testing, in which case Developer shall submit a test procedure to ADOT for approval, prior to the testing.

(C) System Acceptance Test (SAT):

Upon successful completion of the subsystem test, the SAT shall be started. The SAT shall consist of a 30 consecutive day period of operation by ADOT without failure of all Developer-supplied and approved relocated equipment. GPS data shall be submitted and approved prior to beginning the SAT for the periods specified in the ITS Record Documentation item.

The purpose of the SAT is to demonstrate that the total system, consisting of hardware, software, communications, materials and construction, is properly installed, is free from defects and identified problems, exhibits stable and reliable performance, and completely complies with contract documents.

During the SAT, Developer shall ensure that equipment is maintained in operable condition. ADOT personnel shall be provided access to equipment during this period for purposes of verifying its operation. Developer shall identify, isolate, diagnose and troubleshoot system problems and inconsistencies. Developer, in conjunction with ADOT, shall formulate possible solutions and shall implement corrections required in Developer supplied equipment.

Developer shall provide traffic control, bucket truck, test equipment, and labor needed to test, isolate and correct equipment deficiencies found during the SAT. Developer technical personnel having industry standard certification in the field the design and construction of each system component shall be available on site within 48 hours of notification of a problem.

During the SAT, Developer shall record test failures on the System Acceptance Test Failure Log provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and immediately submit the form to the IQF. After the repair has been completed, an updated form shall be submitted to the IQF. The IQF will submit the forms to ADOT for approval. Documentation errors, omissions, and changes occurring prior to, and during, the SAT shall be corrected and resubmitted before the SAT is completed.

System documentation errors, omissions and changes occurring prior to and during the SAT shall be corrected and resubmitted before system acceptance can be completed.

(1) SAT Minor Failure

In the event of a minor failure during the SAT, the test clock shall stop until the system is repaired. At the completion of the repair, the testing shall recommence with 24 hours added to the remaining test time of the system. The following constitute minor failures:

- Failure to receive acceptable CCTV video image at TOC or loss of CCTV control.

(2) SAT Major Failure

In the event of a major failure during the SAT, the test clock shall stop until the system is repaired. At the completion of the repair, the testing shall recommence with the test clock reset to day zero. The following constitute major failures:

- Third failure of the equipment, if determined that failures were caused by faulty installation by Developer.
- Third failure to receive acceptable CCTV video image at TOC or loss of CCTV control of an individual CCTV.
- Failure to correct an issue within 4 hours of being notified by ADOT.

SECTION 751 ITS RECORD DOCUMENTATION:

751-1 Description:

The work under this item shall include maintaining a complete set of ITS record documentation for installation of new, or modifications to existing ITS equipment.

751-2 Construction Requirements:

751-2.01 In-Progress Documentation:

In-progress documentation shall be kept current within 14 Days of ITS Work being performed through Substantial Completion. In-progress documentation shall be provided to ADOT prior to initiation of the required System Acceptance Test (SAT) for that device. In-progress documentation shall include:

- Construction Plans
- Operation Manuals
- Maintenance Manuals
- Equipment Assembly Drawings
- Cabinet and Rack Wiring Diagrams
- Electrical Schematics, Wiring and Logic Diagrams
- System Connection Diagrams
- Fiber Optic Assignments
- Splice Closure Diagrams
- Software Documentation
- Fiber Management Recording
- Communications and Operating Protocols
- Shop Drawings

- Certificates of Compliance
- Warranties
- Parts Lists
- Bore profile of conduits installed by directional drilling

Fiber Management Recording shall be in a format compatible with ADOT's fiber management software. Acceptable manuals shall contain technical operations, maintenance, and troubleshooting information. Advertising brochures and catalog cuts are not acceptable for manuals.

751-2.02 ITS Final Compiled Documentation:

Final acceptance of work in accordance with Contract Documents will not be made until the ITS Final Compiled Documentation has been submitted and has been approved by ADOT.

Developer shall furnish one copy of the ITS Final Compiled Documentation in electronic PDF format, and one printed copy bound in loose-leaf 3-ring binders, grouped logically with printed label tabs.

Developer shall provide one cabinet wiring diagram and fiber optic splice diagram for each control cabinet, labeled with the location name and cabinet number, provided in a weatherproof holder mounted within each control cabinet.

One print of the fiber optic cable connection and splice diagram shall be provided in a weatherproof holder mounted in the pull box with the splice.

Software source code shall be submitted electronically in a format compatible with ADOT's computer system.

Final documentation shall consist of the following documents.

(A) Record drawings:

The record drawings shall include lateral offset dimensions of conduit referenced from back of curb, edge of pavement, barrier, guard rail, bridge wall, or other fixed landmark. The dimensions shall be provided at for new conduit at angle points and tangent sections.

(B) GPS data:

GPS data of new and existing to remain ITS equipment within the project limits shall be collected by an Arizona Registered Land Surveyor, regardless if the equipment was affected by construction. GPS data shall be high-precision corrected, collected with accuracy within 12 inches or less. Developer shall submit a transmittal letter stamped by the surveyor, certifying the accuracy of the GPS survey data. The GPS survey data shall be submitted to ADOT in an Excel spreadsheet with different worksheet tabs for each ITS equipment type listed below.

The GPS survey data for control cabinet foundations for CCTV, DMS, ramp meters, detectors, and traffic signals shall be submitted to ADOT at least 45 Days prior to the start of the system acceptance testing to allow ADOT to integrate the equipment into ADOT's software. The remaining GPS survey data shall be submitted at least 15 Days prior to the start of the system acceptance testing.

The following ITS equipment types and fields shall be collected:

Cabinets:

- Coordinates at center of front door
- FMS Cabinet Identification Number
- MU Cabinet number
- Type: CCTV, DMS, Ramp meter, Detector, Traffic Signal
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

Load Center Cabinets:

- Coordinates at center of front door
- FMS Cabinet Identification Number
- MU Cabinet number
- Type: FMS Load Center
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB
- Street Address:
- Utility Name: APS, SRP, etc.

Node Buildings:

- Coordinates at center of front door
- Node Number:
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

Dynamic Message Signs:

- Coordinates of support foundation on the right side
- DMS ID
- DMS Manufacturer
- Vertical clearance above the roadway measured at the left edge of the catwalk, catwalk at the right edge line, and center of DMS sign.
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

Ramp Meter Signals and Ramp Meter Flashers:

- Coordinates of pole foundation (one point for each pole)
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

Entrance Ramp Queue Loop:

- Coordinates in the center of each loop (one point per loop)
- Loop Size: 6x6
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

Mainline Detection:

- Coordinates in the center of the mainline, centered between loop pairs (one point for all loops)
- Station ID
- Loop Size: 6x6
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

CCTV Poles:

- Coordinates of pole foundation
- CCTV ID
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

Pull Boxes:

- Coordinates in the center of pull box
- Pull box ID
- Type: 7, 7X, 9
- Route Number: examples L-202, I-17, SR-51
- Route direction: NB, SB, WB, EB

(C) Operation Manuals:

Manuals containing a general description and detailed operation and installation instructions shall be provided for each type and model of ITS equipment.

(D) Maintenance Manuals:

Manual containing detailed preventive maintenance and troubleshooting procedures shall be provided for each type or model of ITS equipment. Step-by-step field and bench trouble-shooting procedures shall be included, including normative waveforms and test wattages as applicable. A detailed parts list shall be included. For each part, its circuit or pictorial identification shall be shown, as well as rating information and a manufacturer and associated model or part number.

The list shall include cross-references to part numbers of other manufacturers who make the same replacement part.

(E) Equipment Assembly Drawings:

A drawing showing the physical location and identification shall be for each different electronic unit and each different subassembly of electronic units. Equipment assembly drawings shall be included in the maintenance manual.

(F) Cabinet and Rack Wiring Diagrams:

In addition to the diagram stored in the field cabinet, a wiring diagram shall be provided for each type of cabinet, equipment rack, and junction box containing wire terminals identified by location. The wiring diagram shall depict actual, installed conditions.

(G) System Connection Diagrams:

Connection diagrams for the entire ITS system, including block diagrams, terminal numbers, IP addresses, and conductor color codes shall be cross-referenced to correlate with plan's wiring diagrams. The diagram shall include conduits, pull boxes, detectors, etc.

(H) Fiber Optic Splices and Splice Closures:

Developer shall provide documentation identifying the location and fiber color codes for each field splice performed by Developer. In addition to storing a drawing in each control cabinet, a fiber assignment drawing shall be provided to ADOT for each splice closure throughout the project.

(I) Configuration Information:

Developer shall provide final configuration information for Developer-installed equipment. Configuration information shall include configuration parameters, location, make and model number, serial number, date of installation, vendor, vendor contact information, and warranty expiration date.

SECTION 752 WRONG-WAY DETECTION:

752-1 Description:

The work under this item shall include furnishing and installing a Wrong-way detection (WWD) System including thermal cameras, pole mounted NEMA 3R cabinets, illuminated wrong-way sign assemblies, cabling, connectors, mounting hardware, and accessories required to provide a complete and fully functioning wrong-way detection system integrated with software and equipment used by ADOT. The thermal cameras and pole mounted NEMA 3R cabinets shall be installed on ADOT Type ‘G’ poles unless alternative placement is allowed per the Technical Provisions.

752-2 Functional Requirements

The WWD system shall be capable of:

- Real time detection of wrong way vehicles and bicycles using the ramp. Wrong way bicycles using the ramp can be detected regardless of which lane they are using even if vehicle traffic is present in the correct or wrong way direction of travel.
- Displaying detection zones on the thermal image with associated outputs. Outputs/Inputs status will be indicated on the screen. Parameters will also include the ability to view raw video without any verbiage and/or detectors for surveillance purposes.
- Detecting within its view the presence of vehicles or bicycles in user defined zones. Type of detection capability shall be presence, count, delay, extension, or pulse mode for either arrival or departure of vehicles. Each sensor shall also detect and collect traffic data of passing vehicles in user-defined zones.
- Being programmed remotely with a network connection.
- Storing detector configurations offline.
- Being directionally sensitive. The system shall be omni directional or a sensor that only detects movement: from right to left, left to right, up to down or down to up as seen on the screen.
- Containing a minimum of 8 detection zones per sensor.
- Exporting data to a spreadsheet format, downloadable from a PC.

752-2.01 Event Log Database

The WWD system shall store an onboard database capable of time stamping and storing 500 events. The Event Log Database can be viewed or downloaded as a comma separated value (csv) file and Extensible Markup Language (xml) file. Erasure of the Event Log Database shall not alter programmed configurations. As a minimum, the WWD system shall be capable of logging and time stamping the following events at user selectable intervals between 1 to 60 minutes:

- Firmware upgrade
- Loss of signal
- Resumption of signal
- Configuration change
- Bad thermal quality
- Loss of power to sensor
- Resumption of power to sensor
- Recall activated

752-3 Materials:

All items and materials furnished shall be new, unused, current production models and shall be currently in distribution unless modified by the Technical Provisions. The manufacturer of the detection products shall have a proven track record of traffic detection equipment for more than 20 years.

The Wrong-way detection System shall include the following components:

- Detection Module (Thermal Camera)
- Interface Module
- ADOT Type ‘G’ Poles.
- Pole Mounting Brackets
- BPL Power and Communication Cable
- NEMA 3R Cabinet

Where fiber optic connectivity is required, the system shall also include:

- Fiber Optic Cable
- Patch Panel
- Media Converter
- Switch
- Power Component
- Ethernet Card

752-3.01 Detection Module (Thermal Camera)

The detection module shall be FLIR TraffiSence-2 Thermal Sensor with sunshield.

The sensor shall not depend on any visible or invisible (infrared) illumination or image intensifier to "see" i.e. produce images. The sensor shall be totally passive and not produce any energy or emit light in any bandwidth. The sensor shall allow the user to clearly identify images in the total absence of light.

The sensor shall utilize a Vanadium Oxide (VOx) uncooled microbolometer sensor responding in the LWIR (Long Wave Infrared) spectral range of 7 - 14 ~m, which is beyond what is visible to the human eye.

The sensor shall be based on Vanadium Oxide (VOx) microbolometer detector technology and shall not be susceptible to permanent damage after imaging the sun.

The sensor shall not utilize shutters to prevent damage from the sun, but rather the sensor shall provide uninterrupted video which shall be required for wrong-way detection.

The sensor shall not utilize dynamic apertures to protect the image sensor.

The sensor shall provide a thermal optics that automatically adjust to background thermal changes, and therefore do not require re-adjustment and/or thermal refocusing.

The sensor shall not be susceptible to "image blooming" caused by bright lights as are image intensifiers and visible spectrum cameras.

The sensor shall be factory configured with the following fixed anti-reflection coated Germanium lenses with the Field of View (FOV) and resolutions as indicated:

Device	Resolution (Pixels)	FOV
TrafiSense2 690	640 x 480	90° H x 69° V
TrafiSense2 645	640 x 480	45° H x 35° V
TrafiSense2 632	640 x 480	32° H x 26° V

The sensor shall provide a Noise Equivalent Temperature Difference (NETD) of <50mK f/1.0 or lower.

The sensor shall include Auto Digital Detail Enhancement (Auto DDE), which is an advanced non-linear image processing algorithm to enhance the image detail to match the total dynamic range of the original image allowing details to be visible to the user even in scenes with low or high therma,1 contrast.

The sensor shall utilize Non-Uniformity Correction (NUC) with the following features and benefits:

- Eliminate the need for FPA (Focal Plane Array) temperature stabilization.
- Allow for near instantaneous camera turn-on.
- Reduced system complexity and power consumption.
- Allow for a wider operating temperature range.

The sensor shall include Automatic Gain Control (AGC) circuitry to compensate for scene variations, improve image quality by avoiding saturation and distortion, and to balance signal levels prior to display to maximize image quality.

The Thermal Traffic Camera shall feature both White-Hot and Black-Hot operating modes. In the White-Hot (default) mode warmer objects will be displayed in white and lighter shades than cooler or background areas. In the Black-Hot mode warmer images will be displayed as black or dark grey as compared to cooler background objects.

The sensor shall be furnished in an IP-67 rated outdoor enclosure with mounting bracket. The mounting bracket shall be provided with holes for mounting to a pole, pedestal, or wall mount. All cable connections shall be quick connect. No tools shall be required to connect the sensor once the original adapter has been installed on the wire.

The sensor shall contain a ground conductor which is run as part of the power cable bundle. This ground shall be terminated in the cabinet.

The sensor shall operate on 12-60 VDC.

The sensor shall include a 10-year warranty on the sensor.

The sensor shall meet the following minimum requirements:

Sensor Type	Long-life VOx Uncooled Microbolometer *w/10-year* warranty
Spectral Response	7 to 14IJm
Sensitivity (Thermal Camera sensor)	<50mK *f/1.0*
Pixel Resolution *I* Pitch	640x480 *I* 17 microns
Output (< 1,000 feet) (>1,000 feet)	BPL - Broadband over Power Line Fiber Optic Cable
User Interface	Web Interface
Input Voltage	12-60V DC
Power Consumption	max 9.6W, 400mA@24 VDC
Operating Temperature Range	-34°C to +74°C *I* -29.2°F to +165.2°F (Continuous Operation)
NEMA TS 2	Shall meet requirements of Section 2.1 of NEMA TS 2-2003
Weight	Shall not exceed 1.5kg/3.3lbs (bracket, sunshield, housing sensor and video detection module)
Dimensions	9.8" x 6.3" x 4.7" (nominal, w/ mounting bracket)

752-3.02 EDGE Interface Card

The EDGE interface card and other wrong-way detection equipment shall be housed in a pole mounted NEMA 3R enclosure attached to the ADOT Type ‘G’ pole containing the wrong-way detection camera. The EDGE interface card shall be modular by design and housed in either a self-contained stand-alone unit or fit directly into NEMA TS1 &TS2 type racks or Type 170/2070 input files in the NEMA 3R cabinet. The EDGE card shall be interchangeable between a shelf or rack mount installation without replacing or modifying existing units.

A single EDGE card shall communicate with 1 to 8 sensors and include interface to the agencies existing IP network. Only a single IP address shall be necessary for all sensors and allow for independent streaming of video.

The system shall be designed to operate reliably in the adverse environment of roadside cabinets and shall meet or exceed all NEMA TS1 and TS2, as well as Type 170/2070 environmental specifications.

Ambient operating temperature shall be from -34 to +74 degrees Centigrade (-29.2 to +165.2 degrees Fahrenheit) at 0 to 95% relative humidity non-condensing.

The EDGE interface card shall be connected via RJ45 cable.

The system shall be powered by 12-60 VDC or 12-42 VAC.

Surge ratings shall be set forth in the NEMA TS1 and TS2 specifications.

The EDGE interface board shall have 4 opto-isolated open collector outputs. Twenty-four (24) additional outputs shall be available via the USB expansion port and up to five (5) 4 I/O USB expansion modules.

Must be able to provide loop emulation for presence, bike presence, counting and data collection.

Presence hold time must have parameters that range from 10 to 600 seconds.

Each TI BPL2 EDGE card shall allow for up to 24 digital inputs into the traffic controller via the 4 I/O USB Expansion boards or up to 64 digital inputs into the traffic controller via the PIM Module using an SDLC interface.

Each TI BPL2 EDGE card shall have error detection. Outputs will be turned "ON" if the video signal is bad or the card is not functioning properly. A user defined quality level will automatically put selected outputs to recall in cases of severe degraded visibility such as fog or blizzard. Normal detection shall resume when visibility improves above the user defined thermal quality level.

Using an agencies network, the TI BPL2 Edge card shall be capable of streaming all connected sensors video streams simultaneously via MPEG4/ H.264/MJPEG. These streams shall be available with or without detection overlay.

The n BPL2 EDGE board shall have a reset button on the front panel to reset the thermal sensors to "learn" the roadway image. During "learn", selectable recall shall be capable of being enabled or disabled for immediate operation. Learning time of video detectors shall be less than 6 minutes.

The TrafiSense2 Sensor and TI BPL2 EDGE card shall have internal surge suppression.

The BPL2 EDGE board shall have separate light emitting diodes (LEDs) that indicate:

POWER	LED to verify power and reboot TI board
POWER	LED to verify sensor power and reboot sensors
PIM	Dual color status LED for PIM Connection
OUTPUT Status	LED if the corresponding detection group is active
INPUT Status	LED if the corresponding detection group is active
8 BPL Sensors	Dual color LED Status
RJ45	The TI BPL2 EDGE card has 2 RJ45 connectors
USB	(10/100Mbit/s auto switching)

The 4 I/O USB Expansion board shall also have separate LEDs that indicate:

POWER	Power LED
OUTPUT	LED to indicate Output Status
INPUT	LED to indicate Input Status
Rotary	Rotary Switch that defines output numbers

752-3.03 Video System Communication Module

The Communication board shall be integral with the TI BPL2 EDGE card and fit directly into NEMA TS1 & TS2 type racks or Type 170/2070 input files in the NEMA 3R cabinet.

752-3.04 Image Sensor Mounting Brackets

The mounting brackets shall be capable of mounting the thermal image sensor on ADOT Type ‘G’ poles.

752-3.05 Image Sensor Cable

Power cable shall be installed in conduits or overhead as indicated in the plans. Power cable shall be suitable for exterior use and in direct sunlight. Power cable shall have a minimum of 3 conductors.

The cable shall meet the following requirements:

Conductors/pair count:	3 conductors
Gauge & stranding:	18 AWG minimum, 7-strand Gauge to be determined by distance

Primary insulation type:	Polyvinylchloride
Insulation thickness:	0.015-inch
Color code:	Blue, white, green
Jacket type:	Sunlight resistant direct burial polyvinylchloride
Jacket color:	Black
Jacket thickness:	0.045-inch
Nominal OD:	0.280-inch
Ripcord:	Yes
Voltage rating:	600V
Temp. Rating:	-39°C to 90°C (-38.2°F to 194°F)
Ul type or style:	Type TC or TC-ER
Packaging:	500 feet spools

752-3.06 NEMA 3R Enclosure

NEMA Type 3R Enclosure to be installed on the new ADOT Type 'G' pole shall include a padlock with ADOT masterlock key.

752-3.07 Media Converter

A Media Converter, installed in the NEMA Type 3R Enclosure, shall be provided wherever the camera is connected via fiber optic cable.

752-3.08 Illuminated Wrong-way Sign Assembly

The sign assembly shall include an internally illuminated LED WRONG-WAY sign, flashing LED lights on the border of the sign, sign mounting hardware, electronic components, materials, tools, and labor necessary to provide a complete and fully operational system.

The assembly shall include one 36" x 48 inch" R5-1a "Wrong-way" internally illuminated wrong-way sign. The sign shall include a minimum of 70 red LEDs which illuminate the border of the sign. The sign dimension references the visibly-illuminated portion of the sign panel, and the structural frame of the sign is not included in the dimensions. The LEDs internally illuminating sign panel shall turn on without flashing when the sign is activated. The LED's on the border shall flash at a rate of approximately 60 flashes per minute when the sign is activated. The sign assembly shall be activated for a user-adjustable duration up to 10 minutes triggered by a short pulse contact closure output from the thermal camera system. The sign shall only be activated

when a wrong-way vehicle is detected by the system. The contractor shall furnish electronic components required for the sign including relays, transformers, and flasher.

Components shall be able to withstand and operate at temperature extremes of -22 to +140 degrees F.

All exterior surfaces of the internally illuminated sign shall be powder-coat painted in accordance with Military Standard MIL-C-24712. Finish shall meet the requirements of ASTM D3359, ASTM D3363, and ASTM D552. The internally illuminated sign enclosure shall have a weatherproof design that ensures water does not reach internal components, and shall be able to do so in its design, without the use of silicone. The sign shall have a 3mm or 4mm acrylic front panel that is UV, weather, abrasion and impact resistant. The acrylic panel shall be cyro-acrylite. The front panel shall be replaceable if required. The sign shall be designed and constructed to withstand 150 mph wind loads in conformance with the requirements of the AASHTO publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaries and Traffic Signals," 6th Edition 2013, with 2015 Interim Revisions. Signs shall be tested and certified for the following environmental conditions: Exclusion of Water Test, Strain Relief Test, Temperature Test, Dielectric Voltage-Withstand Test.

The entire surface of the sign panel shall be evenly illuminated with a minimum average brightness reading at the letters of 580 Lux and a variation of no more than 15 percent for any reading from the average (minimum of 50 readings). Each background reading measured shall not vary by more than 10 percent (minimum of 50 readings) from the average of the background brightness readings. The light transmission factor of the sign panel shall provide a letter to a minimum background ratio of 4:1.

The light source for the sign shall be LEDs (light emitting diodes). The LEDs shall evenly illuminate a light panel that is the same dimensions of the sign face. The LEDs shall have a minimum rated lumen maintenance of 70 percent at 60,000 hours (an L70 of 60,000 hours).

Electrical conductors shall enter the sign housing on the side of the sign that is away from traffic lanes or the bottom of the sign. LED single output switching power supply shall be a fully encapsulated, constant- current design built to withstand 300 VAC surge input for 5 seconds, with inherent short circuit/over current/over voltage protection. The Power Supply shall be a UL 1310 Class 2 power unit and shall be housed in a fully isolated plastic case to prevent water intrusion. The sign’s LED single output switching power supply shall be rated for a 1450 mA rated current, a DC voltage range of 9-34 VDC, a power rating of 59.5 Watts, a voltage tolerance of +/- 5.0%percent, an AC current of 0.7Amps at 230VAC, and voltage range of 127 to -370 VDC with 87%percent operating efficiency rating, plus a working temperature of -30 to +70 degrees Celsius. Safety standards shall meet the following criteria: UL1310 Class 2, CAN/CSA C22.2 No. 223-M91 (for LPC-60-1750 only), IP67 approved; design refer to TUV EN60950-1, EN61347-2-13.

The sign manufacturer shall have a demonstrable Quality Assurance Program in place, with proof of regular re-certification by an independent auditing agency. Reports shall be made available upon request.

The sign shall be listed and approved to UL 48 Standards by a Nationally Recognized Testing Laboratory. The outside of the sign shall be marked with a certification mark for Electric Signs UL 48.

The sign sheeting shall have anti-graffiti film applied per the requirements of the sign sheeting manufacturer.

Sign shall have a warranty for a minimum of 5 years.

The sign support hardware shall be certified by the hardware manufacturer that it is structurally adequate and compatible to support the sign assembly considering wind and other loads specified in this TP Attachment 700-4. Manufacturers of sign components shall certify that the components are MUTCD compliant.

ADOT may request one sign assembly to be provided for evaluation and testing for a period of one week prior to approving the material submittal for items related to the sign assembly.

752-4 Construction Requirements:

752-4.01 Thermal Cameras:

Cable from the BPL cameras to the cabinet shall be continuous without splices. The terminal block for the BPL cameras shall be mounted to the side of the NEMA 3R cabinet.

The Developer shall be responsible for ensuring that all necessary features are included when installing the thermal camera detection system as shown on the project plans and in accordance with the requirements of the system manufacturer and these Specifications.

The Developer shall install thermal cameras on new Type G poles or as allowed by the Technical Provisions. Minimum installation height of the camera is 27 feet above the pavement where the detection zone is and shall be confirmed with the thermal camera vendor to achieve optimum viewing angles. Thermal cameras for wrong-way detection shall not be mounted on traffic signal mast arms nor luminaire mast arms.

The Developer shall install the TI BPL2 Edge Interface card and three 4I/O USB expansion cards in the NEMA 3R cabinet housing. The NEMA 3R cabinet shall also include a new 60 VDC power supply and 120 VAC, 15 amp circuit breakers, a 242L DC Isolator, an ethernet media converter and fiber termination unit.

A space shall be provided between equipment installed on DIN rail for air circulation.

The Developer shall install power and communication cables through the FMS conduits as shown on the plans. BPL cables shall run in continuous unspliced lengths between the new thermal cameras and the cabinet.

The Developer shall install cables in the conduit as designated on the approved plans. If the Developer desires to modify which conduits the various cables are installed in, the Developer shall submit their request to ADOT and receive approval prior to installing the cables.

The Developer shall conduct the stand-alone test, subsystem test, and system acceptance test. The Developer shall develop the testing plan and pass/fail requirements and submit to ADOT for approval.

752-4.02 Illuminated Wrong-way Sign Assembly

The illuminated wrong-way sign assembly shall be installed with the bottom of the internally illuminated wrong-way sign 3 feet above the roadway elevation.

Ground for the sign housing and posts shall be provided by a 25-foot coil of # 4 AWG bare copper conductor, or a 14-inch square copper ground plate, installed at the bottom of the foundation for the Type A pole. Electronic components shall be installed in the NEMA 3R cabinet, within the internally illuminated sign housing, or within an enclosure attached to the sign.

The Developer shall perform a field visit together with ADOT or ADOT's designee to precisely locate and stake the sign assemblies considering visibility and site details.

752-4.03 Power Supply Arrangements

The Developer shall obtain power for wrong-way detection including the illuminated wrong-way sign assembly from the nearest load center.

SECTION 753 DYNAMIC MESSAGE SIGNS

753-1 Description:

The work under this item shall include furnishing and installing dynamic message signs (DMS).

753-2 Materials:

The DMS shall be: Daktronics model number VF2420-96X400-20-RGB.

A DMS manufacturer's warranty shall be provided for a period of 2 years staring upon successful completion of the stand-alone test and shall be in accordance with Section 106.13.

The DMS sign shall include manufacturer-supplied power and control cables between the DMS and sign controller, and a manufacturer-supplied control cabinet including the following accessories:

- Sign Controller

- Pullout Drawer
- EIA Equipment Rack
- Ventilation System
- Cabinet lighting
- Main power supply and distribution system
- Photo Sensor Control

Developer shall furnish and install UV-rated flexible metal conduit between the DMS support structure and the DMS sign case. Developer shall furnish and install one 8 AWG green bond conductor between the DMS case and control cabinet conforming to Subsection 732-2.01 of the Standard Specifications. Wiring and grounding shall conform to Section 732-3.03 of the Standard Specifications. All conductors used for power with DMS shall be copper. Aluminum wire shall not be used for DMS.

Developer shall submit shop drawings for each DMS installation conforming to the requirements in the DMS sign structure bid item.

753-3 Construction Requirements:

The control cabinets shall be ground mounted. Developer shall furnish and install silicone caulking, or other approved sealant around the base of the cabinet to form a watertight and dust-proof seal with the foundation.

Developer shall mount communication equipment such as the Ethernet switch, switch power supply, and patch and splice module on the DIN rail shelf leaving a minimum of 5 inches of space for air circulation between devices. Developer shall integrate the communication equipment and DMS sign controller with ADOT's network.

Developer shall install the control and power cables between the DMS and the sign controller in accordance with DMS supplier's recommended routing and installation methods. The power cables shall be terminated by Developer and the control cables shall be left disconnected.

Developer shall arrange, coordinate and provide, for a DMS supplier's field technician to be on-site to field-commission the sign, and initial set-up and testing. The DMS supplier's field technician will terminate and connect the control cables between the DMS and the sign controller during the stand-alone test.

Removable caps shall be placed on unused conduits within the cabinet.

Developer shall record on the plans the vertical clearance above the highest point of pavement and the lowest component of the DMS sign and mounting hardware.

If the DMS will not be operational within 14 consecutive days of installation, Developer shall install ADOT-furnished 36-inch by 36-inch static sign facing traffic with the message "SIGN UNDER TEST". The sign shall be mounted on the vertical member of the DMS support structure with Developer-furnished steel strap or banding. Mounting of the sign by drilling into the support structure is not allowed. Developer shall remove the sign and mounting hardware upon final

acceptance. The sign shall be returned to ADOT after removal. Sign mounting hardware shall become the property of Developer.

Developer shall furnish and install pressure-sensitive, permanent identification decals on the DMS control cabinet, as shown in ADOT ITS Standard Drawings FM-3.13. The decals shall be 3-inch tall, Series C, Gothic letters and shall be top-grade, glass-beaded, reflective black letters on a silver or chrome background.

753-4 Testing Requirements:

(A) Stand-Alone Test:

After Developer has successfully energized all DMS assemblies on the project, the DMS Supplier Testing will be performed by the DMS supplier's field technician. The DMS supplier's field technician will terminate and connect the control cables between the DMS and the sign controller and test functionality of the DMS system.

Developer shall schedule the stand-alone test with ADOT and the DMS supplier at least 4 weeks prior to the desired test date. Developer shall provide the DMS supplier the DMS serial numbers, cabinet serial numbers, and installed locations and mileposts. All DMS assemblies within the project shall be ready for DMS Supplier Testing so Developer's DMS supplier may sequentially perform testing on all DMS assemblies within the project. Developer shall work with the DMS supplier's field technician to troubleshoot and make repairs to the DMS system. Developer shall provide traffic control and a bucket truck with an operator for use by the DMS supplier's field technician during testing.

The DMS supplier shall use their standard test form and submit a complete and organized set of forms in electronic PDF format to the IQF. IQF will submit the form to ADOT for approval.

(B) Subsystem Test (SST):

After successful completion of the above tests, ADOT, with the support of Developer, shall conduct the subsystem test verifying that communication to the sign controller is properly configured and operate without failure or adversely affecting the existing system. The SST shall start on a Monday, Tuesday, or Wednesday and be conducted for 3 consecutive days.

Developer shall replace components that fail the SST and the test shall be restarted on a Monday, Tuesday, or Wednesday and be conducted for 3 consecutive days. Developer shall supply test equipment requested by ADOT to troubleshoot the system.

Developer shall provide traffic control and a bucket truck with an operator for use by the DMS supplier's field technician during the subsystem test. Traffic control will be measured and paid for under their respective traffic control items.

(C) System Acceptance Test (SAT):

Upon successful completion of the subsystem test, the SAT shall be started. The SAT shall consist of a 30-day period of operation without failure of DMS equipment. GPS data shall be

submitted and approved prior to beginning the SAT as per the requirements of Section 116 of the TPs.

The purpose of the SAT is to demonstrate that the total system, consisting of hardware, software, communications, materials, and construction, is properly installed, is free from defects and identified problems, exhibits stable and reliable performance, and complies with contract documents.

During the SAT, Developer shall ensure that equipment is maintained in operable condition. ADOT personnel shall be provided with access to equipment during the SAT for purposes of verifying operation. Developer shall identify, isolate, diagnose and troubleshoot system problems and inconsistencies. Developer, in conjunction with ADOT, shall formulate possible solutions and shall implement corrections required in Developer-supplied equipment. Developer shall provide test equipment and labor needed to test, isolate and correct equipment deficiencies found during the SAT. Developer technical personnel having industry standard certification in the field of the design and construction of each system component shall be available on site within 48 hours of notification of a problem.

During the SAT, Developer shall record test failures on the System Acceptance Test Failure Log provided at:

https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references and immediately submit the form to ADOT. After the repair has been completed, an updated form shall be submitted to ADOT. Documentation errors, omissions, and changes occurring prior to, and during, the SAT shall be corrected and resubmitted before the SAT is completed.

(1) SAT Minor Failure:

In the event of a minor failure during the SAT, the test clock shall stop until the system is repaired. At the completion of the repair, the testing shall recommence with 24 hours added to the remaining test time of the system. The following constitute minor failures:

- Failure of Developer-furnished equipment.
- Failure of an entire communications circuit.
- Failure to communicate to a DMS or an attached confidence camera.

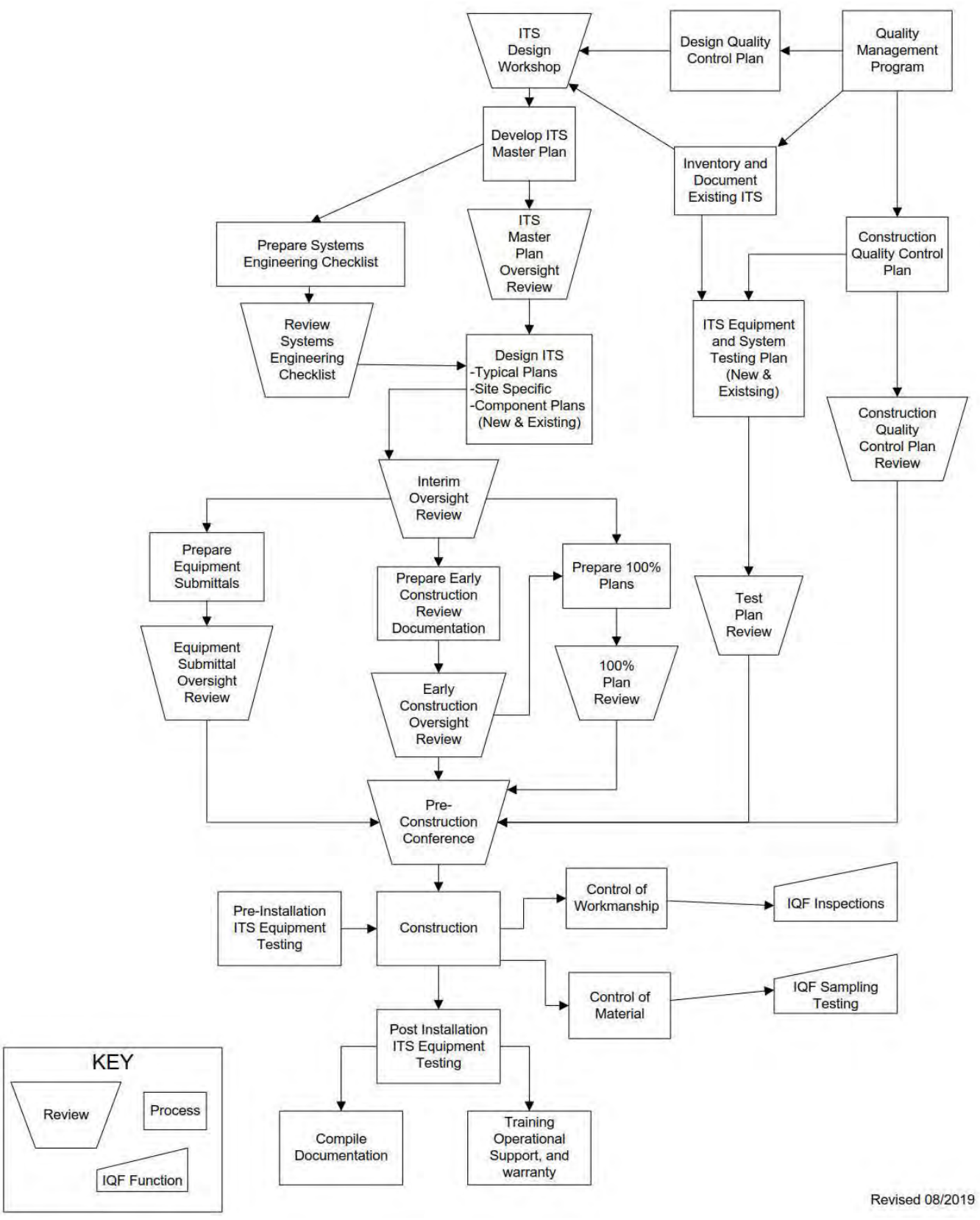
(2) SAT Major Failure

In the event of a major failure during the SAT, the test clock shall stop until the system is repaired. At the completion of the repair, the testing shall recommence with the test clock reset to day zero. The following constitute major failures:

- Failure of Developer-furnished equipment, if determined that failures were caused by faulty installation by Developer.
- Failure of an entire communications circuit for more than 15 minutes within a 24-hour period.

- Failure to communicate to an individual DMS.
- Failure to correct an issue within 4 hours of being notified by ADOT.

TP Attachment 700-5 – ITS Workflow Flow Chart


ITS Design Workshop
Design Quality Control Plan
Quality Management Program
Develop ITS Master Plan
Inventory and Document Existing ITS
Prepare Systems Engineering Checklist
ITS Master Plan Oversight Review
Construction Quality Control Plan
Review Systems Engineering Checklist
Design ITS -Typical Plans -Site Specific -Component Plans (New & Existing)
ITS Equipment and System Testing Plan (New & Existsing)
Construction Quality Control Plan Review
Interim Oversight Review
Prepare Equipment Submittals
Prepare Early Construction Review Documentation
Prepare 100% Plans
Test Plan Review
Equipment Submittal Oversight Review
100% Plan Review
Early Construction Oversight Review
Pre-Construction Conference
Pre-Installation ITS Equipment Testing
Construction
Control of Workmanship
IQF Inspections
Control of Material
IQF Sampling Testing
Post Installation ITS Equipment Testing
Compile Documentation
Training Operational Support, and warranty
KEY
Review
Process
IQF Function
Revised 08/2019

TP Attachment 700-6 – Pull Box (No. 4B)

PULL BOX (NO. 4B):

Description:

The work consists of furnishing and installing locking lid pull boxes for highway lighting, including excavating, backfilling and compacting at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of this item.

Materials:

Pullboxes are to be approximately 13 x 24 x 24 inches and conform to the details on standard drawing TS 1-12. They shall meet all requirements in the Standard Specifications.

The boxes shall be made from reinforced concrete. Covers and extensions shall be installed and located as shown on the project plans and shall be the size specified.

Chipped or cracked pull boxes, covers, and extensions will not be accepted.

Portland cement concrete shall conform to the requirements of Section 1006 for Class S concrete (3,000 PSI) of the Standard Specifications. When requested by the ADOT, pull boxes, covers, and extensions shall be furnished for testing at no additional cost to the Department.

Lids shall be provided with locking devices and the wording “A.D.O.T. ELECTRICAL HIGH VOLTAGE” on the lids. Markings shall be clearly defined and uniform in depth and shall be placed parallel to the long side of the cover. Letters shall be one inch high. The locking mechanism shall consist of a set of jaws which clamp onto the opposing vertical walls of the box and require a deliberately designed tool to engage and disengage. One locking/unlocking tool shall be provided to ADOT after final acceptance. The locking mechanism shall be secured by two ½” – 13 x 1-½” security bolts. These bolts shall be tightened with a torque wrench to the specifications of the manufacturer. The lid shall have a 1-1/2” x ¼” continuous steel band around the perimeter. The lid shall conform to the requirements of ANSI 77-2010.

The box shall be equipped with threaded ferrule loops cast into the base of the box and 12” long galvanized steel arms which attach to the loops.

Construction Requirements:

Section 732 of the Standard Specifications shall govern the requirements for installation.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of the Standard Specifications.

The Contractor shall contact Steve Koebler at (480) 589-8250 prior to ordering pull boxes to determine the pattern used for the security bolts and locking/unlocking tool.

TP Attachment 700-7 – Luminaire (LED) (10,000 Lumens)

LUMINAIRE (LED) (10,000 LUMENS)

Description:

The work under this item consists of furnishing and installing Light Emitting Diode (LED) underdeck luminaires in accordance with the details shown on the plans and in accordance with the requirements of these specifications. The work shall also include submitting shop drawings, and any compliance measurements or meetings necessary for luminaire approval.

General:

The work under this item consists of furnishing all materials and constructing complete and functioning lighting systems in accordance with the plans and these specifications. The work shall consist of but not be limited to the following:

1. Furnish wall mounted LED luminaires, including drivers and controls.

2. Install luminaires and level. Check aiming if necessary.

3. Connect all wiring and install electrical connections from luminaire to the nearest pull box, including fusing.

4. Conduct a 100-hour continuous on test and correct any problems during the test.

No luminaire shall be ordered until shop drawings are approved by ADOT.

Materials:

The luminaire housing shall be fabricated from a non-corrosive material, and shall provide adequate thermal management to prevent overheating the LED modules and electronic driver. The luminaire shall not depend on fans, pumps or liquids for thermal dissipation. All components shall be of non-corrosive material or have corrosion protection.

The housing shall be completely sealed and meet IP54 or better standards for use in wet locations. The seal shall be maintained throughout the temperature ranges resulting from long term operation of the LED elements and electronic driver.

The fixture and all components shall have been demonstrated to pass vibration resistance testing per ANSI C136.31.

The luminaire, housing, and all components shall not exceed a weight of 35 pounds.

The luminaire finish shall be gray, natural silver, or as directed by ADOT.

Optical:

Luminaire initial lumens shall be within the range of 8,000 to 12,000. The LED’s shall produce white light with a Correlated Color Temperature (CCT) of 3,000 degrees Kelvin (± 300K), and a minimum Color Rendering Index (CRI) of 65. The light distribution pattern shall be either

Illuminating Engineering Society (IES) type 3 or type 4. LED modules/arrays shall be IP66 rated at a minimum.

Electrical:

The driver for each luminaire shall be designed for the characteristics of the entire array of LED modules it is to operate and it shall provide the proper voltage and current. The electronic driver shall be replaceable.

The fixture shall be designed to operate normally with a line voltage variation of ± 10 percent. The fixture shall have a minimum of 6kv/3kA surge protection per ANSI C136.2.

All electrical conductors and connections shall conform to the requirements of section 732-2.01. Luminaires shall be fused at the nearest pull box, per ADOT Standard Drawing TS 1-4.

All components shall have a design life of not less than 100,000 hours.

Construction Requirements:

Mounting:

The luminaire shall attach to the wall using bolted connections to either cast in place threaded inserts or a cast in place junction box.

Standards:

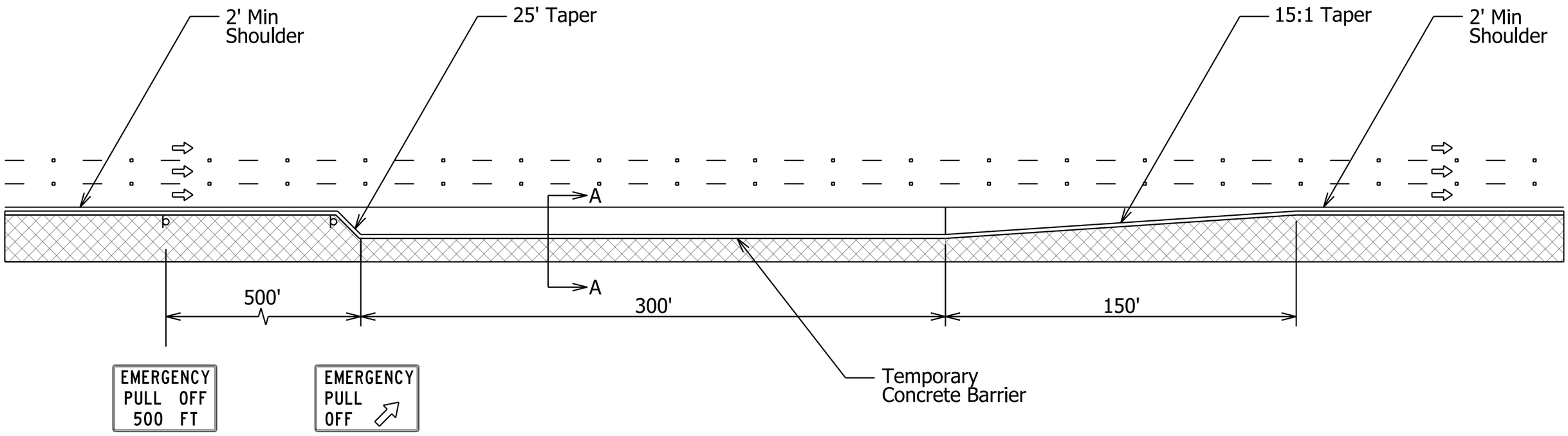
The luminaire and all components shall be rated for operation in ambient temperatures from -20°C to +40°C. All components shall be UL listed and comply with applicable ANSI standards.

Warranty:

A warranty must be provided for the full replacement of the luminaire due to any failure for 5 years.

TP Attachment 700-8

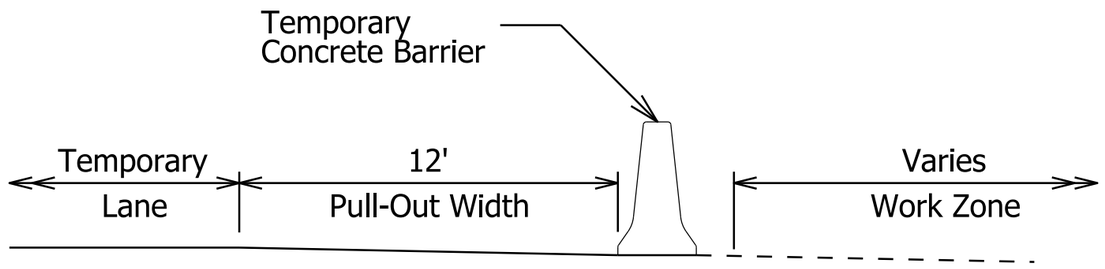
Temporary Emergency Pull-Off Detail



LEGEND

Work Zone

Sign



SECTION A-A

Notes:

1. Pull-off area shall be comprised of existing pavement, temporary asphalt pavement or millings. Pull-off area may be comprised of different materials.

2. "Shoulder Closed and Emergency Pull-Off Area" signs and plaques shall be mounted on the side of the roadway where the shoulder is affected. Usage of these signs on the opposite side of divided highways is optional. Mount all other signs on both sides of the work-affected roadways on divided highways.

3. Emergency pull-off areas should not be located where adequate sight distances for Acceleration and deceleration maneuvers would not exist. The location of temporary Traffic barrier and construction activities occurring on the inside of horizontal Curves just behind that barrier should be considered when determining whether Motorists will have adequate sight distance through a horizontal curve.

4. Emergency pull-off shall not be used for construction ingress or egress.

TP Attachment 700-8
Temporary Emergency Pull-Off Detail
I-10, I-17 (Split) to SR 202L (Santan/So Mtn Freeway)
I-10/SR 143 Interchange

TP Attachment 800-1 – Alameda and Western Canal Art Bridges

PROJECT NARRATIVE

THIS SET OF DRAWINGS DESCRIBES A PUBLIC ART INSTALLATION DESIGNED FOR TWO PEDESTRIAN BRIDGES OVER THE I-10 FREEWAY WITHIN THE CITY OF TEMPE. THE TWO NEW BRIDGES ARE THE ALAMEDA & WESTERN CANAL BRIDGES, AS DESIGNATED BY ADOT.

THE ARTWORK INSTALLATION WILL CONTAIN NINE-TO-TEN STEEL SCULPTURES CONNECTED TO THE TOP OF EACH BRIDGE, FOR A TOTAL OF 18-20 INSTALLATIONS (DEPENDING ON WHAT TEMPE'S BUDGET WILL ALLOW FOR).

THE SCULPTURES ARE EACH OF IDENTICAL SHAPE, STRUCTURE, CONNECTION METHOD, AND FINISH. THEY WILL "LEAN" IN A VARIETY OF ANGLES, THOUGH THEIR LEGS AND CONNECTIONS WILL BE INTEGRAL TO THE FABRICATION, THUS EACH WILL BE CONNECTED UTILIZING THE SAME METHOD.

ART INSTALLATION PROCESS

THE DEVELOPER/BUILDER OF THE BRIDGES WILL INSTALL THE INSTALLATIONS. THE ARTIST HAS PROVIDED FULL STRUCTURAL ENGINEERING FOR THE FABRICATION, INCLUDING THE CONNECTION TO THE BRIDGE TRUSS STRUCTURE. THE DEVELOPER/BUILDER FOR THE BRIDGES MAY WISH TO REVISIT THE TRUSS CONNECTION DESIGN. GIVEN THE BRIDGE STRUCTURE MAY BE REVISED FROM THE CONCEPTUAL DESIGN PROVIDED BY ADOT FOR ART-INSTALLATION DEISGN PURPOSES, REDESIGN OF THE CONNECTION MAY BE REQUIRED. THE ARTIST AND THEIR ENGINEERS ARE OPEN TO RE-WORKING THE CONNECTION DESIGN IF NECESSARY.

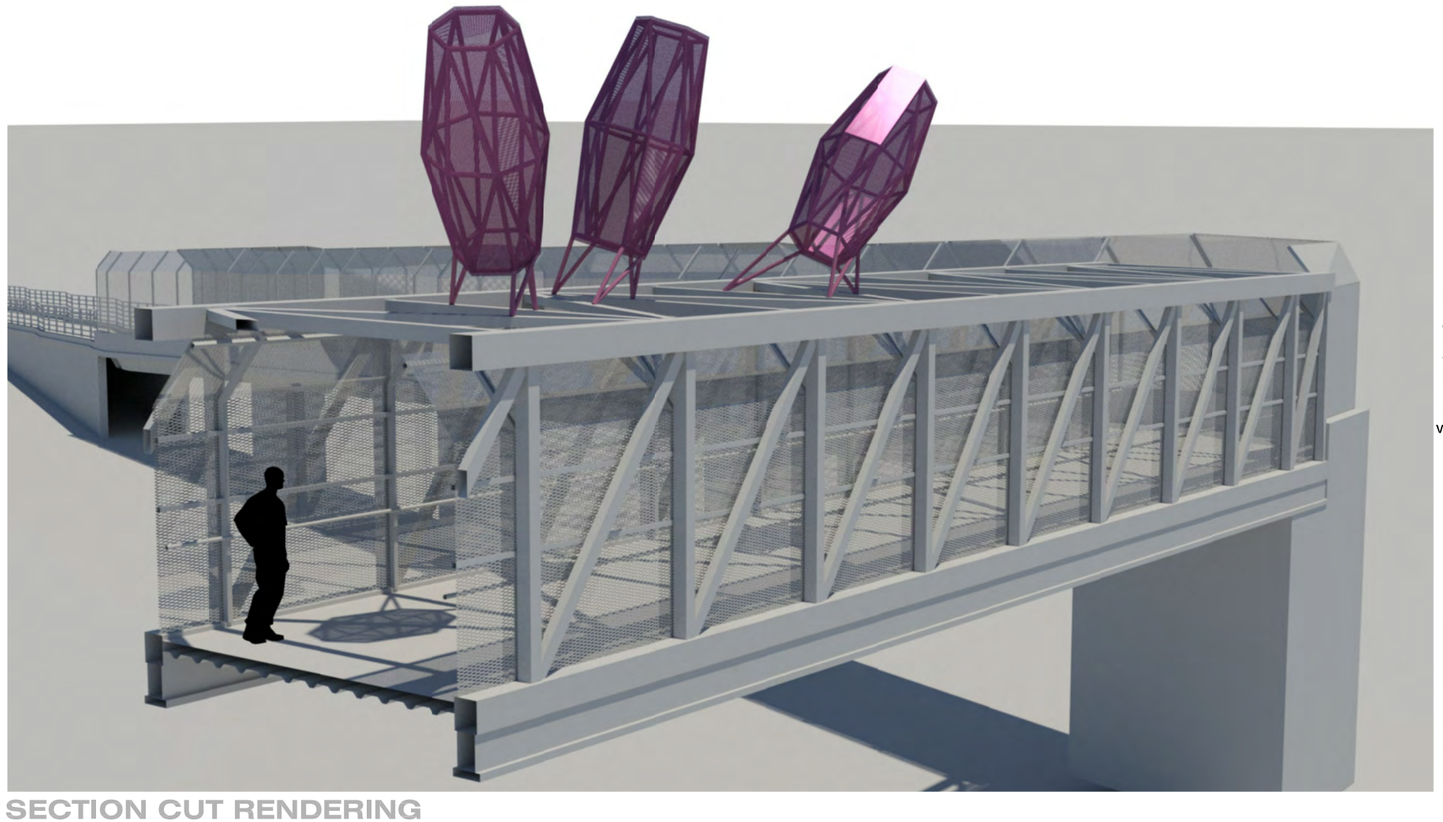
DESIGN TEAM

ARTIST	coLAB studio, llc 1614 E. Cedar Street, Tempe AZ 85281 480.326.0541 contact: Matthew Salenger matt@colabstudio.com www.colabstudio.com
ENGINEERING	Starling Madison Lofquist, inc. 5224 S. 39th Street, Phoenix AZ 85040 602.438.2500 contact: Jesse Light, SE, PE JLight@smleng.com
ART MANAGEMENT	City of Tempe Arts and Culture Public Art 480.350.2827 contact: Rebecca Blume Rothman, Director Rebecca_Rothman@tempe.gov
ADOT MANAGEMENT	Arizona Department of Transportation 602.708.0267 contact: Amy Ritz, Project Manager aritz@azdot.gov

BIDDING NOTES

(PERTAINING ONLY TO THE PUBLIC ART INSTALLATION CONTAINED IN THIS PACKET)

1. FOR BIDDER INFORMATION ONLY: EACH INSTALLATION FORM WILL INCLUDE AN ART-DISC CUT FROM ¼" STEEL PLATE. THOSE ART-DISCS SHALL INCLUDE IMAGERY THAT WILL BE WATER-JET CUT. BIDDERS SHOULD INCLUDE A FIXED PRICE OF $14,000 TOTAL FOR WATER-JET CUTTING ALL DISCS (18-20). DESIGN FOR IMAGERY WILL BE PROVIDED TO THE BIDDER AWARDED THE CONTRACT.
2. FOR BIDDER INFORMATION ONLY: EACH BRIDGE WILL INCLUDE TWO (2) 10"X10"X¼" ETCHED STAINLESS STEEL ART-DESCRIPTION SIGNS MOUNTED TO MESH SCREEN WALLS ALONG PEDESTRIAN WALKWAY. BIDDERS SHALL INCLUDE A FIXED PRICE OF $4000 TOTAL FOR SIGN PRODUCTION AND INSTALLATION (TOTAL OF 4 SIGNS).
3. BIDDER TO NOTE: THE FABRICATION FOR THE PUBLIC ART PROJECT SHALL BE COMPLETED BY FABRICATION SHOPS THAT HAVE PREVIOUSLY FABRICATED A MINIMUM OF FIVE (5) PUBLIC ART PROJECTS SINCE 2014, EACH WITH A SHOP-FABRICATION COST OF $50,000 MINIMUM.



SECTION CUT RENDERING

SHEET INDEX

ART.1 COVER / INFO
ART.2 ART SECTIONS
ART.3 FRUIT DIMENSIONS
ART.4 LOCATION PLANS
S1.0 GSN, PLAN, AND ISOMETRIC VIEWS
S2.0 FRAMING DETAILS
SHOP DRAWINGS (forthcoming)

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FOR ADOT & CITY OF TEMPE

I-10 BRIDGES PUBLIC ART INSTALLATION

ALAMEDA & WESTERN CANAL PED BRIDGES

coLAB
colab studio, llc
art & architecture
1614 e. cedar street
tempe - arizona
85281
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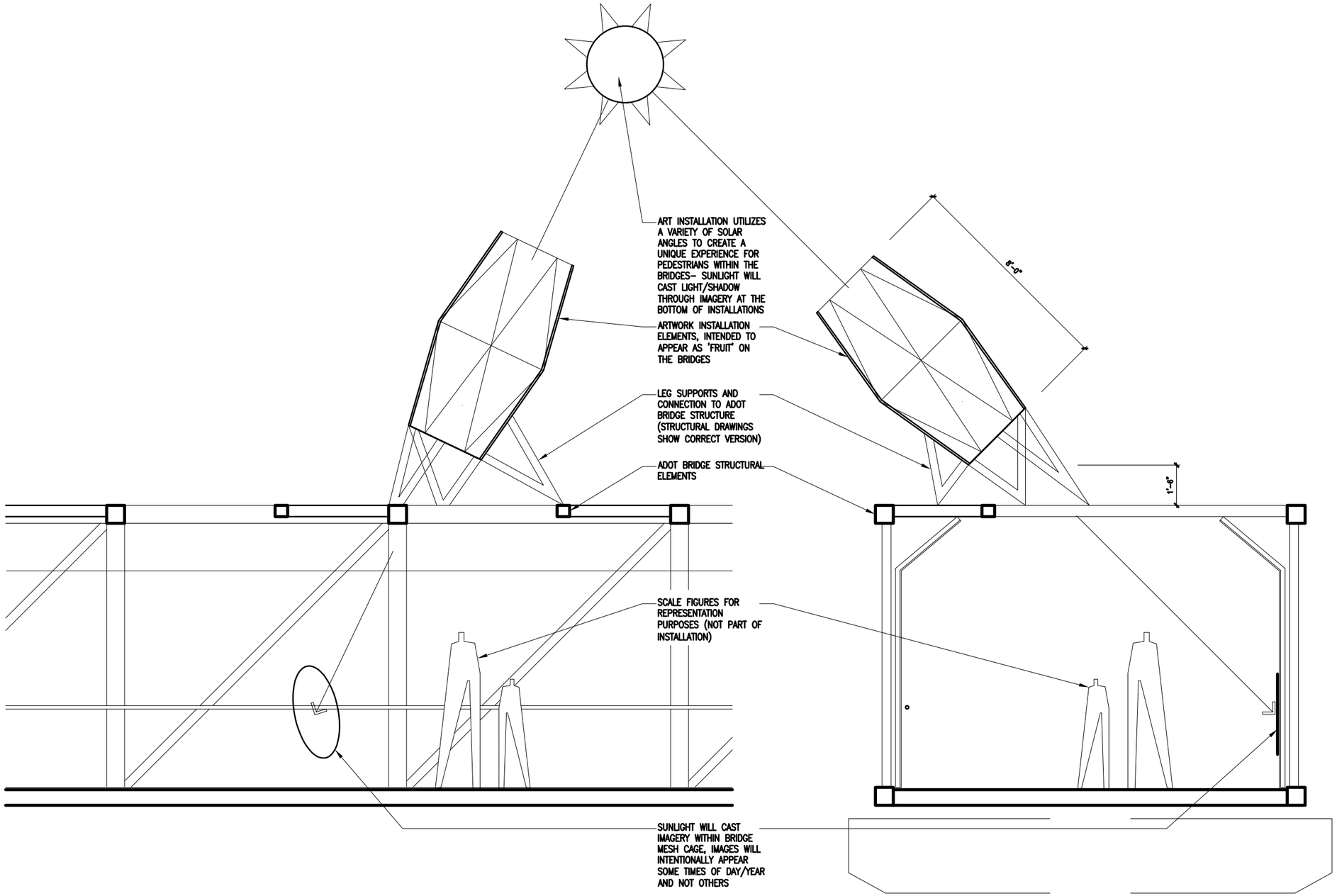
DATE 01.29.20
PROJECT # 19005
DRAWN BY MDS
CHECKED BY
REVISIONS
SHEET #

COVER / INFO

ART.1

NOTES

1. REFERENCE STRUCTURAL DRAWINGS AS THEY GOVERN DESIGN AND FABRICATION INTENT WHERE DISCREPANCIES OCCUR
2. EACH BRIDGE SHALL CONTAIN 9–10 ART 'FRUIT' INSTALLATIONS
3. SEE SHEET ART.3 FOR INFORMATION ON FINISHES



INTERNAL LONGITUDINAL SECTION

INTERNAL TRANSVERSE SECTION

0' 2' 4'

ART SECTIONS

1/4"=1'-0"

These drawings and documents were prepared for this project and are instruments of the architect's service. No part hereof shall be copied, published, or used in any way by any person or by others on other projects, used to complete this project by others, disclosed or made available to others, or used in any extent whatsoever except as expressly authorized in writing by colab studio, llc. The architect retains all rights to these drawings and documents and shall retain all common law, statutory and other reserved rights, including the copyright. Any person, firm or corporation who receives this document, however obtained, shall by virtue hereof, however be deemed to have agreed to the foregoing restrictions.

FOR ADOT & CITY OF TEMPE

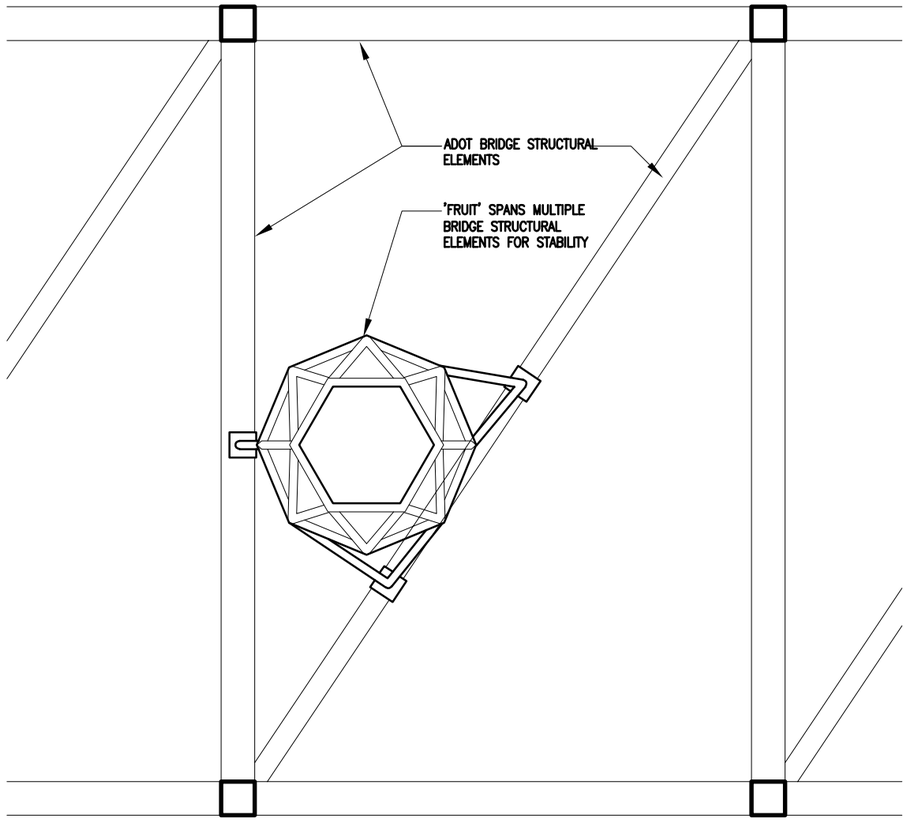
I-10 BRIDGES PUBLIC ART INSTALLATION

ALAMEDA & WESTERN CANAL PED BRIDGES

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TOP VIEW OF ART INSTALLATION

FINISHES

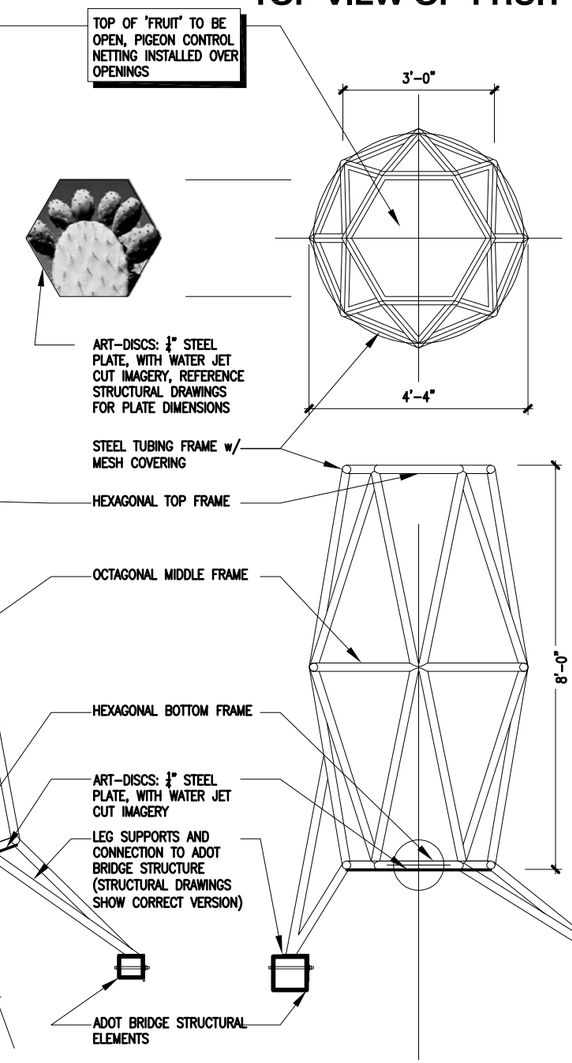
1. EACH ART INSTALLATION SHALL BE FULLY COATED WITH CARBOLINE 8845. THIS INCLUDES FRAME, MESH, LEGS, AND CONNECTIONS.
2. THE COLOR SHALL BE FROM CARBOLINE, AND MATCH SHERWIN WILLIAMS SW6566 "FRAMBOISE" (RGB: 124.54.85; LRV 8.)
3. PIGEON CONTROL NETTING TO BE BLACK.

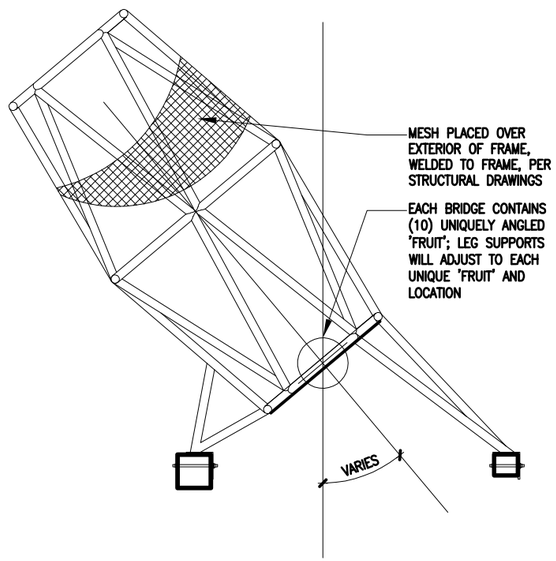
NOTES

1. REFERENCE STRUCTURAL DRAWINGS AS THEY GOVERN DESIGN AND FABRICATION INTENT WHERE DISCREPANCIES OCCUR
2. REFERENCE STRUCTURAL DRAWINGS FOR CONNECTION DETAILS AND CODE INFORMATION.
3. EACH BRIDGE SHALL CONTAIN 9–10 ART 'FRUIT' INSTALLATIONS

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TOP VIEW OF 'FRUIT'





SIDE VIEWS OF 'FRUIT'

0' 2' 4'

'FRUIT' DIMENSIONS

3/8"=1'-0"

FOR ADOT & CITY OF TEMPE

I-10 BRIDGES PUBLIC ART INSTALLATION

ALAMEDA & WESTERN CANAL PED BRIDGES

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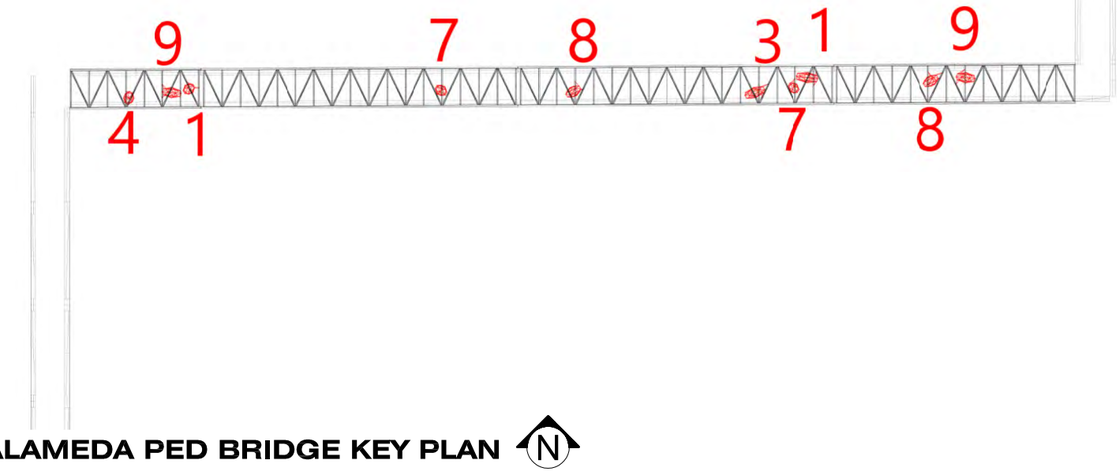
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ART.3

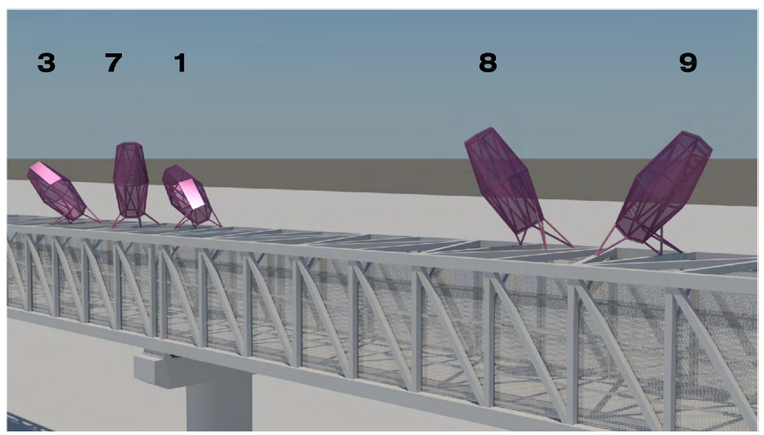
INSTALLATION DESIGNATION & INFORMATION

INSTALL #	SOLAR DATE & TIME	SOLAR ALTITUDE	SOLAR AZIMUTH
1	06.21-13:30	73.5	236.58
2	NOT USED		
3	04.05-15:40	38.53	248.95
4	08.11-12:50	71.36	192.56
5	04.23-10:30	56.26	121.16
6	05.30-16:50	31.33	276.9
7	06.04-11:25	72.56	125.03
8	05.01-14:10	60.14	238.7
9	07.25-9:35	47.85	97.46
10	NOT USED		

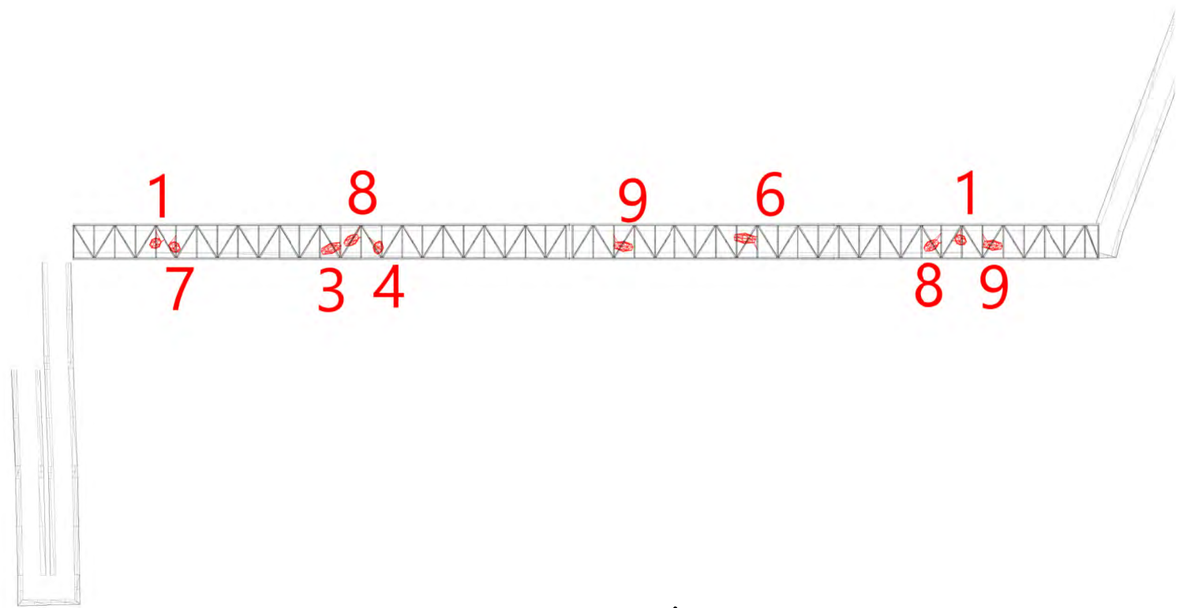
REFERENCE KEY PLANS FOR LOCATIONS



ALAMEDA PED BRIDGE KEY PLAN



RENDERING - ALAMEDA, SOUTH-EAST SIDE



WESTERN CANAL PED BRIDGE KEY PLAN

NOTES

1. LOCATIONS ARE RELATIVE (NON–FIXED), PENDING BRIDGE DESIGN REVISIONS, THOUGH PLACEMENT IN 'RANDOM' APPEARANCE IS INTENTIONAL
2. BIDDER TO PROVIDE INSTALLATION LOCATION PLANS TO ARTIST FOR APPROVAL PRIOR TO INSTALLATION
3. REFERENCE THE INSTALLATION DESIGNATION & INFORMATION MATRIX FOR NUMERICAL & ANGULAR INFORMATION FOR EACH INSTALLATION

These drawings and documents were prepared for this project and are instruments of the architect's service. No part hereof shall be copied, duplicated, or disclosed to anyone for use on or by others on other projects, used to complete this project by others, disclosed or made available to others, or used in connection with any work except as expressly authorized in writing by colab studio, llc. The architect retains all rights to these drawings documents and shall retain all common law, statutory and other reserved rights, including the copyright. Any person, firm or corporation using this document, however obtained, shall by virtue hereof, however be deemed to have agreed to the foregoing restrictions.

FOR ADOT & CITY OF TEMPE

I-10 BRIDGES PUBLIC ART INSTALLATION

ALAMEDA & WESTERN CANAL PED BRIDGES

coLAB
colab studio, llc
art & architecture
1614 e. cedar street
tempe - arizona
85281
(v) 480 326 0541
www.colabstudio.com

90% DESIGN SUBMITTAL

DATE 12 19 19
PROJECT # 19005
DRAWN BY MDS
CHECKED BY
REVISIONS
SHEET #

LOCATION PLANS

NTS

ART.4

GENERAL STRUCTURAL NOTES

DESIGN CRITERIA:

BUILDING CODE: AASHTO LRFD BRIDGE DESIGN SPECIFICATION, 8TH EDITION WITH MAY 2018 ERRATA

McNICHOLS EXPANDED METAL D.L. = 1.2 PSF
HSS2.375"Øx0.109" THICK A500 GR. B TUBE = 2.64 PLF

WIND:
LOAD CASE STRENGTH III V = 115 MPH
LOAD CASE SERVICE I V = 70 MPH
EXPOSURE = C
TOP OF ART HEIGHT = 42 FT; Kz = 1.06; G = 1.0; CD = 1.6

NOTES TO CONTRACTOR:

PROJECT SAFETY IS THE RESPONSIBILITY OF THE CONTRACTOR OR PERSONS IN CHARGE OF THE DAY-TO-DAY CONSTRUCTION. COMPLY WITH ALL AASHTO REQUIREMENTS. PROVIDE TEMPORARY BRACING, SHORING, GUYING OR OTHER MEANS TO AVOID EXCESSIVE STRESSES AND TO HOLD STRUCTURAL ELEMENTS IN PLACE DURING ERECTION.

VERIFY EXISTING CONDITIONS SHOWN IN DRAWINGS. PROMPTLY NOTIFY THE ENGINEER OR ARCHITECT IF DETAILS AND INFORMATION CONTAINED ON THESE PLANS DO NOT CONFORM TO THE CONSTRUCTION SITE CONDITIONS.

VERIFY ALL DIMENSIONS AND ELEVATIONS WITH THE ARCHITECTURAL DRAWINGS AND WITH ACTUAL FIELD CONDITIONS. DIMENSIONAL CONTROL IS THE RESPONSIBILITY OF THE ARCHITECT AND THE GENERAL CONTRACTOR.

IF THERE ARE CONFLICTS IN THE DRAWINGS, THE COSTLIER ITEMS SHOWN SHALL GOVERN FOR BIDDING PURPOSES, OR SUBMIT A PRE-BID "REQUEST FOR CLARIFICATION".

ENGINEERING DESIGN PROVIDED BY OTHERS SHALL BEAR THE SEAL OF AN ENGINEER REGISTERED IN THE STATE OF ARIZONA.

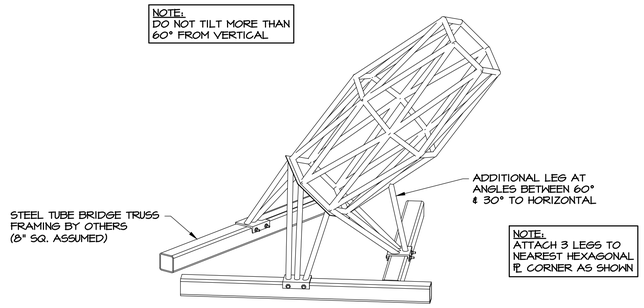
STRUCTURAL STEEL:

CHANNELS AND PLATE: ASTM A36
TUBE STEEL: ASTM A500 GRADE B (Fy = 46 KSI)
BOLTS: ASTM A193 STAINLESS STEEL 18-8

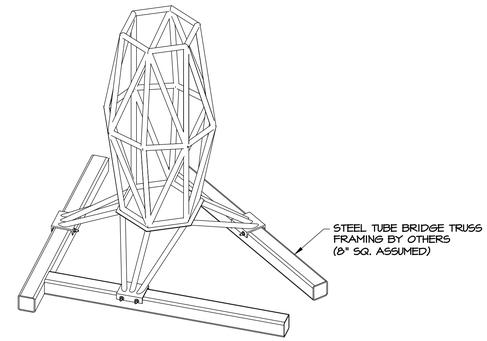
WELDERS SHALL HOLD VALID CERTIFICATES AND HAVE CURRENT EXPERIENCE IN THE TYPES OF WELDS REQUIRED. USE E-10XX SERIES LOW HYDROGEN RODS. CONFORM TO AMERICAN WELDING SOCIETY STANDARDS D1.1 & D1.5.

PAINT STRUCTURAL STEEL WITH ONE SHOP COAT PRIMER OVER CLEAN METAL EXCEPT WHERE STRUCTURAL STEEL IS TO BE PERMANENTLY IN CONTACT WITH CONCRETE OR IS TO RECEIVE SPRAYED-ON FIRE PROOFING.

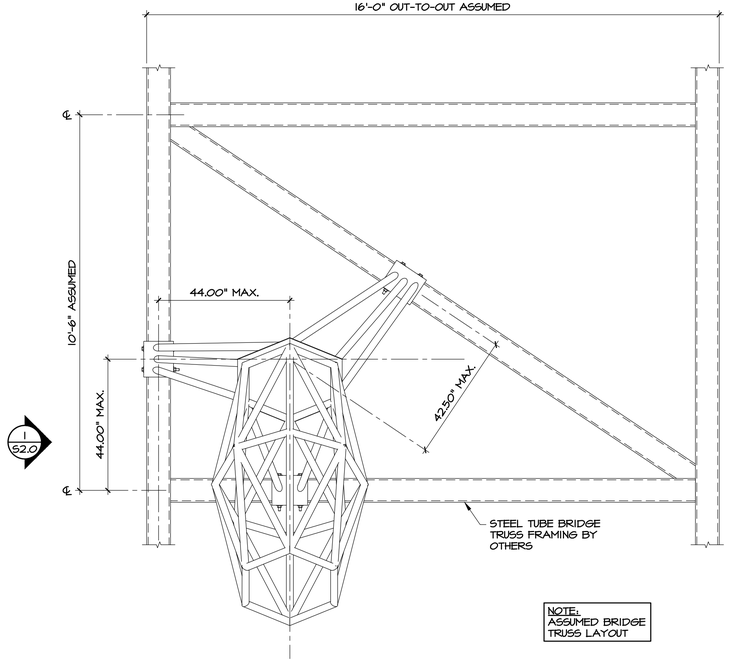
Starling Madison Lofquist, Inc.
5224 S. 39th Street
Phoenix, Arizona 85040
(602) 438-2500
fax. (602) 438-2505
Consulting Structural and Forensic Engineers
JOB # 1018-19



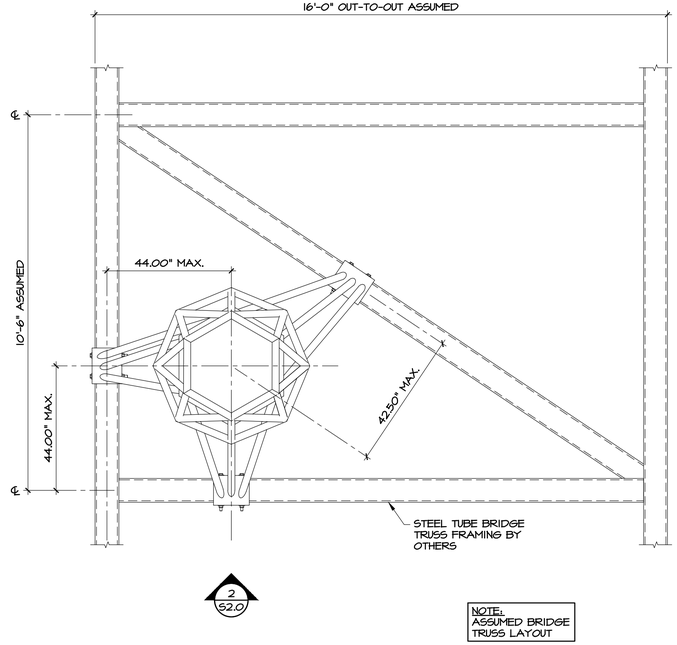
SECTION 1
(SHOWN 45° TO HORIZONTAL)
SCALE: N.T.S.



SECTION 2
(SHOWN 90° TO HORIZONTAL)
SCALE: N.T.S.



SECTION 1 PLAN (45° TO HORIZONTAL)
SCALE: 1/2"=1'-0"



SECTION 2 PLAN (90° TO HORIZONTAL)
SCALE: 1/2"=1'-0"

FOR ADOT & CITY OF TEMPE
I-10 BRIDGES PUBLIC ART INSTALLATION
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1614 e. cedar street
tempe - arizona
85281
(v) 480 326 0541
www.colabstudio.com

Registered Professional Engineer (Structural)
CERTIFICATE NO.
58912
JESSE
LIGHT
Date Signed 12-18-19
ARIZONA, U.S.A.
EXPIRES: 12/31/20

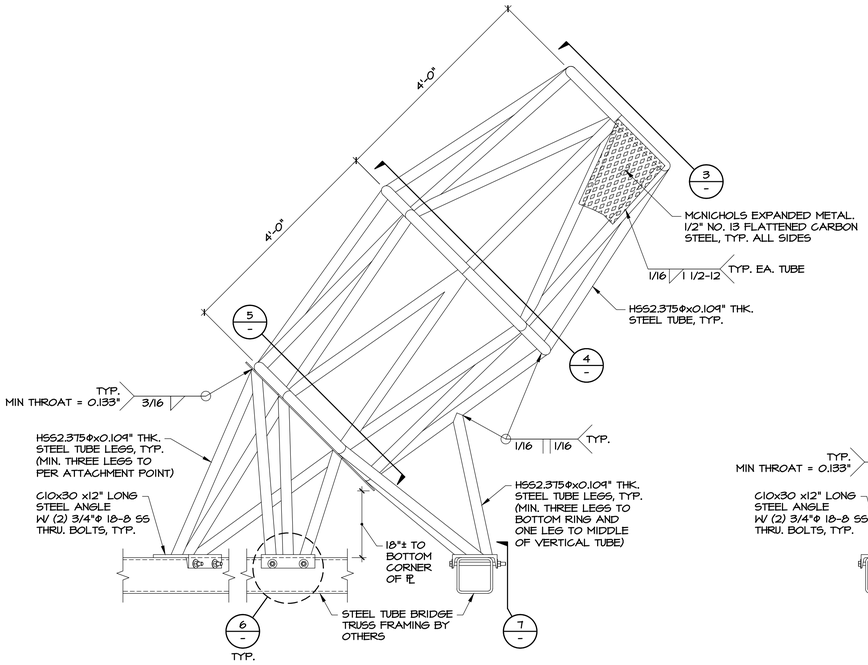
90% DESIGN SUBMITTAL

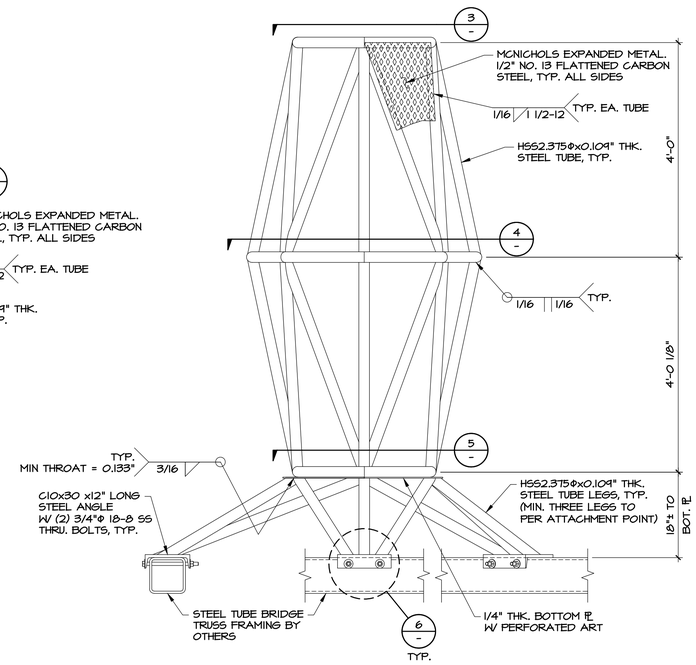
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PROJECT #	19005
DRAWN BY	JS
CHECKED BY	JL
REVISIONS	
SHEET #	1 OF 2

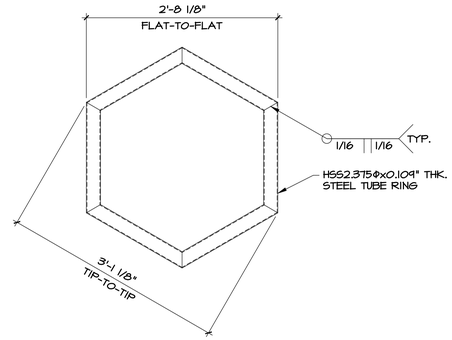
GSN, PLAN AND ISOMETRIC VIEWS

AS NOTED

S1.0



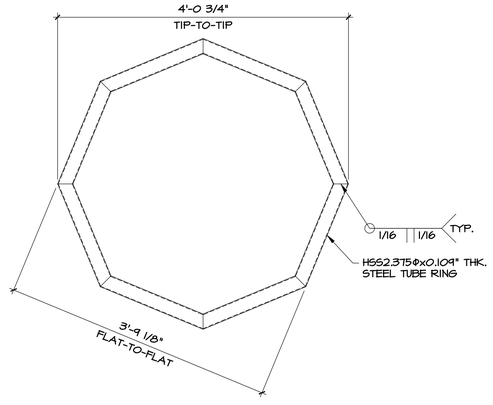


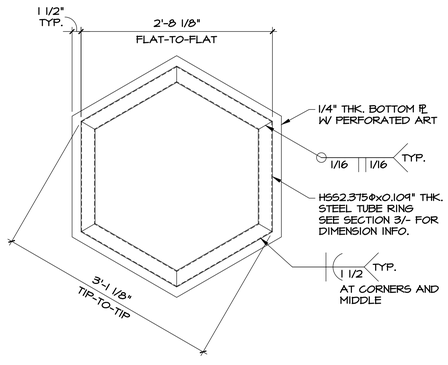


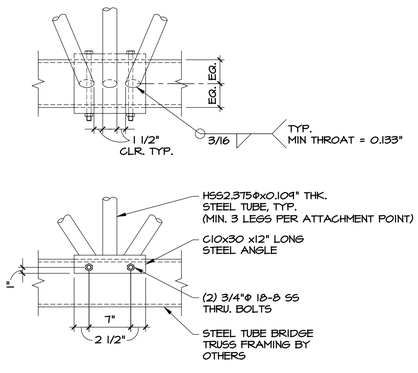
1 SECTION (SHOWN 45° TO HORIZONTAL)
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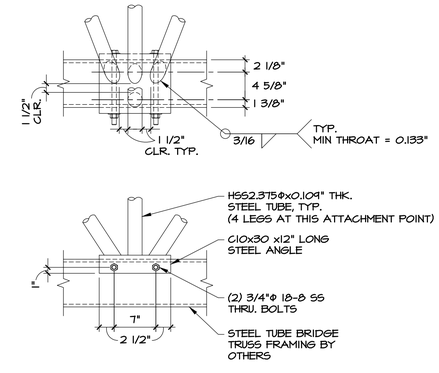
2 SECTION (SHOWN 90° TO HORIZONTAL)
SCALE: 3/4"=1'-0"

3 TOP RING (HEXAGONAL)
SCALE: 1"=1'-0"









4 MIDDLE RING (OCTOGONAL)
SCALE: 1"=1'-0"

5 BOTTOM RING (HEXAGONAL)
SCALE: 1"=1'-0"

6 LEG ATTACHMENT
SCALE: 1"=1'-0"

7 LEG ATTACHMENT
SCALE: 1"=1'-0"

FRAMING DETAILS S2.0

AS NOTED

Starling Madison Lofquist, Inc.
5224 S. 39th Street
Phoenix, Arizona 85040
(602) 438-2500
fax. (602) 438-2505
Consulting Structural and Forensic Engineers
JOB # 1018-19

FOR ADOT & CITY OF TEMPE

I-10 BRIDGES PUBLIC ART INSTALLATION

ALAMEDA & CROSS CUT CANAL BRIDGES

coLAB studio, LLC art + architecture
colab studio, llc
art & architecture
1614 e. cedar street
tempe - arizona
85281
(v) 480 326 0541
www.colabstudio.com

Registered Professional Engineer (Structural) CERTIFICATE NO. 58912 JESSE LIGHT Date Signed 12-18-19 ARIZONA, U.S.A.
EXPIRES: 12/31/20

90% DESIGN SUBMITTAL

DATE	12-18-19
PROJECT #	19005
DRAWN BY	JS
CHECKED BY	JL
REVISIONS	
SHEET #	2 OF 2

Starling Madison Lofquist, Inc.
Consulting Structural and Forensic Engineers
5224 South 39th Street, Phoenix, Arizona 85040
tel: (602) 438-2500 fax: (602) 438-2505 ROC#291316 www.smleng.com

Structural Calculations

Project: Tempe I-10 Bridge Public Art Installation

Location: 2 Pedestrian Bridges in the City of Tempe
Crossing the Interstate 10

Client: coLAB studio, LLC

Date: 12/18/19 **Job No:** 1018-19 **By:** J. Light, S.E.



STARLING MADISON
LOFQUIST INC.
5224 S. 39th STEET
PHOENIX, ARIZONA 85040
(602) 438-2500

Sheet No.: 1

Job No.: 1018-19

Date: 12/18/2019 BY: J. Light,

TABLE OF CONTENTS:

Item:	Page(s):
Project Description	1
Project Scope	1
Code References	1
Wind Load Development, Load Cases & Member List	2
Public Art Work Stress and Fatigue Analysis	3 - 76

Project Description:

These calculations cover the structural design for the public art works to be attached to the top of two (2) Tempe I-10 Bridges and their attachment to the supporting structure. The art work will be constructed from steel. The scope of work is located outside. The components were designed to meet the AASHTO LRFD Bridge Design Specifications, 8th Ed. requirements for load combinatinos Strength III and Service I and for the weld fatigue provisions in section 6.6.

Project Scope:

The following structural calculations pertain only to the public art works and their attachment to the supporting structure. It is assumed that the supporting structure is adequate to safely support forces imposed by the public art works. Starling Madison Lofquist, Inc. assumes no liability beyond what is specifically shown in these calculations.

Code References:

AASHTO LRFD Bridge Design Specfication, 8th Edition with May 2018 Errata

ANSI/AISC 360-16 Specification for Structural Steel Buildings (AISC)

STARLING MADISON
LOFQUIST INC.
5224 S. 39th STEET
PHOENIX, ARIZONA 85040
(602) 438-2500

Job No.: 1018-19

Date: 12/18/2019 BY: J. Light,

Wind Load Developement:

$\varepsilon := 100\% - 64\% = 36\%$ Solid Area $\quad \%Open_{Reduction} := 0.9$

$Z := 42ft$ Exp. = 'C' $\quad K_z := 1.06 \quad G := 1.0 \quad C_D := 1.6$

Strength III:

Load Case 1:

1.25 DC + 1.0 WS

Load Case 2:

0.9 DC + 1.0 WS $\quad V := 115 \ mph$

$$P_{zmesh} := 0.00256 \cdot V^2 \cdot K_z \cdot G \cdot C_D \cdot psf \cdot \%Open_{Reduction} = 51.7 \cdot psf$$

$$P_{ztube} := 0.00256 \cdot V^2 \cdot K_z \cdot G \cdot C_D \cdot psf \cdot \frac{2.375in}{12in} = 11.4 \cdot psf$$

Services I:

Load Case 3:

1.0 DC + 1.0 WS $\quad V := 70 \ mph$

$$P_{zmesh} := \max\left(0.0125 \cdot ksf \cdot C_D, 0.00256 \cdot V^2 \cdot K_z \cdot G \cdot C_D \cdot psf\right) \cdot \%Open_{Reduction} = 19.1 \cdot psf$$

$$P_{ztube} := \max\left(0.0125 \cdot ksf \cdot C_D, 0.00256 \cdot V^2 \cdot K_z \cdot G \cdot C_D \cdot psf\right) \cdot \frac{2.375in}{12in} = 4.2 \cdot psf$$

Member List:

Leg Members:

M97-M115

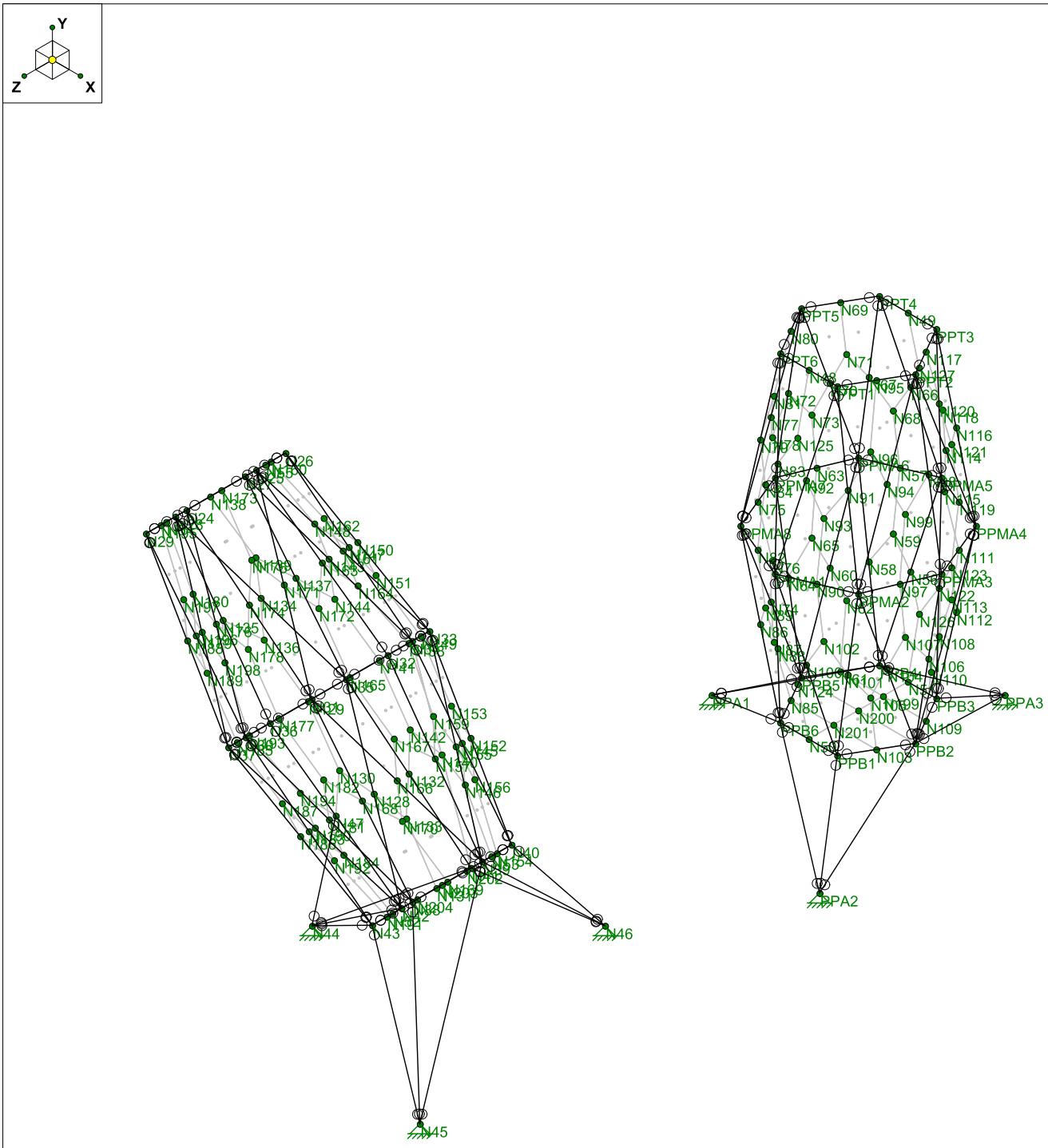
Bottom Ring Members: M1-M6 & M49-M54

Middle Ring Members: M26-M33 & M74-M81

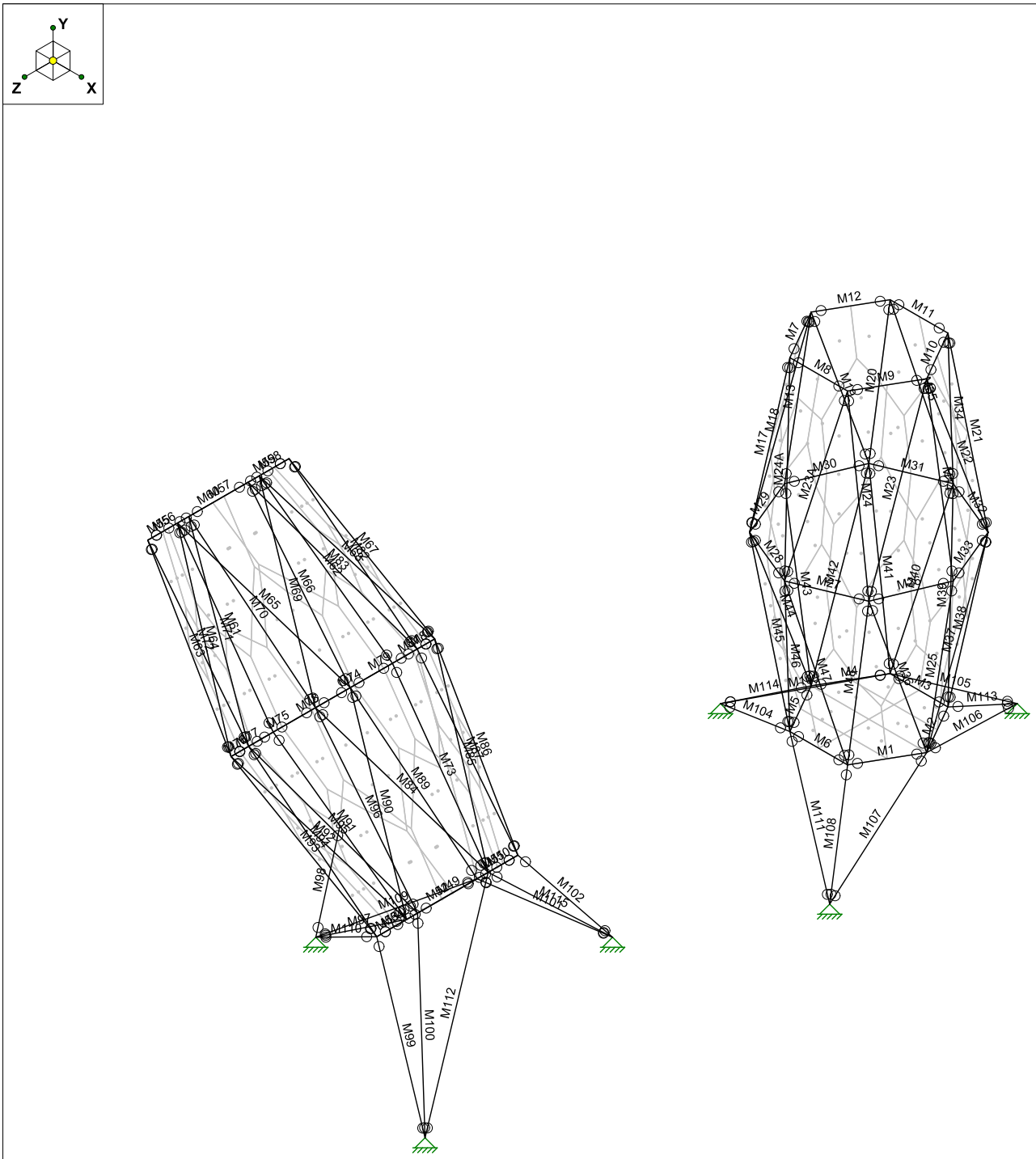
Top Ring Members: M7-M12 & M55-M60

Vertical Members:

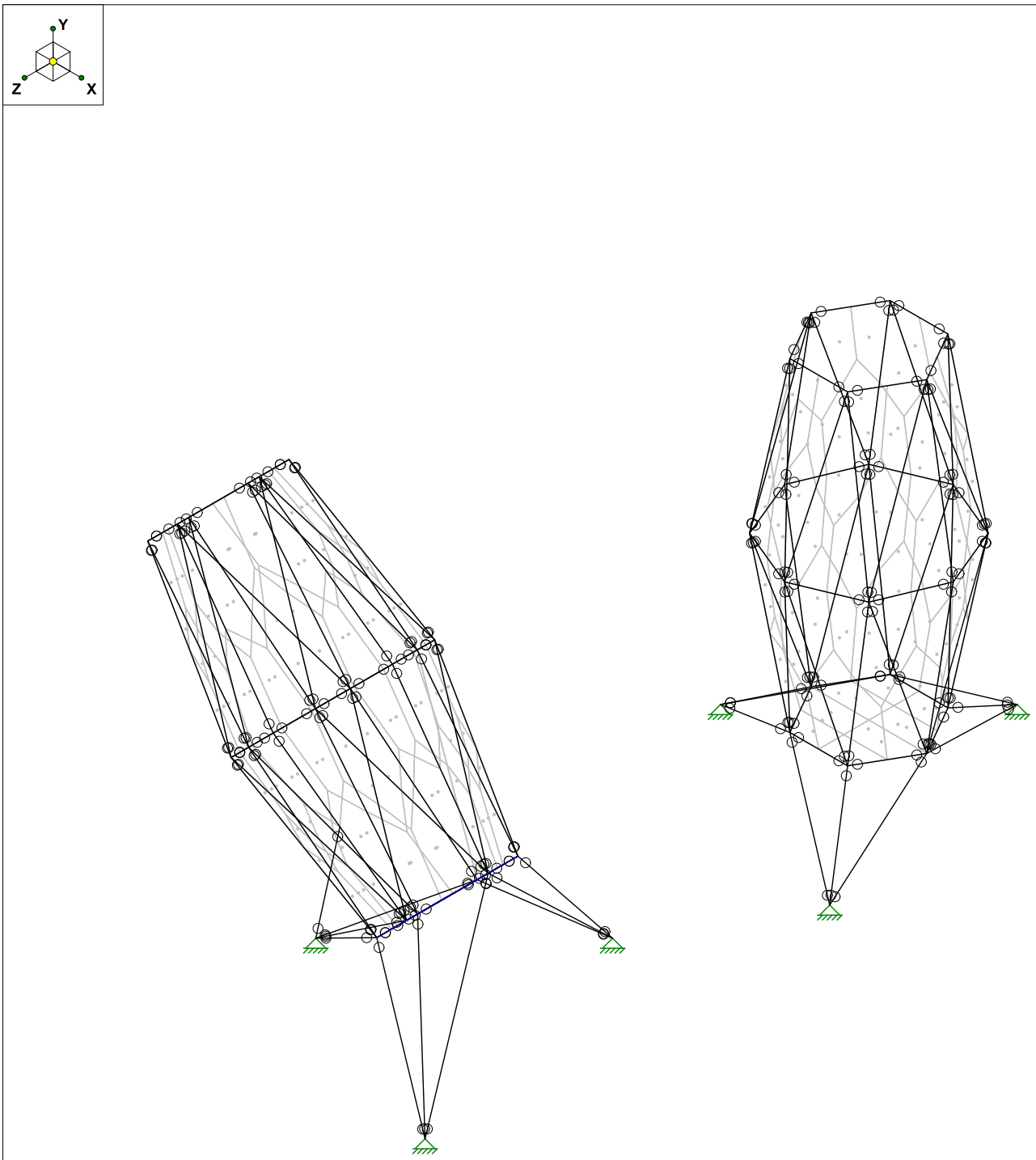
M13-M14, M15-M16 Omitted, M17-M25, M23A-M24A, M34-M48, M61-M73 & M82-M96



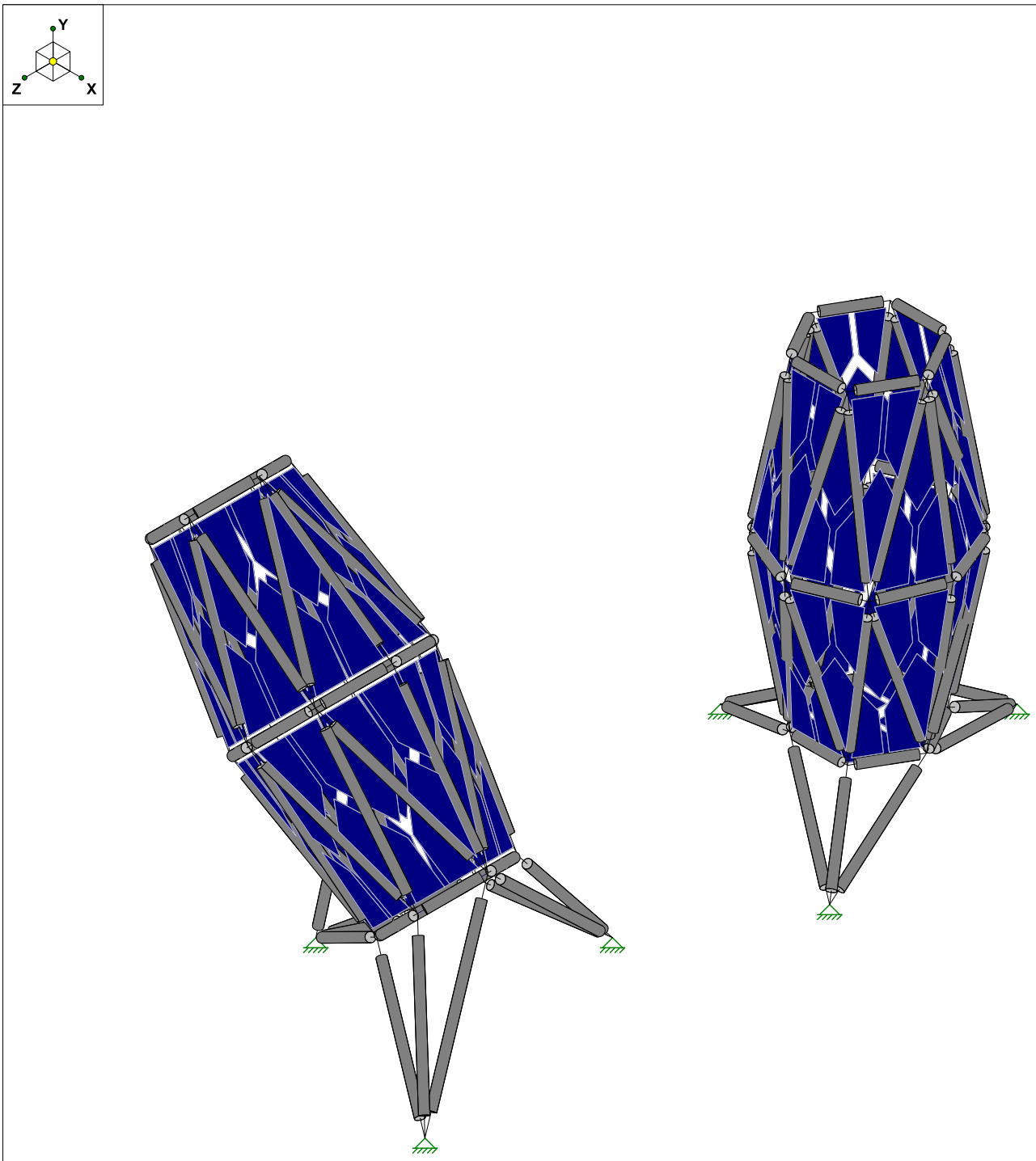
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1018-19		1018-19 Public Art Installations He...



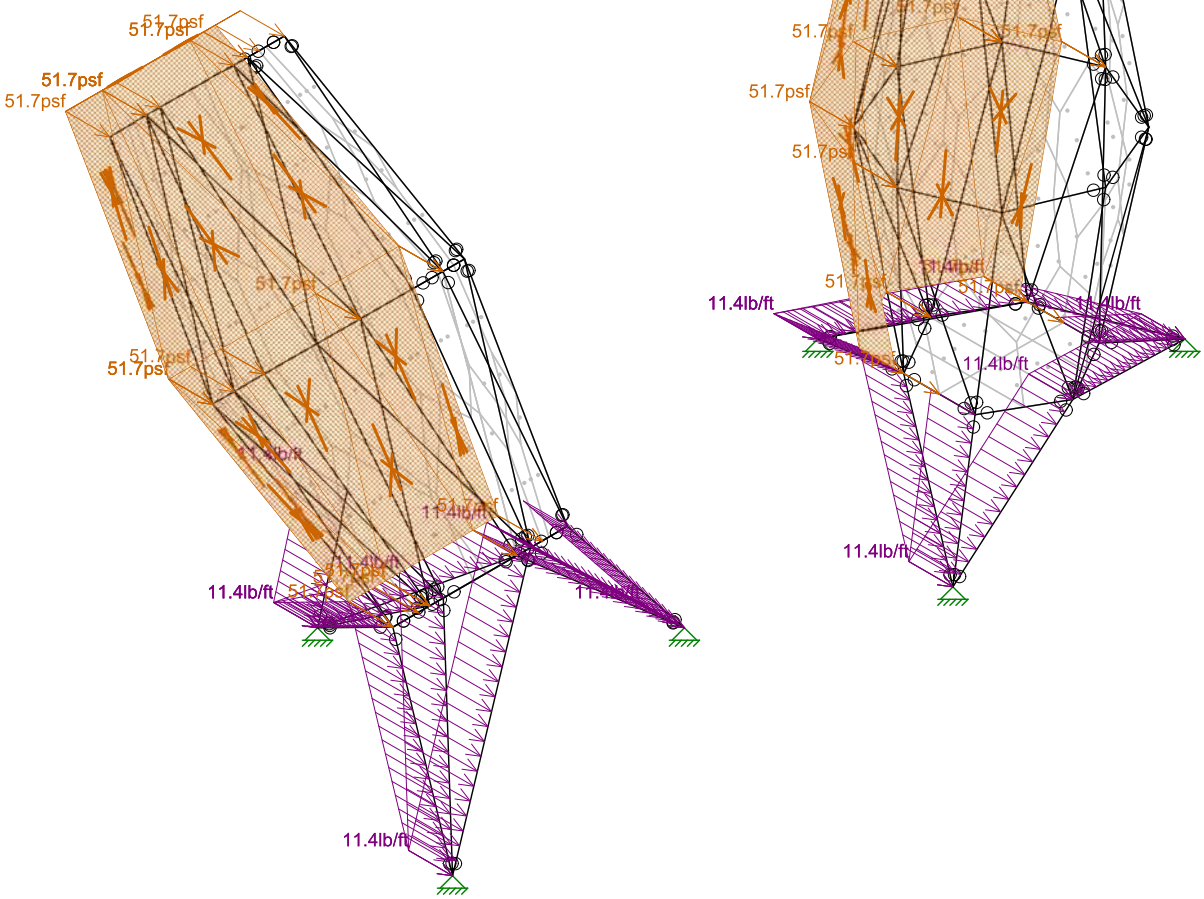
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Starling Madison Lofquist, ...	Tempe I-10 Bridge Art	
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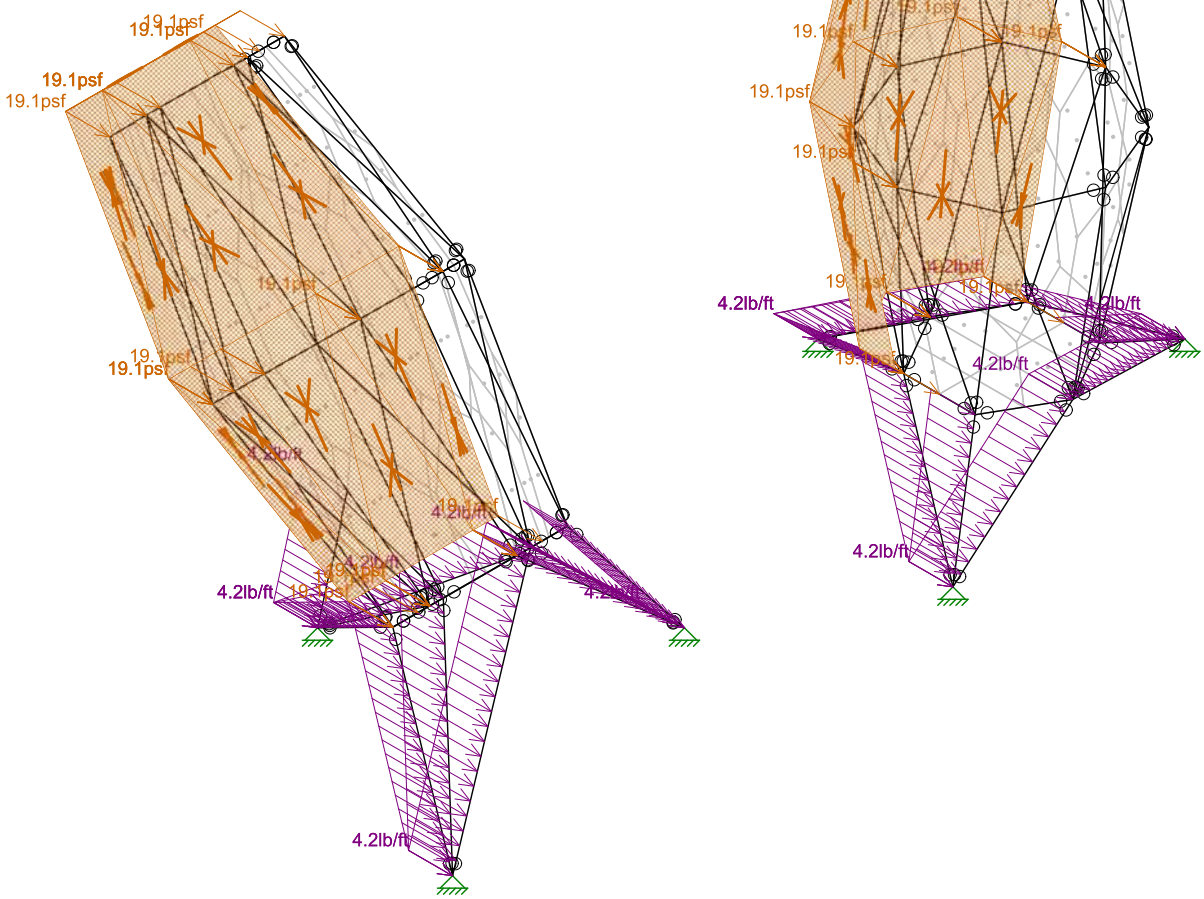


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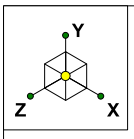
Loads: BLC 2, Wind Load-X LC1&2

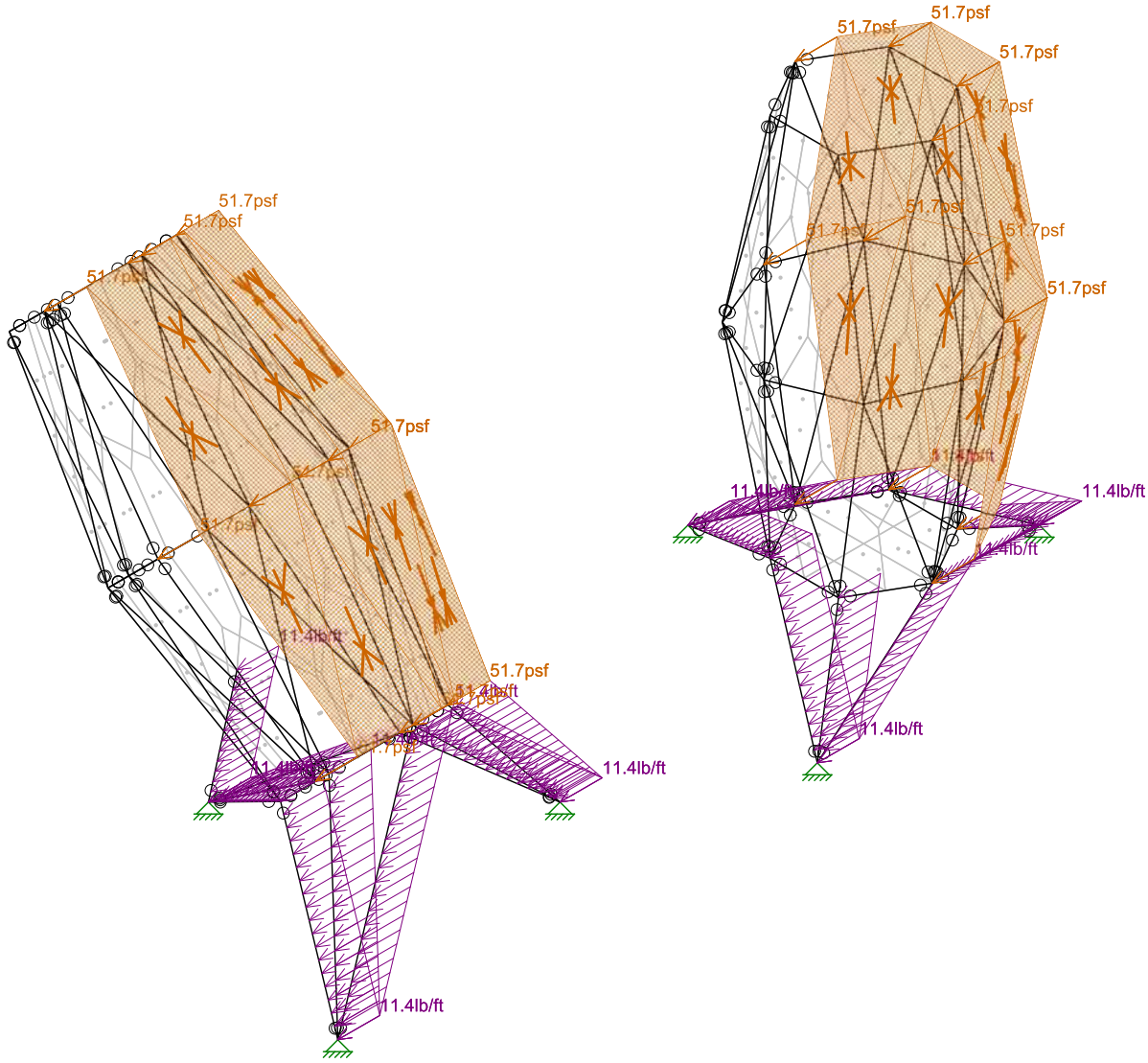
Starling Madison Lofquist, ...		
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1018-19		1018-19 Public Art Installations He...



Loads: BLC 4, Wind Load-X LC3

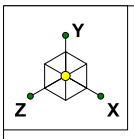
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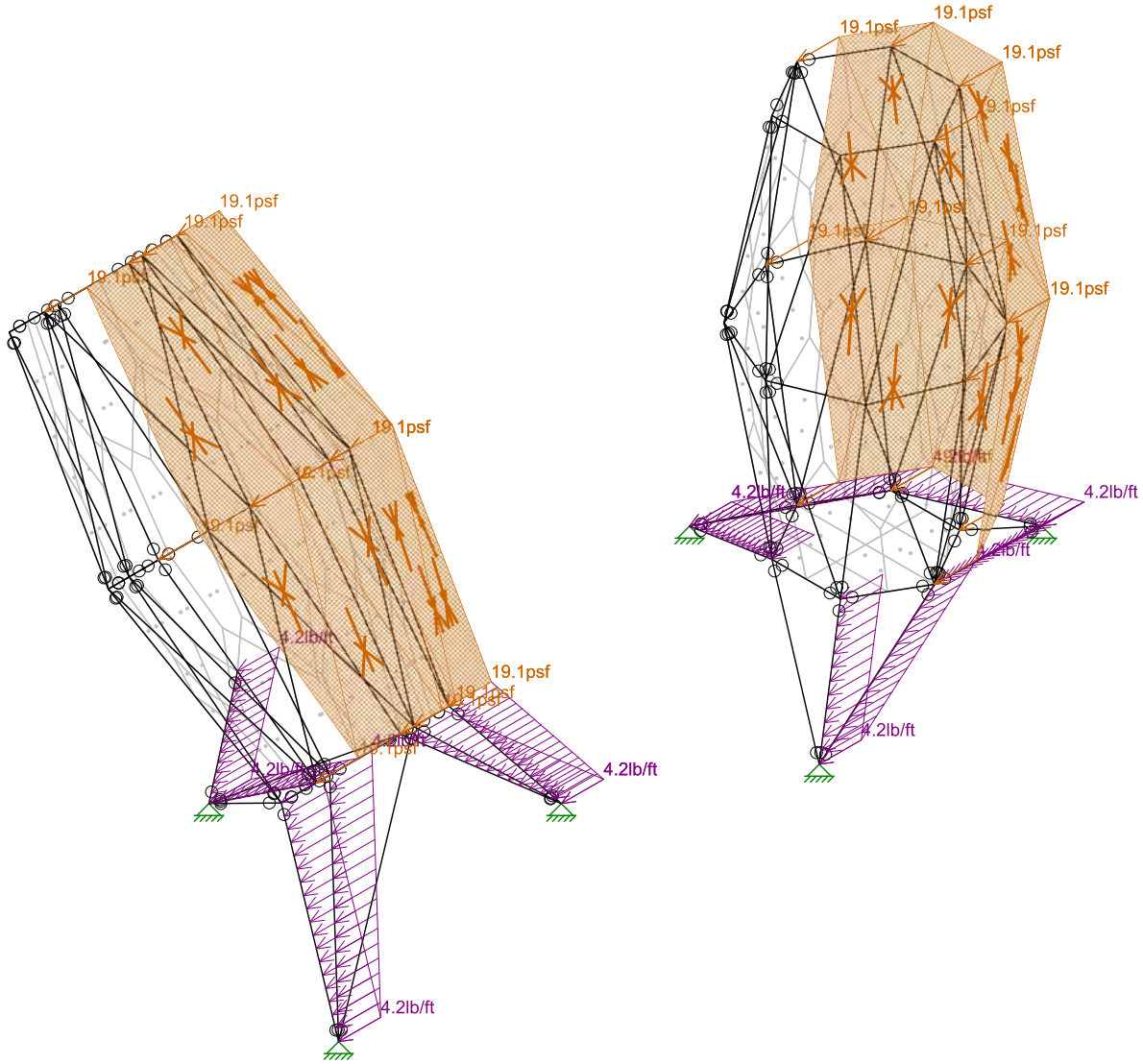




Loads: BLC 3, Wind Load-Z LC1&2

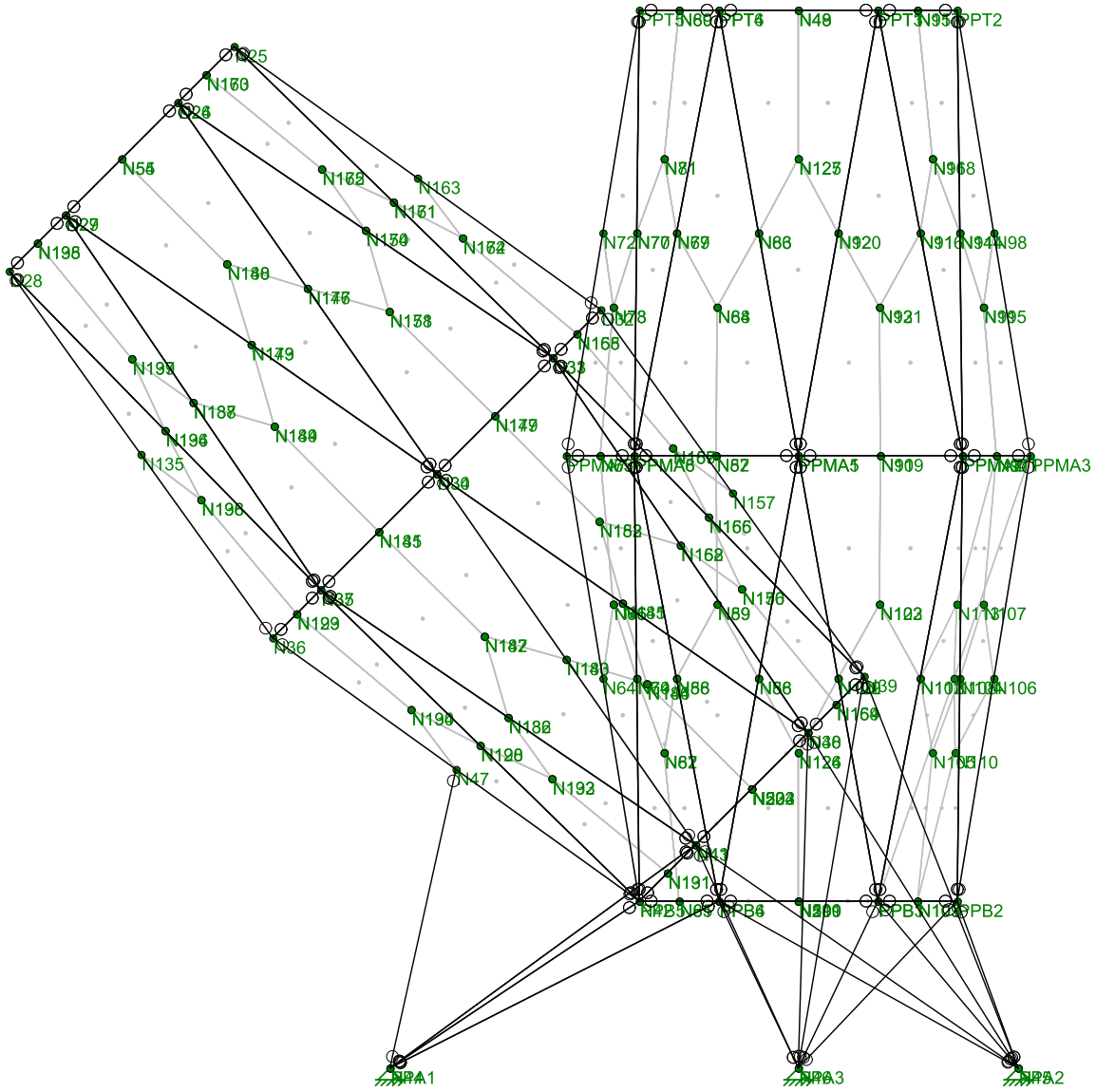
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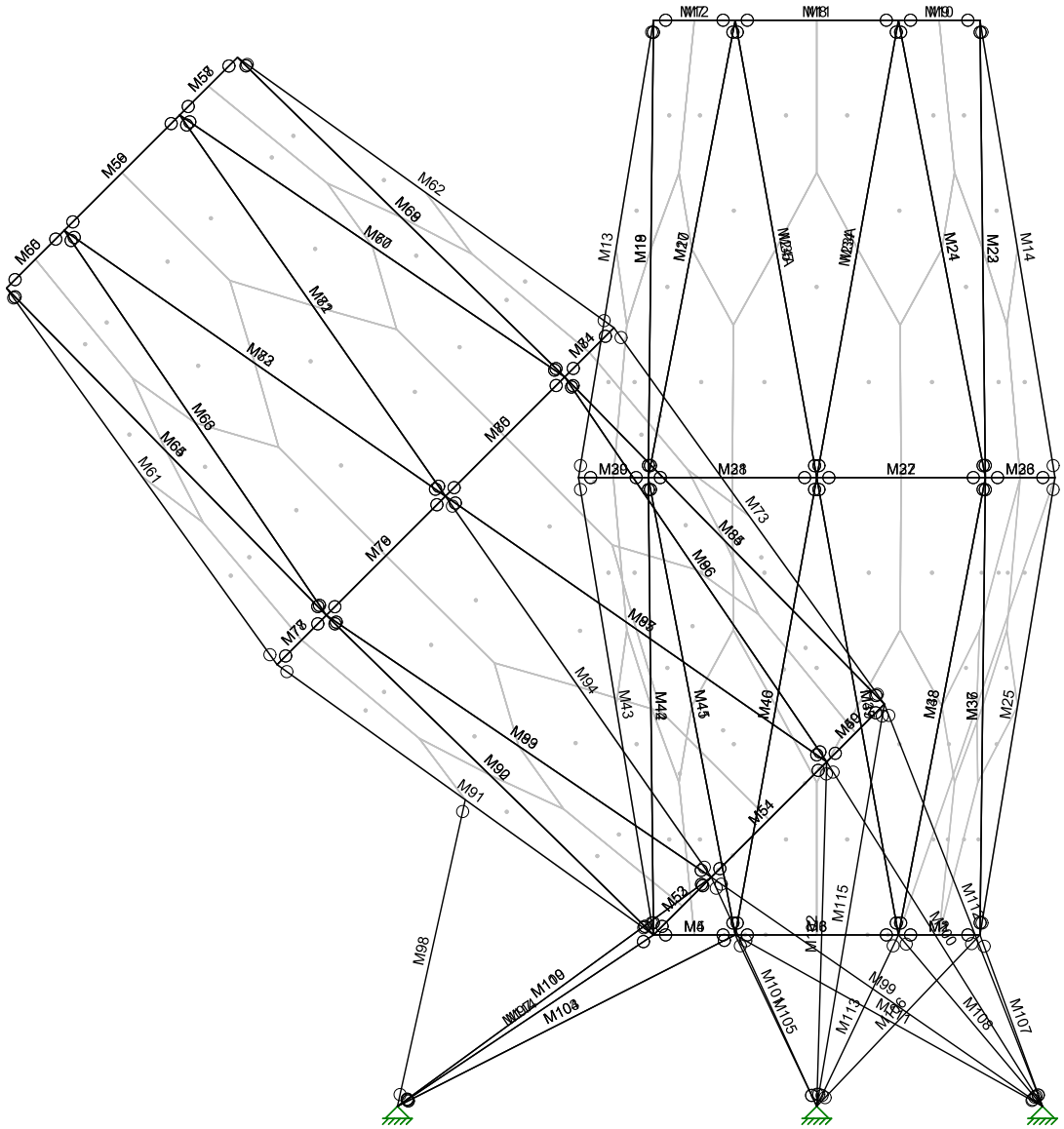


Loads: BLC 5, Wind Load-Z LC3

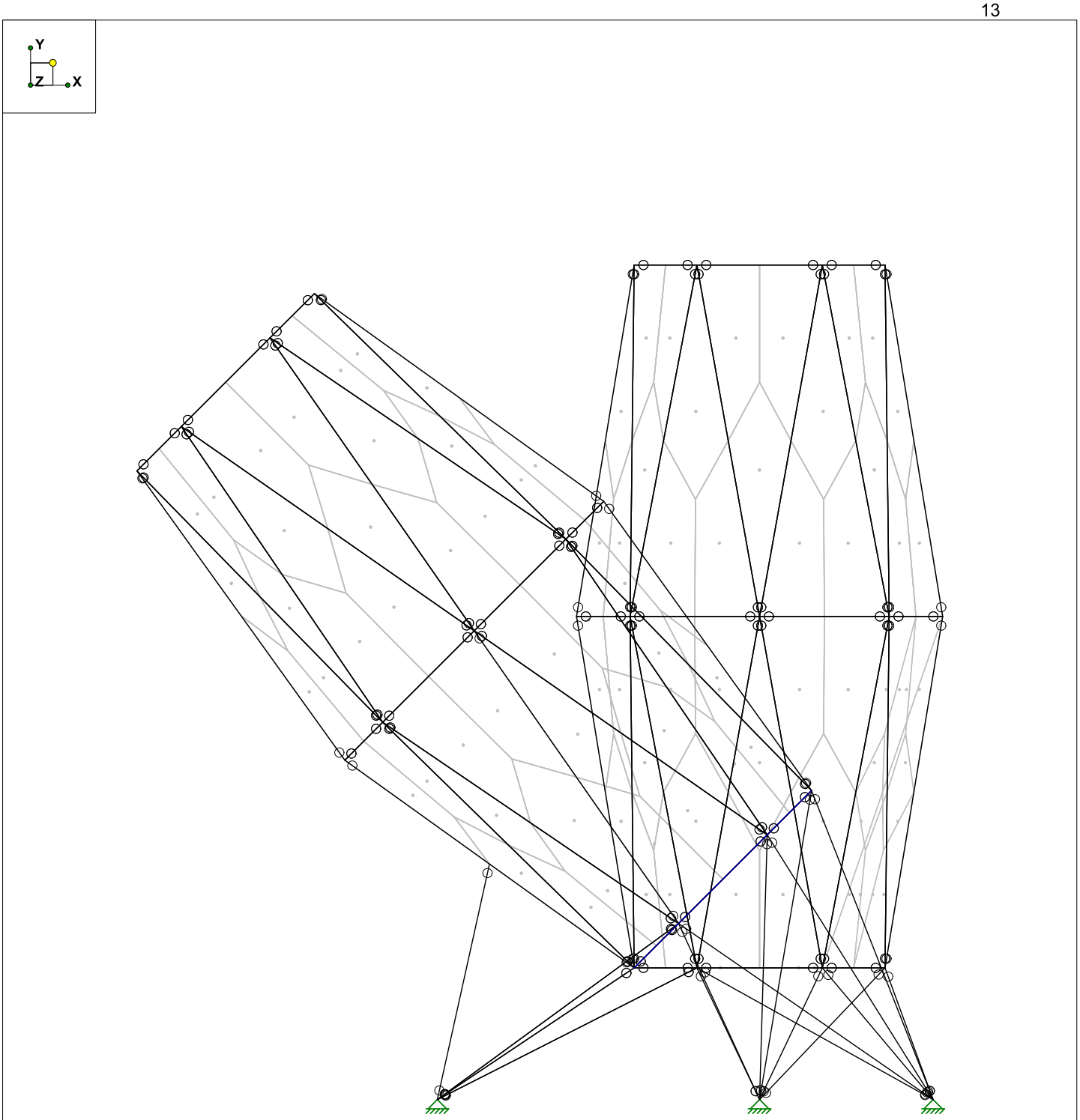
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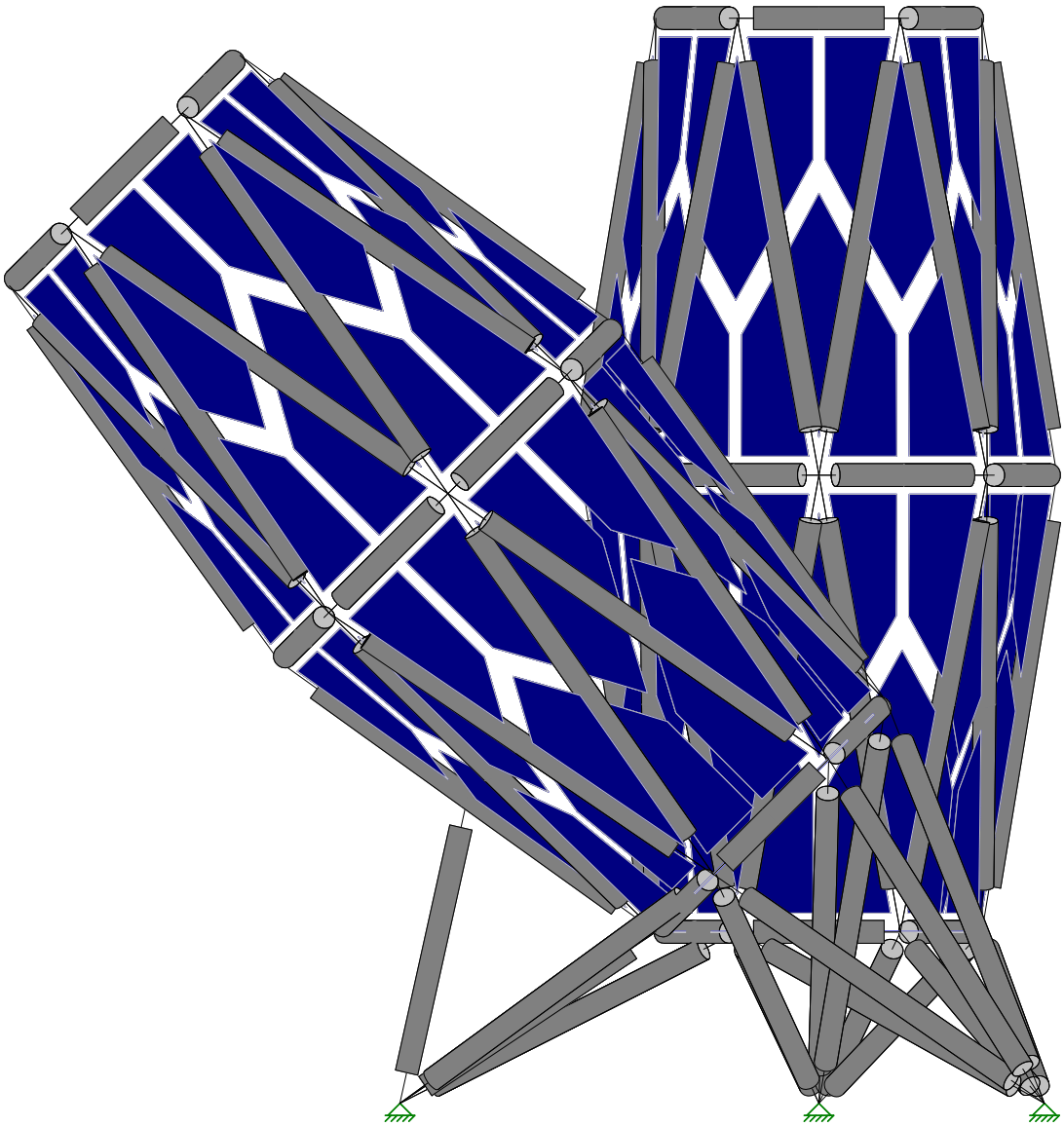
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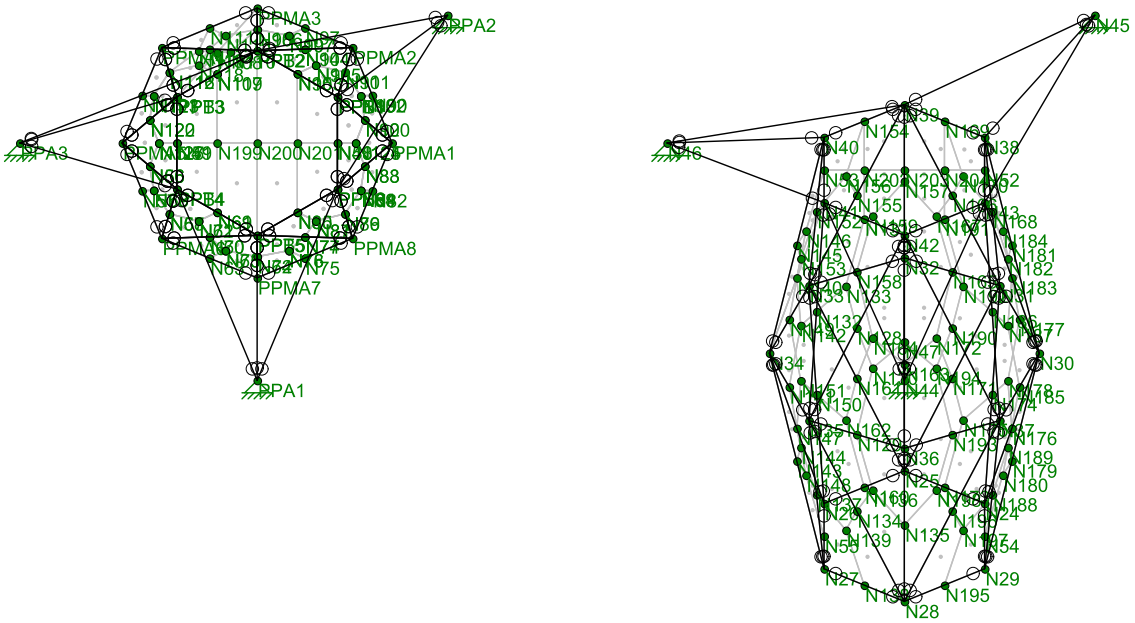
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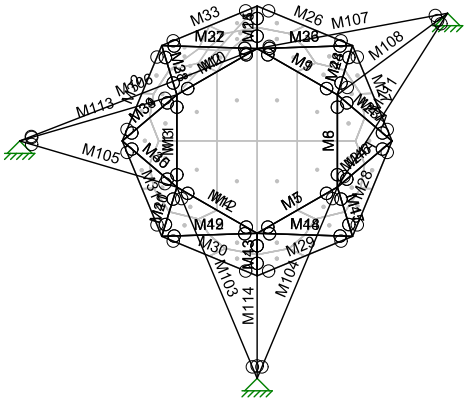
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1018-19		1018-19 Public Art Installations He...

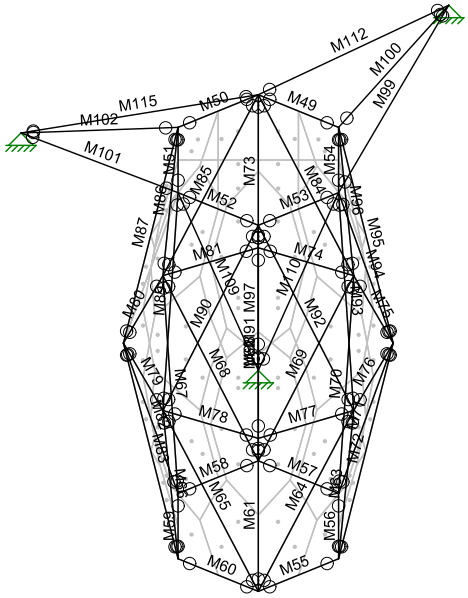


Starling Madison Lofquist, ...		
PP	Tempe I-10 Bridge Art	Dec 17, 2019 at 4:00 PM
1018-19		1018-19 Public Art Installations He...

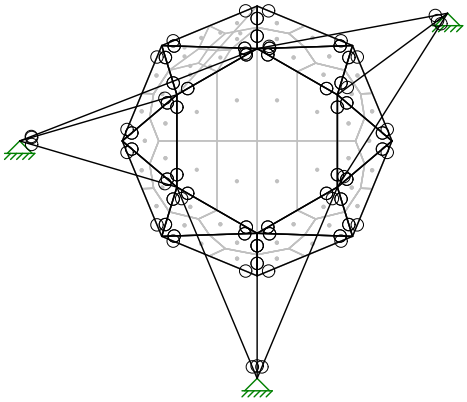


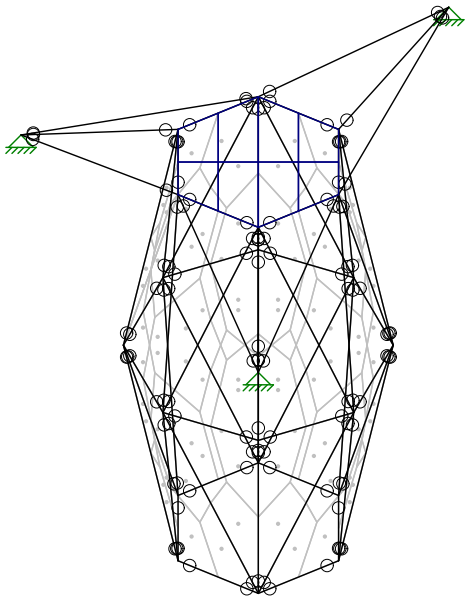
Starling Madison Lofquist, ...		
PP	Tempe I-10 Bridge Art	Dec 17, 2019 at 4:58 PM
1018-19		1018-19 Public Art Installations He...



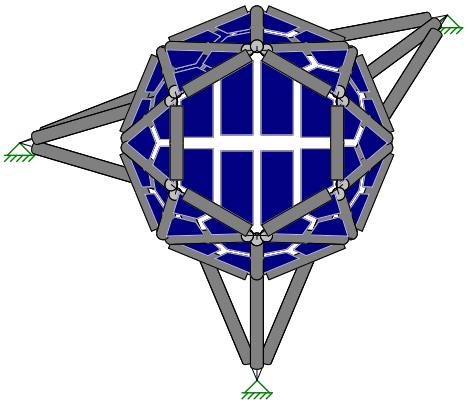


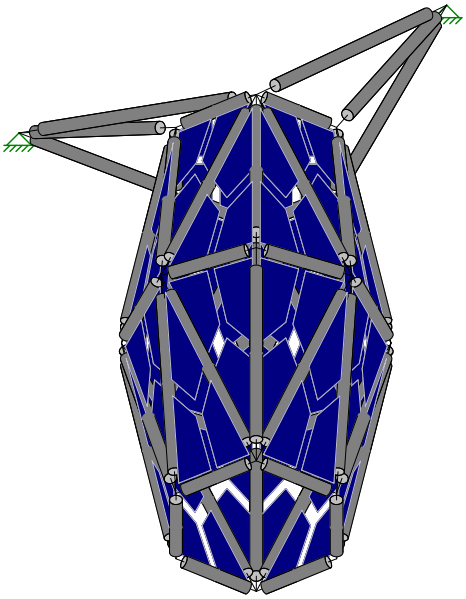
Starling Madison Lofquist, ...	Tempe I-10 Bridge Art	
PP		Dec 17, 2019 at 4:57 PM
1018-19		1018-19 Public Art Installations He...



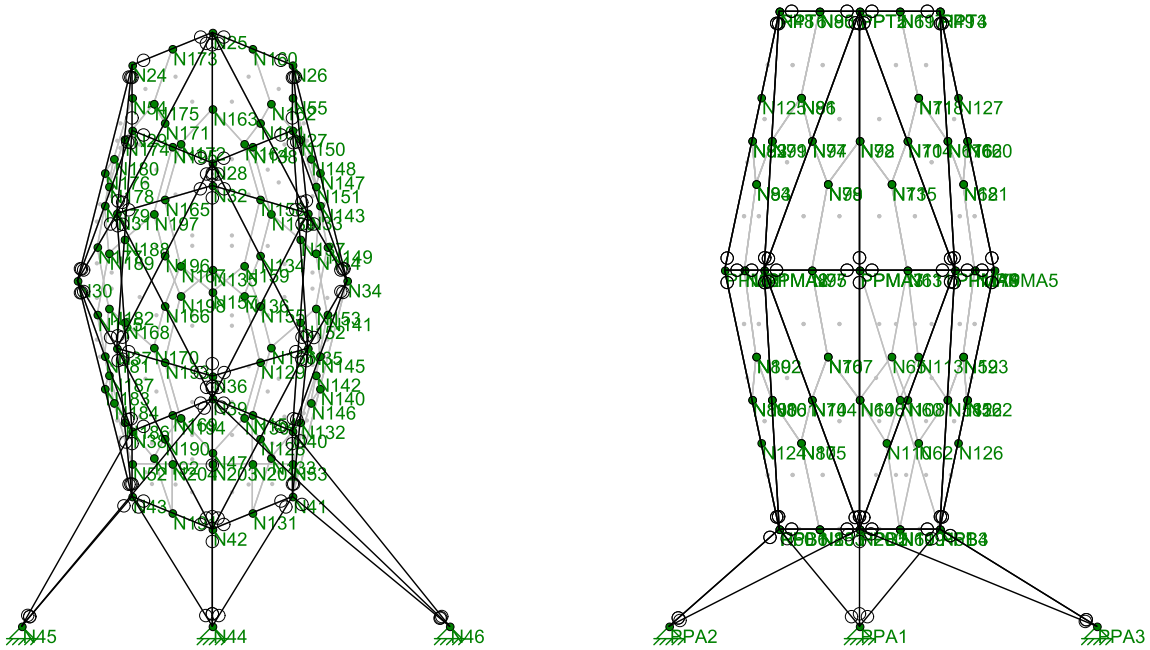


Starling Madison Lofquist, ...	Tempe I-10 Bridge Art	
PP		Dec 17, 2019 at 4:10 PM
1018-19		1018-19 Public Art Installations He...

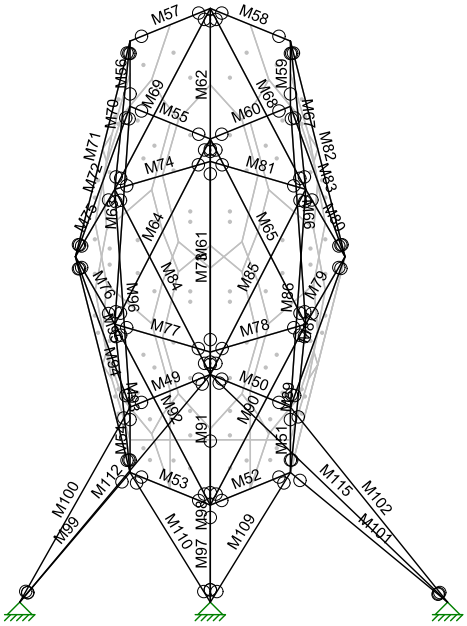


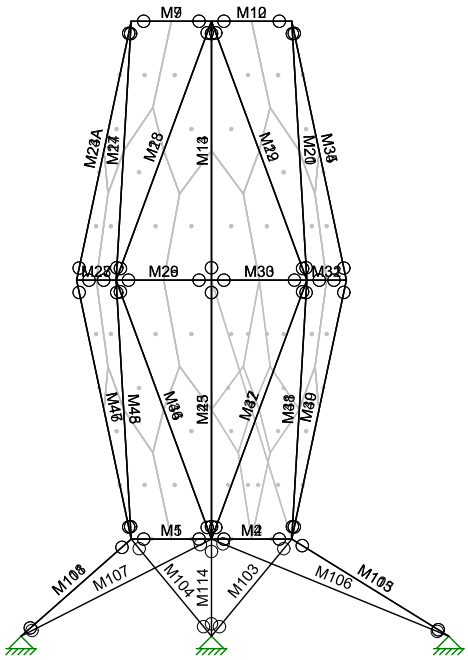


Starling Madison Lofquist, ...	Tempe I-10 Bridge Art	
PP		Dec 17, 2019 at 4:01 PM
1018-19		1018-19 Public Art Installations He...

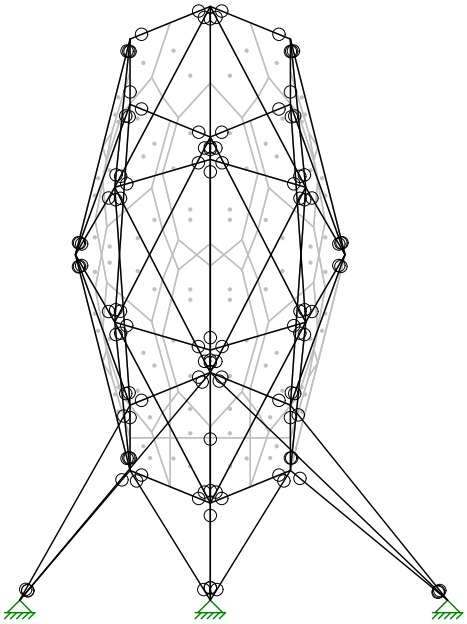


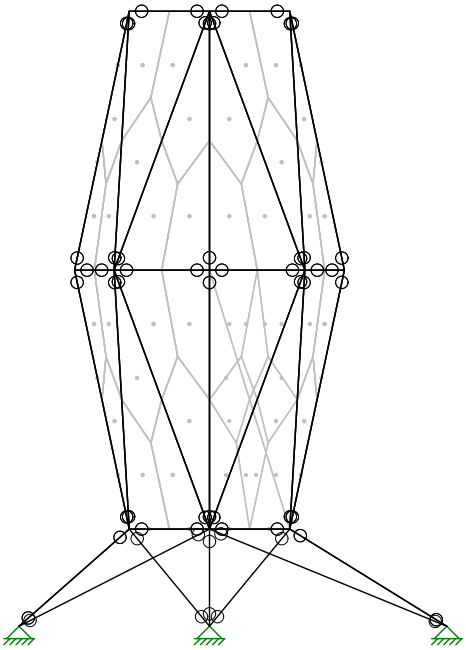
Starling Madison Lofquist, ...		
PP	Tempe I-10 Bridge Art	Dec 17, 2019 at 4:59 PM
1018-19		1018-19 Public Art Installations He...



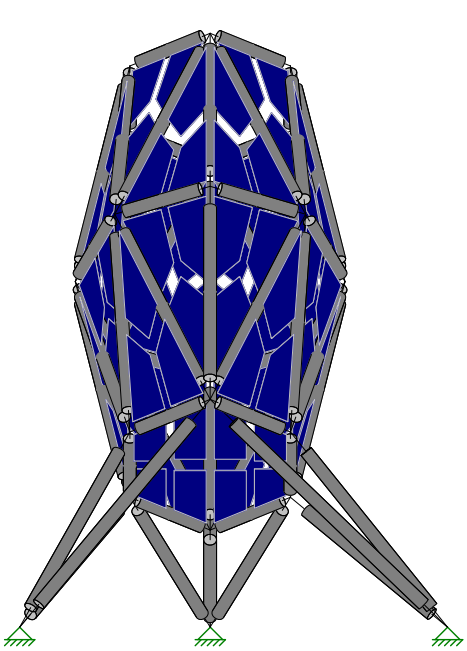


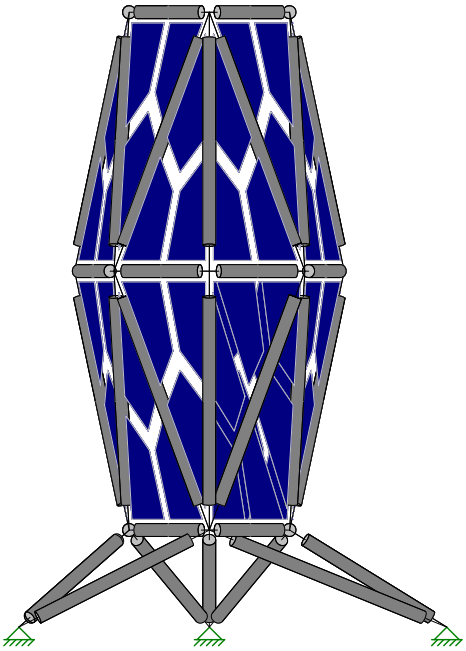
Starling Madison Lofquist, ...		
PP	Tempe I-10 Bridge Art	Dec 17, 2019 at 4:58 PM
1018-19		1018-19 Public Art Installations He...



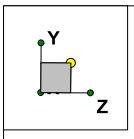


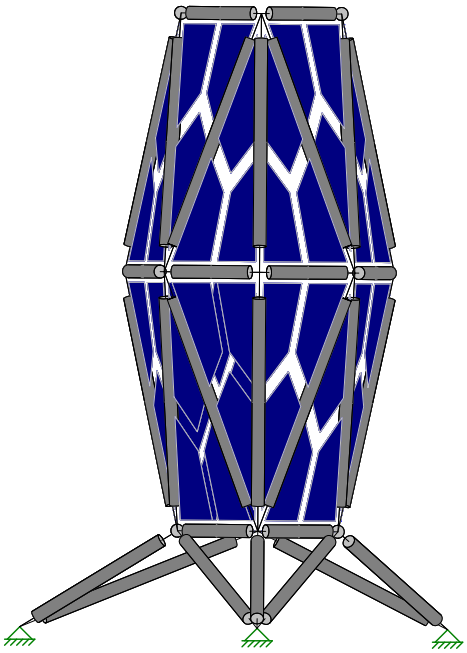
Starling Madison Lofquist, ...	Tempe I-10 Bridge Art	
PP		Dec 17, 2019 at 4:11 PM
1018-19		1018-19 Public Art Installations He...

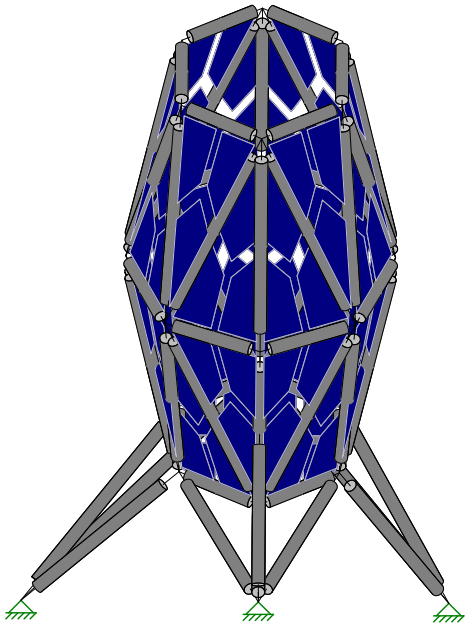




Starling Madison Lofquist, ...	Tempe I-10 Bridge Art	
PP		Dec 17, 2019 at 4:01 PM
1018-19		1018-19 Public Art Installations He...







Starling Madison Lofquist, ...		
PP	Tempe I-10 Bridge Art	Dec 17, 2019 at 4:02 PM
1018-19		1018-19 Public Art Installations He...

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (/1E..	Density[k/ft...	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A500 Gr.B RND	29000	11154	.3	.65	.527	42	1.4	58	1.3
2	A500 Gr. C RND	29000	11154	.3	.65	.527	46	1.4	62	1.3

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	HSS2.375x0.109 ...	HSS2.375x0.109	Column	Tube	A500 Gr.B R...	Typical	.776	.499	.499	.998
2	HSS2.375x0.109 ...	HSS2.375x0.109	Column	Tube	A500 Gr.B R...	Typical	.776	.499	.499	.998

Joint Coordinates and Temperatures

	Label	X [in]	Y [in]	Z [in]	Temp [F]	Detach From Diap...
1	PPT1	8.562497	95.999962	14.874994	0	
2	PPT2	17.124993	95.999962	0	0	
3	PPT3	8.562497	95.999962	-14.874994	0	
4	PPT4	-8.562497	95.999962	-14.874994	0	
5	PPT5	-17.124993	95.999962	0	0	
6	PPT6	-8.562497	95.999962	14.874994	0	
7	PPMA1	0	47.999981	24.99999	0	
8	PPMA2	17.687493	47.999981	17.687493	0	
9	PPMA3	24.99999	47.999981	0	0	
10	PPMA4	17.687493	47.999981	-17.687493	0	
11	PPMA5	0	47.999981	-24.99999	0	
12	PPMA6	-17.687493	47.999981	-17.687493	0	
13	PPMA7	-24.99999	47.999981	0	0	
14	PPMA8	-17.687493	47.999981	17.687493	0	
15	PPB1	8.562497	0	14.874994	0	
16	PPB2	17.124993	0	0	0	
17	PPB3	8.562497	0	-14.874994	0	
18	PPB4	-8.562497	0	-14.874994	0	
19	PPB5	-17.124993	0	0	0	
20	PPB6	-8.562497	0	14.874994	0	
21	PPA1	-44	-18	0	0	
22	PPA2	23.6875	-18	35.3125	0	
23	PPA3	0	-18	-44	0	
24	N24	-66.843419	86.046022	134.874994	0	
25	N25	-60.788819	92.100621	120	0	
26	N26	-66.843419	86.046022	105.125006	0	
27	N27	-78.952618	73.936823	105.125006	0	
28	N28	-85.007217	67.882224	120	0	
29	N29	-78.952618	73.936823	134.874994	0	
30	N30	-38.956906	46.050311	144.99999	0	
31	N31	-26.44996	58.557257	137.687493	0	
32	N32	-21.279244	63.727973	120	0	
33	N33	-26.44996	58.557257	102.312507	0	
34	N34	-38.956906	46.050311	95.00001	0	
35	N35	-51.463852	33.543365	102.312507	0	
36	N36	-56.634569	28.372648	120	0	
37	N37	-51.463852	33.543365	137.687493	0	
38	N38	1.038805	18.163798	134.874994	0	

Joint Coordinates and Temperatures (Continued)

	Label	X [in]	Y [in]	Z [in]	Temp [F]	Detach From Diap...
39	N39	7.093404	24.218398	120	0	
40	N40	1.038805	18.163798	105.125006	0	
41	N41	-11.070394	6.054599	105.125006	0	
42	N42	-17.124993	0	120	0	
43	N43	-11.070394	6.054599	134.874994	0	
44	N44	-44	-18	120	0	
45	N45	23.6875	-18	155.3124	0	
46	N46	0	-18	76	0	
47	N47	-36.879781	14.186324	120	0	
48	N48	0	95.999962	14.874994	0	
49	N49	0	95.999962	-14.874994	0	
50	N50	0	0	14.874994	0	
51	N51	0	0	-14.874994	0	
52	N52	-5.015794	12.109199	134.874994	0	
53	N53	-5.015794	12.109199	105.125006	0	
54	N54	-72.898018	79.991423	134.874994	0	
55	N55	-72.898018	79.991423	105.125006	0	
56	N56	-4.281248	23.99999	-19.937492	0	
57	N57	-8.843746	47.999981	-21.343741	0	
58	N58	-13.124995	23.99999	-16.281243	0	
59	N59	-8.749996	31.999987	-19.187492	0	
60	N60	-17.406243	23.99999	-8.843746	0	
61	N61	-12.843745	0	-7.437497	0	
62	N62	-14.458328	15.999994	-10.854162	0	
63	N63	-21.343741	47.999981	-8.843746	0	
64	N64	-21.062492	23.99999	0	0	
65	N65	-19.937492	31.999987	-5.895831	0	
66	N66	-4.281248	71.999971	-19.937492	0	
67	N67	-13.124995	71.999971	-16.281243	0	
68	N68	-8.749996	63.999974	-19.187492	0	
69	N69	-12.843745	95.999962	-7.437497	0	
70	N70	-17.406243	71.999971	-8.843746	0	
71	N71	-14.458328	79.999968	-10.854162	0	
72	N72	-21.062492	71.999971	0	0	
73	N73	-19.937492	63.999974	-5.895831	0	
74	N74	-17.406243	23.99999	8.843746	0	
75	N75	-21.343741	47.999981	8.843746	0	
76	N76	-19.937492	31.999987	5.895831	0	
77	N77	-17.406243	71.999971	8.843746	0	
78	N78	-19.937492	63.999974	5.895831	0	
79	N79	-13.124995	71.999971	16.281243	0	
80	N80	-12.843745	95.999962	7.437497	0	
81	N81	-14.458328	79.999968	10.854162	0	
82	N82	-8.843746	47.999981	21.343741	0	
83	N83	-4.281248	71.999971	19.937492	0	
84	N84	-8.749996	63.999974	19.187492	0	
85	N85	-12.843745	0	7.437497	0	
86	N86	-13.124995	23.99999	16.281243	0	
87	N87	-14.458328	15.999994	10.854162	0	
88	N88	-4.281248	23.99999	19.937492	0	
89	N89	-8.749996	31.999987	19.187492	0	
90	N90	8.843746	47.999981	21.343741	0	

Joint Coordinates and Temperatures (Continued)

	Label	X [in]	Y [in]	Z [in]	Temp [F]	Detach From Diap...
91	N91	13.124995	71.999971	16.281243	0	
92	N92	4.281248	71.999971	19.937492	0	
93	N93	8.749996	63.999974	19.187492	0	
94	N94	17.406243	71.999971	8.843746	0	
95	N95	12.843745	95.999962	7.437497	0	
96	N96	14.458328	79.999968	10.854162	0	
97	N97	21.343741	47.999981	8.843746	0	
98	N98	21.062492	71.999971	0	0	
99	N99	19.937492	63.999974	5.895831	0	
100	N100	4.281248	23.99999	19.937492	0	
101	N101	13.124995	23.99999	16.281243	0	
102	N102	8.749996	31.999987	19.187492	0	
103	N103	12.843745	0	7.437497	0	
104	N104	17.406243	23.99999	8.843746	0	
105	N105	14.458328	15.999994	10.854162	0	
106	N106	21.062492	23.99999	0	0	
107	N107	19.937492	31.999987	5.895831	0	
108	N108	16.781243	23.99999	-7.437497	0	
109	N109	12.843745	0	-7.437497	0	
110	N110	16.895827	15.999994	-4.958331	0	
111	N111	21.343741	47.999981	-8.843746	0	
112	N112	13.124995	23.99999	-16.281243	0	
113	N113	17.083327	31.999987	-10.854162	0	
114	N114	17.406243	71.999971	-8.843746	0	
115	N115	19.937492	63.999974	-5.895831	0	
116	N116	13.124995	71.999971	-16.281243	0	
117	N117	12.843745	95.999962	-7.437497	0	
118	N118	14.458328	79.999968	-10.854162	0	
119	N119	8.843746	47.999981	-21.343741	0	
120	N120	4.281248	71.999971	-19.937492	0	
121	N121	8.749996	63.999974	-19.187492	0	
122	N122	4.281248	23.99999	-19.937492	0	
123	N123	8.749996	31.999987	-19.187492	0	
124	N124	0	15.999994	18.249993	0	
125	N125	0	79.999968	18.249993	0	
126	N126	0	15.999994	-18.249993	0	
127	N127	0	79.999968	-18.249993	0	
128	N128	-34.294423	16.771682	111.156254	0	
129	N129	-54.049211	30.958006	111.156254	0	
130	N130	-41.741138	20.638671	114.104169	0	
131	N131	-14.097693	3.0273	112.562503	0	
132	N132	-31.267123	19.798982	103.718757	0	
133	N133	-26.55308	13.199321	109.145838	0	
134	N134	-68.235535	50.712794	111.156254	0	
135	N135	-70.820893	48.127436	120	0	
136	N136	-64.368546	43.266079	114.104169	0	
137	N137	-65.208235	53.740094	103.718757	0	
138	N138	-81.979917	70.909524	112.562503	0	
139	N139	-71.807896	58.454137	109.145838	0	
140	N140	-25.01365	26.052455	100.062508	0	
141	N141	-45.210379	39.796838	98.656259	0	
142	N142	-33.830384	28.549425	100.812508	0	

Joint Coordinates and Temperatures (Continued)

	Label	X [in]	Y [in]	Z [in]	Temp [F]	Detach From Diap...
143	N143	-58.954762	59.993567	100.062508	0	
144	N144	-56.457792	51.176833	100.812508	0	
145	N145	-18.959051	32.107054	100.062508	0	
146	N146	-16.329498	23.422903	101.750007	0	
147	N147	-52.900163	66.048166	100.062508	0	
148	N148	-61.584314	68.677719	101.750007	0	
149	N149	-32.703433	52.303784	98.656259	0	
150	N150	-46.646689	72.301639	103.718757	0	
151	N151	-44.083428	63.551197	100.812508	0	
152	N152	-12.705578	38.360528	103.718757	0	
153	N153	-21.45602	40.923789	100.812508	0	
154	N154	4.066105	21.191098	112.562503	0	
155	N155	-9.678278	41.387827	111.156254	0	
156	N156	-6.105917	33.646484	109.145838	0	
157	N157	-7.09292	43.973185	120	0	
158	N158	-23.864602	61.142615	111.156254	0	
159	N159	-13.545267	48.834543	114.104169	0	
160	N160	-63.816119	89.073322	112.562503	0	
161	N161	-43.61939	75.328939	111.156254	0	
162	N162	-51.360733	78.9013	109.145838	0	
163	N163	-41.034032	77.914297	120	0	
164	N164	-36.172674	71.46195	114.104169	0	
165	N165	-23.864602	61.142615	128.843746	0	
166	N166	-9.678278	41.387827	128.843746	0	
167	N167	-13.545267	48.834543	125.895831	0	
168	N168	-12.705578	38.360528	136.281243	0	
169	N169	4.066105	21.191098	127.437497	0	
170	N170	-6.105917	33.646484	130.854162	0	
171	N171	-43.61939	75.328939	128.843746	0	
172	N172	-36.172674	71.46195	125.895831	0	
173	N173	-63.816119	89.073322	127.437497	0	
174	N174	-46.646689	72.301639	136.281243	0	
175	N175	-51.360733	78.9013	130.854162	0	
176	N176	-52.900163	66.048166	139.937492	0	
177	N177	-32.703433	52.303784	141.343741	0	
178	N178	-44.083428	63.551197	139.187492	0	
179	N179	-58.954762	59.993567	139.937492	0	
180	N180	-61.584314	68.677719	138.249993	0	
181	N181	-18.959051	32.107054	139.937492	0	
182	N182	-21.45602	40.923789	139.187492	0	
183	N183	-25.01365	26.052455	139.937492	0	
184	N184	-16.329498	23.422903	138.249993	0	
185	N185	-45.210379	39.796838	141.343741	0	
186	N186	-31.267123	19.798982	136.281243	0	
187	N187	-33.830384	28.549425	139.187492	0	
188	N188	-65.208235	53.740094	136.281243	0	
189	N189	-56.457792	51.176833	139.187492	0	
190	N190	-34.294423	16.771682	128.843746	0	
191	N191	-14.097693	3.0273	127.437497	0	
192	N192	-26.55308	13.199321	130.854162	0	
193	N193	-54.049211	30.958006	128.843746	0	
194	N194	-41.741138	20.638671	125.895831	0	

Joint Coordinates and Temperatures (Continued)

	Label	X [in]	Y [in]	Z [in]	Temp [F]	Detach From Diap...
195	N195	-81.979917	70.909524	127.437497	0	
196	N196	-68.235535	50.712794	128.843746	0	
197	N197	-71.807896	58.454137	130.854162	0	
198	N198	-64.368546	43.266079	125.895831	0	
199	N199	0	0	-7.437497	0	
200	N200	0	0	0	0	
201	N201	0	0	7.437497	0	
202	N202	-5.015794	12.109199	112.562503	0	
203	N203	-5.015794	12.109199	120	0	
204	N204	-5.015794	12.109199	127.437497	0	

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N45	Reaction	Reaction	Reaction			
2	N46	Reaction	Reaction	Reaction			
3	N44	Reaction	Reaction	Reaction			
4	PPA2	Reaction	Reaction	Reaction			
5	PPA3	Reaction	Reaction	Reaction			
6	PPA1	Reaction	Reaction	Reaction			

Hot Rolled Steel Design Parameters

	Label	Shape	Length[in]	Lbyy[in]	Lbzz[in]	Lcomp top[i...	Lcomp bot[i...	L-torq...	Kyy	Kzz	Cb	Functi...
1	M1	HSS2.375x0.109 ...	17.163									Lateral
2	M2	HSS2.375x0.109 ...	17.163									Lateral
3	M3	HSS2.375x0.109 ...	17.125									Lateral
4	M4	HSS2.375x0.109 ...	17.163									Lateral
5	M5	HSS2.375x0.109 ...	17.163									Lateral
6	M6	HSS2.375x0.109 ...	17.125									Lateral
7	M7	HSS2.375x0.109 ...	17.163									Lateral
8	M8	HSS2.375x0.109 ...	17.125									Lateral
9	M9	HSS2.375x0.109 ...	17.163									Lateral
10	M10	HSS2.375x0.109 ...	17.163									Lateral
11	M11	HSS2.375x0.109 ...	17.125									Lateral
12	M12	HSS2.375x0.109 ...	17.163									Lateral
13	M13	HSS2.375x0.109 ...	48.642									Lateral
14	M14	HSS2.375x0.109 ...	48.642									Lateral
15	M17	HSS2.375x0.109 ...	48.941									Lateral
16	M18	HSS2.375x0.109 ...	51.158									Lateral
17	M19	HSS2.375x0.109 ...	51.158									Lateral
18	M20	HSS2.375x0.109 ...	48.941									Lateral
19	M21	HSS2.375x0.109 ...	48.941									Lateral
20	M22	HSS2.375x0.109 ...	51.158									Lateral
21	M23	HSS2.375x0.109 ...	51.158									Lateral
22	M24	HSS2.375x0.109 ...	48.941									Lateral
23	M23A	HSS2.375x0.109 ...	49.798									Lateral
24	M24A	HSS2.375x0.109 ...	49.798									Lateral
25	M25	HSS2.375x0.109 ...	48.642									Lateral
26	M26	HSS2.375x0.109 ...	19.139									Lateral
27	M27	HSS2.375x0.109 ...	19.139									Lateral

Hot Rolled Steel Design Parameters (Continued)

	Label	Shape	Length[in]	Lbyy[in]	Lbzz[in]	Lcomp top[i...	Lcomp bot[i...	L-torq...	Kyy	Kzz	Cb	Functi...
28	M28	HSS2.375x0.109 ...	19.139									Lateral
29	M29	HSS2.375x0.109 ...	19.139									Lateral
30	M30	HSS2.375x0.109 ...	19.139									Lateral
31	M31	HSS2.375x0.109 ...	19.139									Lateral
32	M32	HSS2.375x0.109 ...	19.139									Lateral
33	M33	HSS2.375x0.109 ...	19.139									Lateral
34	M34	HSS2.375x0.109 ...	49.798									Lateral
35	M35	HSS2.375x0.109 ...	49.798									Lateral
36	M36	HSS2.375x0.109 ...	51.158									Lateral
37	M37	HSS2.375x0.109 ...	51.158									Lateral
38	M38	HSS2.375x0.109 ...	48.941									Lateral
39	M39	HSS2.375x0.109 ...	49.798									Lateral
40	M40	HSS2.375x0.109 ...	49.798									Lateral
41	M41	HSS2.375x0.109 ...	48.941									Lateral
42	M42	HSS2.375x0.109 ...	51.158									Lateral
43	M43	HSS2.375x0.109 ...	48.642									Lateral
44	M44	HSS2.375x0.109 ...	51.158									Lateral
45	M45	HSS2.375x0.109 ...	48.941									Lateral
46	M46	HSS2.375x0.109 ...	49.798									Lateral
47	M47	HSS2.375x0.109 ...	49.798									Lateral
48	M48	HSS2.375x0.109 ...	48.941									Lateral
49	M49	HSS2.375x0.109 ...	17.163									Lateral
50	M50	HSS2.375x0.109 ...	17.163									Lateral
51	M51	HSS2.375x0.109 ...	17.125									Lateral
52	M52	HSS2.375x0.109 ...	17.163									Lateral
53	M53	HSS2.375x0.109 ...	17.163									Lateral
54	M54	HSS2.375x0.109 ...	17.125									Lateral
55	M55	HSS2.375x0.109 ...	17.163									Lateral
56	M56	HSS2.375x0.109 ...	17.125									Lateral
57	M57	HSS2.375x0.109 ...	17.163									Lateral
58	M58	HSS2.375x0.109 ...	17.163									Lateral
59	M59	HSS2.375x0.109 ...	17.125									Lateral
60	M60	HSS2.375x0.109 ...	17.163									Lateral
61	M61	HSS2.375x0.109 ...	48.642									Lateral
62	M62	HSS2.375x0.109 ...	48.642									Lateral
63	M63	HSS2.375x0.109 ...	48.941									Lateral
64	M64	HSS2.375x0.109 ...	51.158									Lateral
65	M65	HSS2.375x0.109 ...	51.158									Lateral
66	M66	HSS2.375x0.109 ...	48.941									Lateral
67	M67	HSS2.375x0.109 ...	48.941									Lateral
68	M68	HSS2.375x0.109 ...	51.158									Lateral
69	M69	HSS2.375x0.109 ...	51.158									Lateral
70	M70	HSS2.375x0.109 ...	48.941									Lateral
71	M71	HSS2.375x0.109 ...	49.798									Lateral
72	M72	HSS2.375x0.109 ...	49.798									Lateral
73	M73	HSS2.375x0.109 ...	48.642									Lateral
74	M74	HSS2.375x0.109 ...	19.139									Lateral
75	M75	HSS2.375x0.109 ...	19.139									Lateral
76	M76	HSS2.375x0.109 ...	19.139									Lateral
77	M77	HSS2.375x0.109 ...	19.139									Lateral
78	M78	HSS2.375x0.109 ...	19.139									Lateral
79	M79	HSS2.375x0.109 ...	19.139									Lateral

Hot Rolled Steel Design Parameters (Continued)

	Label	Shape	Length[in]	Lbyy[in]	Lbzz[in]	Lcomp top[i...	Lcomp bot[i...	L-torq...	Kyy	Kzz	Cb	Functi...
80	M80	HSS2.375x0.109 ...	19.139									Lateral
81	M81	HSS2.375x0.109 ...	19.139									Lateral
82	M82	HSS2.375x0.109 ...	49.798									Lateral
83	M83	HSS2.375x0.109 ...	49.798									Lateral
84	M84	HSS2.375x0.109 ...	51.158									Lateral
85	M85	HSS2.375x0.109 ...	51.158									Lateral
86	M86	HSS2.375x0.109 ...	48.941									Lateral
87	M87	HSS2.375x0.109 ...	49.798									Lateral
88	M88	HSS2.375x0.109 ...	49.798									Lateral
89	M89	HSS2.375x0.109 ...	48.941									Lateral
90	M90	HSS2.375x0.109 ...	51.158									Lateral
91	M91	HSS2.375x0.109 ...	48.642									Lateral
92	M92	HSS2.375x0.109 ...	51.158									Lateral
93	M93	HSS2.375x0.109 ...	48.941									Lateral
94	M94	HSS2.375x0.109 ...	49.798									Lateral
95	M95	HSS2.375x0.109 ...	49.798									Lateral
96	M96	HSS2.375x0.109 ...	48.941									Lateral
97	M97	HSS2.375x0.109 ...	32.346									Lateral
98	M98	HSS2.375x0.109 ...	32.964									Lateral
99	M99	HSS2.375x0.109 ...	46.951									Lateral
100	M100	HSS2.375x0.109 ...	47.312									Lateral
101	M101	HSS2.375x0.109 ...	39.363									Lateral
102	M102	HSS2.375x0.109 ...	46.445									Lateral
103	M103	HSS2.375x0.109 ...	42.439									Lateral
104	M104	HSS2.375x0.109 ...	42.439									Lateral
105	M105	HSS2.375x0.109 ...	35.293									Lateral
106	M106	HSS2.375x0.109 ...	50.53									Lateral
107	M107	HSS2.375x0.109 ...	40.175									Lateral
108	M108	HSS2.375x0.109 ...	31.152									Lateral
109	M109	HSS2.375x0.109 ...	43.408									Lateral
110	M110	HSS2.375x0.109 ...	43.408									Lateral
111	M111	HSS2.375x0.109 ...	42.211									Lateral
112	M112	HSS2.375x0.109 ...	57.487									Lateral
113	M113	HSS2.375x0.109 ...	35.293									Lateral
114	M114	HSS2.375x0.109 ...	32.346									Lateral
115	M115	HSS2.375x0.109 ...	61.39									Lateral

Plate Primary Data

	Label	A Joint	B Joint	C Joint	D Joint	Material	Thickness[in]
1	P57	PPB4	N56	N59	N58	gen_Steel	.001
2	P58	N56	PPMA5	N57	N59	gen_Steel	.001
3	P59	N58	N59	N57	PPMA6	gen_Steel	.001
4	P59A	PPB4	N58	N62	N61	gen_Steel	.001
5	P60	N58	PPMA6	N60	N62	gen_Steel	.001
6	P61	N61	N62	N60	PPB5	gen_Steel	.001
7	P61A	PPB5	N60	N65	N64	gen_Steel	.001
8	P62	N60	PPMA6	N63	N65	gen_Steel	.001
9	P63	N64	N65	N63	PPMA7	gen_Steel	.001
10	P63A	PPMA5	N66	N68	N57	gen_Steel	.001
11	P64	N66	PPT4	N67	N68	gen_Steel	.001

Plate Primary Data (Continued)

	Label	A Joint	B Joint	C Joint	D Joint	Material	Thickness[in]
12	P65	N57	N68	N67	PPMA6	gen_Steel	.001
13	P65A	PPMA6	N67	N71	N70	gen_Steel	.001
14	P66	N67	PPT4	N69	N71	gen_Steel	.001
15	P67	N70	N71	N69	PPT5	gen_Steel	.001
16	P67A	PPMA6	N63	N73	N70	gen_Steel	.001
17	P68	N63	PPMA7	N72	N73	gen_Steel	.001
18	P69	N70	N73	N72	PPT5	gen_Steel	.001
19	P69A	PPB5	N74	N76	N64	gen_Steel	.001
20	P70	N74	PPMA8	N75	N76	gen_Steel	.001
21	P71	N64	N76	N75	PPMA7	gen_Steel	.001
22	P71A	PPMA8	N77	N78	N75	gen_Steel	.001
23	P72	N77	PPT5	N72	N78	gen_Steel	.001
24	P73	N75	N78	N72	PPMA7	gen_Steel	.001
25	P73A	PPMA8	N79	N81	N77	gen_Steel	.001
26	P74	N79	PPT6	N80	N81	gen_Steel	.001
27	P75	N77	N81	N80	PPT5	gen_Steel	.001
28	P75A	PPMA8	N82	N84	N79	gen_Steel	.001
29	P76	N82	PPMA1	N83	N84	gen_Steel	.001
30	P77	N79	N84	N83	PPT6	gen_Steel	.001
31	P77A	PPB5	N85	N87	N74	gen_Steel	.001
32	P78	N85	PPB6	N86	N87	gen_Steel	.001
33	P79	N74	N87	N86	PPMA8	gen_Steel	.001
34	P79A	PPB6	N88	N89	N86	gen_Steel	.001
35	P80	N88	PPMA1	N82	N89	gen_Steel	.001
36	P81	N86	N89	N82	PPMA8	gen_Steel	.001
37	P81A	PPMA1	N90	N93	N92	gen_Steel	.001
38	P82	N90	PPMA2	N91	N93	gen_Steel	.001
39	P83	N92	N93	N91	PPT1	gen_Steel	.001
40	P83A	PPMA2	N94	N96	N91	gen_Steel	.001
41	P84	N94	PPT2	N95	N96	gen_Steel	.001
42	P85	N91	N96	N95	PPT1	gen_Steel	.001
43	P85A	PPMA2	N97	N99	N94	gen_Steel	.001
44	P86	N97	PPMA3	N98	N99	gen_Steel	.001
45	P87	N94	N99	N98	PPT2	gen_Steel	.001
46	P87A	PPMA1	N100	N102	N90	gen_Steel	.001
47	P88	N100	PPB1	N101	N102	gen_Steel	.001
48	P89	N90	N102	N101	PPMA2	gen_Steel	.001
49	P89A	PPB1	N103	N105	N101	gen_Steel	.001
50	P90	N103	PPB2	N104	N105	gen_Steel	.001
51	P91	N101	N105	N104	PPMA2	gen_Steel	.001
52	P91A	PPB2	N106	N107	N104	gen_Steel	.001
53	P92	N106	PPMA3	N97	N107	gen_Steel	.001
54	P93	N104	N107	N97	PPMA2	gen_Steel	.001
55	P93A	PPB3	N108	N110	N109	gen_Steel	.001
56	P94	N108	PPMA3	N106	N110	gen_Steel	.001
57	P95	N109	N110	N106	PPB2	gen_Steel	.001
58	P95A	PPB3	N108	N113	N112	gen_Steel	.001
59	P96	N108	PPMA3	N111	N113	gen_Steel	.001
60	P97	N112	N113	N111	PPMA4	gen_Steel	.001
61	P97A	PPMA3	N111	N115	N98	gen_Steel	.001
62	P98	N111	PPMA4	N114	N115	gen_Steel	.001
63	P99	N98	N115	N114	PPT2	gen_Steel	.001

Plate Primary Data (Continued)

	Label	A Joint	B Joint	C Joint	D Joint	Material	Thickness[in]
64	P99A	PPMA4	N116	N118	N114	gen_Steel	.001
65	P100	N116	PPT3	N117	N118	gen_Steel	.001
66	P101	N114	N118	N117	PPT2	gen_Steel	.001
67	P101A	PPMA4	N119	N121	N116	gen_Steel	.001
68	P102	N119	PPMA5	N120	N121	gen_Steel	.001
69	P103	N116	N121	N120	PPT3	gen_Steel	.001
70	P103A	PPMA4	N112	N123	N119	gen_Steel	.001
71	P104	N112	PPB3	N122	N123	gen_Steel	.001
72	P105	N119	N123	N122	PPMA5	gen_Steel	.001
73	P105A	PPB6	N50	N124	N88	gen_Steel	.001
74	P106	N50	PPB1	N100	N124	gen_Steel	.001
75	P107	N88	N124	N100	PPMA1	gen_Steel	.001
76	P107A	PPMA1	N92	N125	N83	gen_Steel	.001
77	P108	N92	PPT1	N48	N125	gen_Steel	.001
78	P109	N83	N125	N48	PPT6	gen_Steel	.001
79	P109A	PPB3	N51	N126	N122	gen_Steel	.001
80	P110	N51	PPB4	N56	N126	gen_Steel	.001
81	P111	N122	N126	N56	PPMA5	gen_Steel	.001
82	P111A	PPMA5	N66	N127	N120	gen_Steel	.001
83	P112	N66	PPT4	N49	N127	gen_Steel	.001
84	P113	N120	N127	N49	PPT3	gen_Steel	.001
85	P113A	N42	N128	N130	N47	gen_Steel	.001
86	P114	N128	N35	N129	N130	gen_Steel	.001
87	P115	N47	N130	N129	N36	gen_Steel	.001
88	P115A	N42	N131	N133	N128	gen_Steel	.001
89	P116	N131	N41	N132	N133	gen_Steel	.001
90	P117	N128	N133	N132	N35	gen_Steel	.001
91	P117A	N36	N129	N136	N135	gen_Steel	.001
92	P118	N129	N35	N134	N136	gen_Steel	.001
93	P119	N135	N136	N134	N28	gen_Steel	.001
94	P119A	N35	N137	N139	N134	gen_Steel	.001
95	P120	N137	N27	N138	N139	gen_Steel	.001
96	P121	N134	N139	N138	N28	gen_Steel	.001
97	P121A	N35	N132	N142	N141	gen_Steel	.001
98	P122	N132	N41	N140	N142	gen_Steel	.001
99	P123	N141	N142	N140	N34	gen_Steel	.001
100	P123A	N35	N141	N144	N137	gen_Steel	.001
101	P124	N141	N34	N143	N144	gen_Steel	.001
102	P125	N137	N144	N143	N27	gen_Steel	.001
103	P125A	N34	N140	N146	N145	gen_Steel	.001
104	P126	N140	N41	N53	N146	gen_Steel	.001
105	P127	N145	N146	N53	N40	gen_Steel	.001
106	P127A	N34	N147	N148	N143	gen_Steel	.001
107	P128	N147	N26	N55	N148	gen_Steel	.001
108	P129	N143	N148	N55	N27	gen_Steel	.001
109	P129A	N34	N149	N151	N147	gen_Steel	.001
110	P130	N149	N33	N150	N151	gen_Steel	.001
111	P131	N147	N151	N150	N26	gen_Steel	.001
112	P131A	N34	N145	N153	N149	gen_Steel	.001
113	P132	N145	N40	N152	N153	gen_Steel	.001
114	P133	N149	N153	N152	N33	gen_Steel	.001
115	P133A	N40	N154	N156	N152	gen_Steel	.001

Plate Primary Data (Continued)

	Label	A Joint	B Joint	C Joint	D Joint	Material	Thickness[in]
116	P134	N154	N39	N155	N156	gen_Steel	.001
117	P135	N152	N156	N155	N33	gen_Steel	.001
118	P135A	N39	N157	N159	N155	gen_Steel	.001
119	P136	N157	N32	N158	N159	gen_Steel	.001
120	P137	N155	N159	N158	N33	gen_Steel	.001
121	P137A	N33	N150	N162	N161	gen_Steel	.001
122	P138	N150	N26	N160	N162	gen_Steel	.001
123	P139	N161	N162	N160	N25	gen_Steel	.001
124	P139A	N33	N161	N164	N158	gen_Steel	.001
125	P140	N161	N25	N163	N164	gen_Steel	.001
126	P141	N158	N164	N163	N32	gen_Steel	.001
127	P141A	N39	N157	N167	N166	gen_Steel	.001
128	P142	N157	N32	N165	N167	gen_Steel	.001
129	P143	N166	N167	N165	N31	gen_Steel	.001
130	P143A	N39	N166	N170	N169	gen_Steel	.001
131	P144	N166	N31	N168	N170	gen_Steel	.001
132	P145	N169	N170	N168	N38	gen_Steel	.001
133	P145A	N31	N165	N172	N171	gen_Steel	.001
134	P146	N165	N32	N163	N172	gen_Steel	.001
135	P147	N171	N172	N163	N25	gen_Steel	.001
136	P147A	N25	N173	N175	N171	gen_Steel	.001
137	P148	N173	N24	N174	N175	gen_Steel	.001
138	P149	N171	N175	N174	N31	gen_Steel	.001
139	P149A	N24	N176	N178	N174	gen_Steel	.001
140	P150	N176	N30	N177	N178	gen_Steel	.001
141	P151	N174	N178	N177	N31	gen_Steel	.001
142	P151A	N24	N54	N180	N176	gen_Steel	.001
143	P152	N54	N29	N179	N180	gen_Steel	.001
144	P153	N176	N180	N179	N30	gen_Steel	.001
145	P153A	N30	N181	N182	N177	gen_Steel	.001
146	P154	N181	N38	N168	N182	gen_Steel	.001
147	P155	N177	N182	N168	N31	gen_Steel	.001
148	P155A	N38	N181	N184	N52	gen_Steel	.001
149	P156	N181	N30	N183	N184	gen_Steel	.001
150	P157	N52	N184	N183	N43	gen_Steel	.001
151	P157A	N43	N183	N187	N186	gen_Steel	.001
152	P158	N183	N30	N185	N187	gen_Steel	.001
153	P159	N186	N187	N185	N37	gen_Steel	.001
154	P159A	N30	N179	N189	N185	gen_Steel	.001
155	P160	N179	N29	N188	N189	gen_Steel	.001
156	P161	N185	N189	N188	N37	gen_Steel	.001
157	P161A	N43	N186	N192	N191	gen_Steel	.001
158	P162	N186	N37	N190	N192	gen_Steel	.001
159	P163	N191	N192	N190	N42	gen_Steel	.001
160	P163A	N42	N190	N194	N47	gen_Steel	.001
161	P164	N190	N37	N193	N194	gen_Steel	.001
162	P165	N47	N194	N193	N36	gen_Steel	.001
163	P165A	N37	N188	N197	N196	gen_Steel	.001
164	P166	N188	N29	N195	N197	gen_Steel	.001
165	P167	N196	N197	N195	N28	gen_Steel	.001
166	P167A	N37	N196	N198	N193	gen_Steel	.001
167	P168	N196	N28	N135	N198	gen_Steel	.001

Plate Primary Data (Continued)

	Label	A Joint	B Joint	C Joint	D Joint	Material	Thickness[in]
168	P169	N193	N198	N135	N36	gen_Steel	.001
169	P173	PPB3	N109	N199	N51	gen_Steel	.125
170	P174	N109	PPB2	N200	N199	gen_Steel	.125
171	P175	N51	N199	N61	PPB4	gen_Steel	.125
172	P176	N199	N200	PPB5	N61	gen_Steel	.125
173	P176A	PPB2	N103	N201	N200	gen_Steel	.125
174	P177	N103	PPB1	N50	N201	gen_Steel	.125
175	P178	N200	N201	N85	PPB5	gen_Steel	.125
176	P179	N201	N50	PPB6	N85	gen_Steel	.125
177	P179A	N41	N131	N202	N53	gen_Steel	.125
178	P180	N131	N42	N203	N202	gen_Steel	.125
179	P181	N53	N202	N154	N40	gen_Steel	.125
180	P182	N202	N203	N39	N154	gen_Steel	.125
181	P182A	N42	N191	N204	N203	gen_Steel	.125
182	P183	N191	N43	N52	N204	gen_Steel	.125
183	P184	N203	N204	N169	N39	gen_Steel	.125
184	P185	N204	N52	N38	N169	gen_Steel	.125

Member Distributed Loads (BLC 2 : Wind Load-X LC1&2)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
1	M97	X	11.4	11.4	0	0
2	M98	X	11.4	11.4	0	0
3	M99	X	11.4	11.4	0	0
4	M100	X	11.4	11.4	0	0
5	M101	X	11.4	11.4	0	0
6	M102	X	11.4	11.4	0	0
7	M103	X	11.4	11.4	0	0
8	M104	X	11.4	11.4	0	0
9	M105	X	11.4	11.4	0	0
10	M106	X	11.4	11.4	0	0
11	M107	X	11.4	11.4	0	0
12	M108	X	11.4	11.4	0	0
13	M109	X	11.4	11.4	0	0
14	M110	X	11.4	11.4	0	0
15	M111	X	11.4	11.4	0	0
16	M112	X	11.4	11.4	0	0
17	M113	X	11.4	11.4	0	0
18	M114	X	11.4	11.4	0	0
19	M115	X	11.4	11.4	0	0

Member Distributed Loads (BLC 3 : Wind Load-Z LC1&2)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
1	M106	Z	11.4	11.4	0	0
2	M105	Z	11.4	11.4	0	0
3	M103	Z	11.4	11.4	0	0
4	M104	Z	11.4	11.4	0	0
5	M107	Z	11.4	11.4	0	0
6	M108	Z	11.4	11.4	0	0
7	M102	Z	11.4	11.4	0	0
8	M101	Z	11.4	11.4	0	0

Member Distributed Loads (BLC 3 : Wind Load-Z LC1&2) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
9	M98	Z	11.4	11.4	0	0
10	M97	Z	11.4	11.4	0	0
11	M99	Z	11.4	11.4	0	0
12	M100	Z	11.4	11.4	0	0
13	M113	Z	11.4	11.4	0	0
14	M114	Z	11.4	11.4	0	0
15	M111	Z	11.4	11.4	0	0
16	M115	Z	11.4	11.4	0	0
17	M112	Z	11.4	11.4	0	0
18	M109	Z	11.4	11.4	0	0
19	M110	Z	11.4	11.4	0	0

Member Distributed Loads (BLC 4 : Wind Load-X LC3)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
1	M97	X	4.2	4.2	0	0
2	M98	X	4.2	4.2	0	0
3	M99	X	4.2	4.2	0	0
4	M100	X	4.2	4.2	0	0
5	M101	X	4.2	4.2	0	0
6	M102	X	4.2	4.2	0	0
7	M103	X	4.2	4.2	0	0
8	M104	X	4.2	4.2	0	0
9	M105	X	4.2	4.2	0	0
10	M106	X	4.2	4.2	0	0
11	M107	X	4.2	4.2	0	0
12	M108	X	4.2	4.2	0	0
13	M109	X	4.2	4.2	0	0
14	M110	X	4.2	4.2	0	0
15	M111	X	4.2	4.2	0	0
16	M112	X	4.2	4.2	0	0
17	M113	X	4.2	4.2	0	0
18	M114	X	4.2	4.2	0	0
19	M115	X	4.2	4.2	0	0

Member Distributed Loads (BLC 5 : Wind Load-Z LC3)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
1	M106	Z	4.2	4.2	0	0
2	M105	Z	4.2	4.2	0	0
3	M103	Z	4.2	4.2	0	0
4	M104	Z	4.2	4.2	0	0
5	M107	Z	4.2	4.2	0	0
6	M108	Z	4.2	4.2	0	0
7	M102	Z	4.2	4.2	0	0
8	M101	Z	4.2	4.2	0	0
9	M98	Z	4.2	4.2	0	0
10	M97	Z	4.2	4.2	0	0
11	M99	Z	4.2	4.2	0	0
12	M100	Z	4.2	4.2	0	0

Member Distributed Loads (BLC 6 : BLC 1 Transient Area Loads)

Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]

Member Distributed Loads (BLC 6 : BLC 1 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
1	M4	Y	-12.555	-10.774	3.953	7.071
2	M4	Y	-10.774	-11.24	7.071	10.188
3	M4	Y	-11.24	-13.954	10.188	13.305
4	M5	Y	-4.727	-4.727	.78	12.78
5	M6	Y	-12.995	-4.727	0	17.125
6	M1	Y	-12.556	-10.774	3.953	7.071
7	M1	Y	-10.774	-11.24	7.071	10.188
8	M1	Y	-11.24	-13.953	10.188	13.305
9	M2	Y	-4.729	-4.729	.78	12.78
10	M3	Y	-12.991	-4.729	0	17.125
11	M50	Y	-11.188	-4.729	0	17.163
12	M51	Y	-3.768	-3.768	2.562	14.562
13	M52	Y	-12.151	-3.768	0	17.163
14	M49	Y	-12.151	-3.768	0	17.163
15	M53	Y	-12.149	-3.768	0	17.163
16	M54	Y	-3.768	-3.768	2.562	14.562
17	M31	Y	1.606	1.606	.612	18.184
18	M40	Y	.688	.389	4.98	24.899
19	M40	Y	.389	.09	24.899	44.818
20	M41	Y	.206	.379	0	22.023
21	M41	Y	.379	.553	22.023	44.046
22	M41	Y	.864	.565	0	16.314
23	M41	Y	.565	.294	16.314	32.627
24	M41	Y	.294	.051	32.627	48.941
25	M42	Y	.545	.803	5.116	28.137
26	M42	Y	.803	1.123	28.137	51.158
27	M30	Y	1.61	1.61	.262	17.851
28	M43	Y	.212	.778	4.864	24.321
29	M43	Y	.778	1.344	24.321	43.778
30	M20	Y	.553	.379	4.894	26.917
31	M20	Y	.379	.206	26.917	48.941
32	M35	Y	.09	.389	4.98	24.899
33	M35	Y	.389	.688	24.899	44.818
34	M19	Y	1.124	.802	0	23.021
35	M19	Y	.802	.544	23.021	46.042
36	M20	Y	.05	.294	0	16.314
37	M20	Y	.294	.565	16.314	32.627
38	M20	Y	.565	.864	32.627	48.941
39	M13	Y	.211	.777	4.864	24.321
40	M13	Y	.777	1.343	24.321	43.778
41	M29	Y	1.605	1.605	1.288	18.878
42	M44	Y	1.125	.803	0	23.021
43	M44	Y	.803	.545	23.021	46.042
44	M18	Y	.545	.803	5.116	28.137
45	M18	Y	.803	1.125	28.137	51.158
46	M17	Y	.864	.565	0	16.314
47	M17	Y	.565	.294	16.314	32.627
48	M17	Y	.294	.05	32.627	48.941
49	M17	Y	.205	.379	0	22.023
50	M17	Y	.379	.553	22.023	44.046
51	M24A	Y	.687	.388	4.98	24.899
52	M24A	Y	.388	.089	24.899	44.818

Member Distributed Loads (BLC 6 : BLC 1 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
53	M28	Y	1.608	1.608	.959	18.527
54	M45	Y	.05	.294	0	16.314
55	M45	Y	.294	.565	16.314	32.627
56	M45	Y	.565	.864	32.627	48.941
57	M45	Y	.553	.379	4.894	26.917
58	M45	Y	.379	.206	26.917	48.941
59	M46	Y	.09	.389	4.98	24.899
60	M46	Y	.389	.688	24.899	44.818
61	M24	Y	.553	.379	4.894	26.917
62	M24	Y	.379	.205	26.917	48.941
63	M23A	Y	.089	.388	4.98	24.899
64	M23A	Y	.388	.687	24.899	44.818
65	M27	Y	1.608	1.608	.613	18.18
66	M23	Y	1.122	.802	0	23.021
67	M23	Y	.802	.544	23.021	46.042
68	M24	Y	.051	.294	0	16.314
69	M24	Y	.294	.565	16.314	32.627
70	M24	Y	.565	.864	32.627	48.941
71	M14	Y	.211	.776	4.864	24.321
72	M14	Y	.776	1.342	24.321	43.778
73	M26	Y	1.615	1.615	.263	17.835
74	M47	Y	.688	.389	4.98	24.899
75	M47	Y	.389	.09	24.899	44.818
76	M48	Y	.206	.379	0	22.023
77	M48	Y	.379	.553	22.023	44.046
78	M36	Y	1.124	.802	0	23.021
79	M36	Y	.802	.544	23.021	46.042
80	M48	Y	.864	.565	0	16.314
81	M48	Y	.565	.294	16.314	32.627
82	M48	Y	.294	.05	32.627	48.941
83	M25	Y	.671	.388	4.864	24.321
84	M25	Y	.388	.105	24.321	43.778
85	M2	Y	.534	.534	5.532	17.163
86	M25	Y	-.033	.38	0	12.16
87	M25	Y	.38	.668	12.16	24.321
88	M25	Y	.668	1.01	24.321	36.481
89	M25	Y	1.01	1.737	36.481	48.642
90	M33	Y	.81	.81	0	17.545
91	M38	Y	1.214	.969	4.894	15.906
92	M38	Y	.969	.865	15.906	26.917
93	M38	Y	.865	.52	26.917	37.929
94	M38	Y	.52	.004	37.929	48.941
95	M22	Y	.544	.802	5.116	28.137
96	M22	Y	.802	1.124	28.137	51.158
97	M33	Y	.807	.807	1.305	18.876
98	M21	Y	.864	.565	0	16.314
99	M21	Y	.565	.294	16.314	32.627
100	M21	Y	.294	.05	32.627	48.941
101	M21	Y	.205	.379	0	22.023
102	M21	Y	.379	.553	22.023	44.046
103	M32	Y	1.608	1.608	.959	18.527
104	M34	Y	.687	.388	4.98	24.899

Member Distributed Loads (BLC 6 : BLC 1 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
105	M34	Y	.388	.089	24.899	44.818
106	M38	Y	.553	.379	4.894	26.917
107	M38	Y	.379	.206	26.917	48.941
108	M39	Y	.09	.389	4.98	24.899
109	M39	Y	.389	.688	24.899	44.818
110	M46	Y	.848	.554	0	16.599
111	M46	Y	.554	.289	16.599	33.199
112	M46	Y	.289	.052	33.199	49.798
113	M47	Y	-.017	.441	4.98	27.389
114	M47	Y	.441	.969	27.389	49.798
115	M23A	Y	.848	.554	0	16.599
116	M23A	Y	.554	.289	16.599	33.199
117	M23A	Y	.289	.052	33.199	49.798
118	M24A	Y	-.017	.441	4.98	27.389
119	M24A	Y	.441	.969	27.389	49.798
120	M39	Y	.848	.554	0	16.599
121	M39	Y	.554	.289	16.599	33.199
122	M39	Y	.289	.052	33.199	49.798
123	M40	Y	-.017	.441	4.98	27.389
124	M40	Y	.441	.969	27.389	49.798
125	M34	Y	-.017	.441	4.98	27.389
126	M34	Y	.441	.969	27.389	49.798
127	M35	Y	.848	.554	0	16.599
128	M35	Y	.554	.289	16.599	33.199
129	M35	Y	.289	.052	33.199	49.798
130	M78	Y	1.61	1.61	.262	17.851
131	M90	Y	.545	.803	5.116	28.137
132	M90	Y	.803	1.125	28.137	51.158
133	M91	Y	.212	.778	4.864	24.321
134	M91	Y	.778	1.344	24.321	43.778
135	M89	Y	.864	.565	0	16.314
136	M89	Y	.565	.294	16.314	32.627
137	M89	Y	.294	.05	32.627	48.941
138	M61	Y	.211	.777	4.864	24.321
139	M61	Y	.777	1.343	24.321	43.778
140	M65	Y	1.124	.802	0	23.021
141	M65	Y	.802	.544	23.021	46.042
142	M66	Y	.05	.294	0	16.314
143	M66	Y	.294	.565	16.314	32.627
144	M66	Y	.565	.864	32.627	48.941
145	M79	Y	1.608	1.608	.612	18.184
146	M88	Y	.688	.389	4.98	24.899
147	M88	Y	.389	.09	24.899	44.818
148	M89	Y	.206	.379	0	22.023
149	M89	Y	.379	.553	22.023	44.046
150	M66	Y	.553	.379	4.894	26.917
151	M66	Y	.379	.205	26.917	48.941
152	M83	Y	.089	.388	4.98	24.899
153	M83	Y	.388	.687	24.899	44.818
154	M87	Y	.969	.441	0	22.409
155	M87	Y	.441	-.017	22.409	44.818
156	M88	Y	.052	.289	0	16.599

Member Distributed Loads (BLC 6 : BLC 1 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
157	M88	Y	.289	.554	16.599	33.199
158	M88	Y	.554	.848	33.199	49.798
159	M82	Y	.052	.289	0	16.599
160	M82	Y	.289	.554	16.599	33.199
161	M82	Y	.554	.848	33.199	49.798
162	M83	Y	.969	.441	0	22.409
163	M83	Y	.441	-.017	22.409	44.818
164	M67	Y	.205	.379	0	22.023
165	M67	Y	.379	.553	22.023	44.046
166	M80	Y	1.608	1.608	.959	18.527
167	M82	Y	.687	.388	4.98	24.899
168	M82	Y	.388	.089	24.899	44.818
169	M86	Y	.553	.379	4.894	26.917
170	M86	Y	.379	.206	26.917	48.941
171	M87	Y	.09	.389	4.98	24.899
172	M87	Y	.389	.688	24.899	44.818
173	M85	Y	1.124	.802	0	23.021
174	M85	Y	.802	.544	23.021	46.042
175	M86	Y	.05	.294	0	16.314
176	M86	Y	.294	.565	16.314	32.627
177	M86	Y	.565	.864	32.627	48.941
178	M73	Y	1.342	.776	4.864	24.321
179	M73	Y	.776	.211	24.321	43.778
180	M81	Y	.807	.807	1.305	18.876
181	M67	Y	.864	.565	0	16.314
182	M67	Y	.565	.294	16.314	32.627
183	M67	Y	.294	.05	32.627	48.941
184	M68	Y	.545	.803	5.116	28.137
185	M68	Y	.803	1.125	28.137	51.158
186	M62	Y	.211	.777	4.864	24.321
187	M62	Y	.777	1.343	24.321	43.778
188	M81	Y	.802	.802	1.288	18.878
189	M74	Y	1.615	1.615	.263	17.835
190	M84	Y	1.122	.802	0	23.021
191	M84	Y	.802	.544	23.021	46.042
192	M96	Y	.864	.565	0	16.314
193	M96	Y	.565	.294	16.314	32.627
194	M96	Y	.294	.051	32.627	48.941
195	M69	Y	1.124	.802	0	23.021
196	M69	Y	.802	.544	23.021	46.042
197	M70	Y	.05	.294	0	16.314
198	M70	Y	.294	.565	16.314	32.627
199	M70	Y	.565	.864	32.627	48.941
200	M70	Y	.553	.379	4.894	26.917
201	M70	Y	.379	.206	26.917	48.941
202	M71	Y	.09	.389	4.98	24.899
203	M71	Y	.389	.688	24.899	44.818
204	M75	Y	1.606	1.606	.612	18.184
205	M71	Y	.848	.554	0	16.599
206	M71	Y	.554	.289	16.599	33.199
207	M71	Y	.289	.052	33.199	49.798
208	M72	Y	-.017	.441	4.98	27.389

Member Distributed Loads (BLC 6 : BLC 1 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
209	M72	Y	.441	.969	27.389	49.798
210	M95	Y	.688	.389	4.98	24.899
211	M95	Y	.389	.09	24.899	44.818
212	M96	Y	.206	.379	0	22.023
213	M96	Y	.379	.553	22.023	44.046
214	M94	Y	.848	.554	0	16.599
215	M94	Y	.554	.289	16.599	33.199
216	M94	Y	.289	.052	33.199	49.798
217	M95	Y	-.017	.441	4.98	27.389
218	M95	Y	.441	.969	27.389	49.798
219	M76	Y	1.606	1.606	.956	18.527
220	M93	Y	.553	.379	4.894	26.917
221	M93	Y	.379	.206	26.917	48.941
222	M94	Y	.09	.389	4.98	24.899
223	M94	Y	.389	.688	24.899	44.818
224	M63	Y	.206	.379	0	22.023
225	M63	Y	.379	.553	22.023	44.046
226	M72	Y	.688	.389	4.98	24.899
227	M72	Y	.389	.09	24.899	44.818
228	M92	Y	1.123	.803	0	23.021
229	M92	Y	.803	.545	23.021	46.042
230	M93	Y	.051	.294	0	16.314
231	M93	Y	.294	.565	16.314	32.627
232	M93	Y	.565	.864	32.627	48.941
233	M77	Y	1.605	1.605	1.288	18.878
234	M63	Y	.864	.565	0	16.314
235	M63	Y	.565	.294	16.314	32.627
236	M63	Y	.294	.05	32.627	48.941
237	M64	Y	.545	.803	5.116	28.137
238	M64	Y	.803	1.125	28.137	51.158

Member Distributed Loads (BLC 7 : BLC 2 Transient Area Loads)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
1	M3	X	6.022	6.022	4.614	16.614
2	M40	X	.837	8.723	0	9.96
3	M40	X	8.723	15.028	9.96	19.919
4	M40	X	15.028	24.496	19.919	29.879
5	M40	X	24.496	27.178	29.879	39.838
6	M40	X	27.178	15.506	39.838	49.798
7	M31	X	69.266	69.266	.612	18.184
8	M40	X	29.625	16.74	4.98	24.899
9	M40	X	16.74	3.856	24.899	44.818
10	M41	X	8.86	16.344	0	22.023
11	M41	X	16.344	23.828	22.023	44.046
12	M41	X	37.212	24.357	0	16.314
13	M41	X	24.357	12.678	16.314	32.627
14	M41	X	12.678	2.176	32.627	48.941
15	M42	X	23.492	34.589	5.116	28.137
16	M42	X	34.589	48.387	28.137	51.158
17	M30	X	69.352	69.352	.262	17.851
18	M43	X	9.127	33.521	4.864	24.321

Member Distributed Loads (BLC 7 : BLC 2 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
19	M43	X	33.521	57.915	24.321	43.778
20	M29	X	69.143	69.143	1.288	18.878
21	M44	X	48.387	34.589	0	23.021
22	M44	X	34.589	23.492	23.021	46.042
23	M45	X	2.176	12.678	0	16.314
24	M45	X	12.678	24.357	16.314	32.627
25	M45	X	24.357	37.212	32.627	48.941
26	M28	X	69.323	69.323	.959	18.527
27	M45	X	23.819	16.334	4.894	26.917
28	M45	X	16.334	8.849	26.917	48.941
29	M46	X	3.851	16.73	4.98	24.899
30	M46	X	16.73	29.609	24.899	44.818
31	M6	X	6.022	6.022	.511	12.511
32	M46	X	15.506	27.178	0	9.96
33	M46	X	27.178	24.496	9.96	19.919
34	M46	X	24.496	15.028	19.919	29.879
35	M46	X	15.028	8.723	29.879	39.838
36	M46	X	8.723	.837	39.838	49.798
37	M8	X	6.022	6.022	.511	12.511
38	M24A	X	.837	8.723	0	9.96
39	M24A	X	8.723	15.028	9.96	19.919
40	M24A	X	15.028	24.496	19.919	29.879
41	M24A	X	24.496	27.178	29.879	39.838
42	M24A	X	27.178	15.506	39.838	49.798
43	M17	X	8.849	16.334	0	22.023
44	M17	X	16.334	23.819	22.023	44.046
45	M24A	X	29.609	16.73	4.98	24.899
46	M24A	X	16.73	3.851	24.899	44.818
47	M17	X	37.212	24.357	0	16.314
48	M17	X	24.357	12.678	16.314	32.627
49	M17	X	12.678	2.176	32.627	48.941
50	M18	X	23.492	34.589	5.116	28.137
51	M18	X	34.589	48.387	28.137	51.158
52	M13	X	9.099	33.487	4.864	24.321
53	M13	X	33.487	57.875	24.321	43.778
54	M19	X	48.354	34.552	0	23.021
55	M19	X	34.552	23.451	23.021	46.042
56	M20	X	2.176	12.678	0	16.314
57	M20	X	12.678	24.357	16.314	32.627
58	M20	X	24.357	37.212	32.627	48.941
59	M20	X	23.819	16.334	4.894	26.917
60	M20	X	16.334	8.849	26.917	48.941
61	M35	X	3.851	16.73	4.98	24.899
62	M35	X	16.73	29.609	24.899	44.818
63	M11	X	6.022	6.022	4.614	16.614
64	M35	X	15.506	27.178	0	9.96
65	M35	X	27.178	24.496	9.96	19.919
66	M35	X	24.496	15.028	19.919	29.879
67	M35	X	15.028	8.723	29.879	39.838
68	M35	X	8.723	.837	39.838	49.798
69	M54	X	6.022	6.022	.511	12.511
70	M94	X	15.506	27.178	0	9.96

Member Distributed Loads (BLC 7 : BLC 2 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
71	M94	X	27.178	24.496	9.96	19.919
72	M94	X	24.496	15.028	19.919	29.879
73	M94	X	15.028	8.723	29.879	39.838
74	M94	X	8.723	.837	39.838	49.798
75	M56	X	6.022	6.022	.511	12.511
76	M72	X	.837	8.723	0	9.96
77	M72	X	8.723	15.028	9.96	19.919
78	M72	X	15.028	24.496	19.919	29.879
79	M72	X	24.496	27.178	29.879	39.838
80	M72	X	27.178	15.506	39.838	49.798
81	M76	X	69.21	69.21	.956	18.527
82	M93	X	23.828	16.344	4.894	26.917
83	M93	X	16.344	8.86	26.917	48.941
84	M94	X	3.856	16.74	4.98	24.899
85	M94	X	16.74	29.625	24.899	44.818
86	M92	X	48.424	34.554	0	23.021
87	M92	X	34.554	23.438	23.021	46.042
88	M93	X	2.168	12.646	0	16.314
89	M93	X	12.646	24.337	16.314	32.627
90	M93	X	24.337	37.239	32.627	48.941
91	M77	X	69.562	69.562	1.305	18.876
92	M91	X	9.071	33.453	4.864	24.321
93	M91	X	33.453	57.835	24.321	43.778
94	M78	X	69.562	69.562	.263	17.835
95	M90	X	23.451	34.552	5.116	28.137
96	M90	X	34.552	48.354	28.137	51.158
97	M89	X	37.212	24.357	0	16.314
98	M89	X	24.357	12.678	16.314	32.627
99	M89	X	12.678	2.176	32.627	48.941
100	M79	X	69.323	69.323	.613	18.18
101	M88	X	29.609	16.73	4.98	24.899
102	M88	X	16.73	3.851	24.899	44.818
103	M89	X	8.849	16.334	0	22.023
104	M89	X	16.334	23.819	22.023	44.046
105	M51	X	6.022	6.022	4.614	16.614
106	M88	X	.837	8.723	0	9.96
107	M88	X	8.723	15.028	9.96	19.919
108	M88	X	15.028	24.496	19.919	29.879
109	M88	X	24.496	27.178	29.879	39.838
110	M88	X	27.178	15.506	39.838	49.798
111	M63	X	8.86	16.344	0	22.023
112	M63	X	16.344	23.828	22.023	44.046
113	M72	X	29.625	16.74	4.98	24.899
114	M72	X	16.74	3.856	24.899	44.818
115	M63	X	37.239	24.337	0	16.314
116	M63	X	24.337	12.646	16.314	32.627
117	M63	X	12.646	2.168	32.627	48.941
118	M64	X	23.438	34.554	5.116	28.137
119	M64	X	34.554	48.424	28.137	51.158
120	M61	X	9.071	33.453	4.864	24.321
121	M61	X	33.453	57.835	24.321	43.778
122	M65	X	48.354	34.552	0	23.021

Member Distributed Loads (BLC 7 : BLC 2 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
123	M65	X	34.552	23.451	23.021	46.042
124	M66	X	2.176	12.678	0	16.314
125	M66	X	12.678	24.357	16.314	32.627
126	M66	X	24.357	37.212	32.627	48.941
127	M66	X	23.819	16.334	4.894	26.917
128	M66	X	16.334	8.849	26.917	48.941
129	M83	X	3.851	16.73	4.98	24.899
130	M83	X	16.73	29.609	24.899	44.818
131	M59	X	6.022	6.022	4.614	16.614
132	M83	X	15.506	27.178	0	9.96
133	M83	X	27.178	24.496	9.96	19.919
134	M83	X	24.496	15.028	19.919	29.879
135	M83	X	15.028	8.723	29.879	39.838
136	M83	X	8.723	.837	39.838	49.798
137	M58	X	55.121	27.178	0	17.163
138	M59	X	19.479	19.479	2.563	14.563
139	M60	X	62.813	19.479	0	17.163
140	M55	X	62.159	19.479	0	17.163
141	M56	X	19.441	19.441	2.485	14.485
142	M57	X	63.565	19.441	0	17.163

Member Distributed Loads (BLC 8 : BLC 3 Transient Area Loads)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
1	M13	Z	4.535	16.726	4.864	24.321
2	M13	Z	16.726	28.917	24.321	43.778
3	M19	Z	48.354	34.552	0	23.021
4	M19	Z	34.552	23.451	23.021	46.042
5	M30	Z	69.352	69.352	.263	17.835
6	M20	Z	2.176	12.678	0	16.314
7	M20	Z	12.678	24.357	16.314	32.627
8	M20	Z	24.357	37.212	32.627	48.941
9	M20	Z	23.819	16.334	4.894	26.917
10	M20	Z	16.334	8.849	26.917	48.941
11	M31	Z	69.266	69.266	.613	18.18
12	M35	Z	3.851	16.73	4.98	24.899
13	M35	Z	16.73	29.609	24.899	44.818
14	M34	Z	-.74	19.015	4.98	27.389
15	M34	Z	19.015	41.731	27.389	49.798
16	M35	Z	36.518	23.871	0	16.599
17	M35	Z	23.871	12.44	16.599	33.199
18	M35	Z	12.44	2.226	33.199	49.798
19	M21	Z	8.86	16.344	0	22.023
20	M21	Z	16.344	23.828	22.023	44.046
21	M32	Z	69.21	69.21	.956	18.527
22	M34	Z	29.625	16.74	4.98	24.899
23	M34	Z	16.74	3.856	24.899	44.818
24	M21	Z	37.212	24.357	0	16.314
25	M21	Z	24.357	12.678	16.314	32.627
26	M21	Z	12.678	2.176	32.627	48.941
27	M22	Z	23.492	34.589	5.116	28.137
28	M22	Z	34.589	48.387	28.137	51.158

Member Distributed Loads (BLC 8 : BLC 3 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
29	M14	Z	4.563	16.76	4.864	24.321
30	M14	Z	16.76	28.958	24.321	43.778
31	M33	Z	69.143	69.143	1.288	18.878
32	M42	Z	23.492	34.589	5.116	28.137
33	M42	Z	34.589	48.387	28.137	51.158
34	M43	Z	4.563	16.76	4.864	24.321
35	M43	Z	16.76	28.958	24.321	43.778
36	M41	Z	37.212	24.357	0	16.314
37	M41	Z	24.357	12.678	16.314	32.627
38	M41	Z	12.678	2.176	32.627	48.941
39	M40	Z	29.625	16.74	4.98	24.899
40	M40	Z	16.74	3.856	24.899	44.818
41	M41	Z	8.86	16.344	0	22.023
42	M41	Z	16.344	23.828	22.023	44.046
43	M39	Z	41.731	19.015	0	22.409
44	M39	Z	19.015	-.74	22.409	44.818
45	M40	Z	2.226	12.44	0	16.599
46	M40	Z	12.44	23.871	16.599	33.199
47	M40	Z	23.871	36.518	33.199	49.798
48	M38	Z	23.828	16.344	4.894	26.917
49	M38	Z	16.344	8.86	26.917	48.941
50	M39	Z	3.856	16.74	4.98	24.899
51	M39	Z	16.74	29.625	24.899	44.818
52	M37	Z	48.457	34.591	0	23.021
53	M37	Z	34.591	23.479	23.021	46.042
54	M38	Z	2.168	12.646	0	16.314
55	M38	Z	12.646	24.337	16.314	32.627
56	M38	Z	24.337	37.239	32.627	48.941
57	M25	Z	28.958	16.76	4.864	24.321
58	M25	Z	16.76	4.563	24.321	43.778
59	M61	Z	4.535	16.726	4.864	24.321
60	M61	Z	16.726	28.917	24.321	43.778
61	M65	Z	48.424	34.554	0	23.021
62	M65	Z	34.554	23.438	23.021	46.042
63	M78	Z	69.352	69.352	.263	17.835
64	M66	Z	2.168	12.646	0	16.314
65	M66	Z	12.646	24.337	16.314	32.627
66	M66	Z	24.337	37.239	32.627	48.941
67	M66	Z	23.828	16.344	4.894	26.917
68	M66	Z	16.344	8.86	26.917	48.941
69	M79	Z	69.21	69.21	.612	18.184
70	M83	Z	3.856	16.74	4.98	24.899
71	M83	Z	16.74	29.625	24.899	44.818
72	M82	Z	-.74	19.015	4.98	27.389
73	M82	Z	19.015	41.731	27.389	49.798
74	M83	Z	36.518	23.871	0	16.599
75	M83	Z	23.871	12.44	16.599	33.199
76	M83	Z	12.44	2.226	33.199	49.798
77	M67	Z	8.86	16.344	0	22.023
78	M67	Z	16.344	23.828	22.023	44.046
79	M80	Z	69.21	69.21	.956	18.527
80	M82	Z	29.625	16.74	4.98	24.899

Member Distributed Loads (BLC 8 : BLC 3 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,F...	Start Location[in,%]	End Location[in,%]
81	M82	Z	16.74	3.856	24.899	44.818
82	M67	Z	37.212	24.357	0	16.314
83	M67	Z	24.357	12.678	16.314	32.627
84	M67	Z	12.678	2.176	32.627	48.941
85	M68	Z	23.492	34.589	5.116	28.137
86	M68	Z	34.589	48.387	28.137	51.158
87	M62	Z	4.563	16.76	4.864	24.321
88	M62	Z	16.76	28.958	24.321	43.778
89	M81	Z	69.143	69.143	1.288	18.878
90	M90	Z	23.492	34.589	5.116	28.137
91	M90	Z	34.589	48.387	28.137	51.158
92	M91	Z	4.563	16.76	4.864	24.321
93	M91	Z	16.76	28.958	24.321	43.778
94	M89	Z	37.212	24.357	0	16.314
95	M89	Z	24.357	12.678	16.314	32.627
96	M89	Z	12.678	2.176	32.627	48.941
97	M88	Z	29.625	16.74	4.98	24.899
98	M88	Z	16.74	3.856	24.899	44.818
99	M89	Z	8.86	16.344	0	22.023
100	M89	Z	16.344	23.828	22.023	44.046
101	M87	Z	41.731	19.015	0	22.409
102	M87	Z	19.015	-.74	22.409	44.818
103	M88	Z	2.226	12.44	0	16.599
104	M88	Z	12.44	23.871	16.599	33.199
105	M88	Z	23.871	36.518	33.199	49.798
106	M86	Z	23.828	16.344	4.894	26.917
107	M86	Z	16.344	8.86	26.917	48.941
108	M87	Z	3.856	16.74	4.98	24.899
109	M87	Z	16.74	29.625	24.899	44.818
110	M85	Z	48.387	34.589	0	23.021
111	M85	Z	34.589	23.492	23.021	46.042
112	M86	Z	2.176	12.678	0	16.314
113	M86	Z	12.678	24.357	16.314	32.627
114	M86	Z	24.357	37.212	32.627	48.941
115	M73	Z	28.958	16.76	4.864	24.321
116	M73	Z	16.76	4.563	24.321	43.778

Member Area Loads (BLC 1 : Dead Load)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	PPB4	PPB5	PPB6	PPB1	Y	Two Way	-10
2	PPB4	PPB3	PPB2	PPB1	Y	Two Way	-10
3	N39	N40	N41	N42	Y	Two Way	-10
4	N42	N43	N38	N39	Y	Two Way	-10
5	PPB4	PPMA5	PPMA6		Y	Two Way	1.2
6	PPB4	PPMA6	PPB5		Y	Two Way	1.2
7	PPB5	PPMA6	PPMA7		Y	Two Way	1.2
8	PPMA5	PPT4	PPMA6		Y	Two Way	1.2
9	PPMA6	PPT4	PPT5		Y	Two Way	1.2
10	PPMA6	PPMA7	PPT5		Y	Two Way	1.2
11	PPB5	PPMA8	PPMA7		Y	Two Way	1.2

Member Area Loads (BLC 1 : Dead Load) (Continued)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
12	PPMA8	PPT5	PPMA7		Y	Two Way	1.2
13	PPMA8	PPT6	PPT5		Y	Two Way	1.2
14	PPMA8	PPMA1	PPT6		Y	Two Way	1.2
15	PPB5	PPB6	PPMA8		Y	Two Way	1.2
16	PPB6	PPMA1	PPMA8		Y	Two Way	1.2
17	PPMA1	PPMA2	PPT1		Y	Two Way	1.2
18	PPMA2	PPT2	PPT1		Y	Two Way	1.2
19	PPMA2	PPMA3	PPT2		Y	Two Way	1.2
20	PPMA1	PPB1	PPMA2		Y	Two Way	1.2
21	PPB1	PPB2	PPMA2		Y	Two Way	1.2
22	PPB2	PPMA3	PPMA2		Y	Two Way	1.2
23	PPB3	PPMA3	PPB2		Y	Two Way	1.2
24	PPB3	PPMA3	PPMA4		Y	Two Way	1.2
25	PPMA3	PPMA4	PPT2		Y	Two Way	1.2
26	PPMA4	PPT3	PPT2		Y	Two Way	1.2
27	PPMA4	PPMA5	PPT3		Y	Two Way	1.2
28	PPMA4	PPB3	PPMA5		Y	Two Way	1.2
29	PPB6	PPB1	PPMA1		Y	Two Way	1.2
30	PPMA1	PPT1	PPT6		Y	Two Way	1.2
31	PPB3	PPB4	PPMA5		Y	Two Way	1.2
32	PPMA5	PPT4	PPT3		Y	Two Way	1.2
33	N42	N35	N36		Y	Two Way	1.2
34	N42	N41	N35		Y	Two Way	1.2
35	N36	N35	N28		Y	Two Way	1.2
36	N35	N27	N28		Y	Two Way	1.2
37	N35	N41	N34		Y	Two Way	1.2
38	N35	N34	N27		Y	Two Way	1.2
39	N34	N41	N40		Y	Two Way	1.2
40	N34	N26	N27		Y	Two Way	1.2
41	N34	N33	N26		Y	Two Way	1.2
42	N34	N40	N33		Y	Two Way	1.2
43	N40	N39	N33		Y	Two Way	1.2
44	N39	N32	N33		Y	Two Way	1.2
45	N33	N26	N25		Y	Two Way	1.2
46	N33	N25	N32		Y	Two Way	1.2
47	N39	N32	N31		Y	Two Way	1.2
48	N39	N31	N38		Y	Two Way	1.2
49	N31	N32	N25		Y	Two Way	1.2
50	N25	N24	N31		Y	Two Way	1.2
51	N24	N30	N31		Y	Two Way	1.2
52	N24	N29	N30		Y	Two Way	1.2
53	N30	N38	N31		Y	Two Way	1.2
54	N38	N30	N43		Y	Two Way	1.2
55	N43	N30	N37		Y	Two Way	1.2
56	N30	N29	N37		Y	Two Way	1.2
57	N43	N37	N42		Y	Two Way	1.2
58	N42	N37	N36		Y	Two Way	1.2
59	N37	N29	N28		Y	Two Way	1.2
60	N37	N28	N36		Y	Two Way	1.2

Member Area Loads (BLC 2 : Wind Load-X LC1&2)

Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]

Member Area Loads (BLC 2 : Wind Load-X LC1&2) (Continued)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N51	PPB4	PPMA5		X	Two Way	51.7
2	PPMA5	PPB4	PPMA6		X	Two Way	51.7
3	PPB4	PPMA6	PPB5		X	Two Way	51.7
4	PPMA6	PPB5	PPMA7		X	Two Way	51.7
5	PPMA7	PPB5	PPMA8		X	Two Way	51.7
6	PPB5	PPMA8	PPB6		X	Two Way	51.7
7	PPMA8	PPMA1	PPB6		X	Two Way	51.7
8	N50	PPB6	PPMA1		X	Two Way	51.7
9	N48	PPMA1	PPT6		X	Two Way	51.7
10	PPMA1	PPMA8	PPT6		X	Two Way	51.7
11	PPT6	PPMA8	PPT5		X	Two Way	51.7
12	PPT5	PPMA8	PPMA7		X	Two Way	51.7
13	PPT5	PPMA7	PPMA6		X	Two Way	51.7
14	PPT5	PPMA6	PPT4		X	Two Way	51.7
15	PPT4	PPMA6	PPMA5		X	Two Way	51.7
16	N49	PPT4	PPMA5		X	Two Way	51.7
17	N52	N30	N43		X	Two Way	51.7
18	N30	N54	N29		X	Two Way	51.7
19	N43	N30	N37		X	Two Way	51.7
20	N37	N43	N42		X	Two Way	51.7
21	N37	N36	N42		X	Two Way	51.7
22	N42	N36	N35		X	Two Way	51.7
23	N35	N42	N41		X	Two Way	51.7
24	N35	N34	N41		X	Two Way	51.7
25	N53	N41	N34		X	Two Way	51.7
26	N29	N30	N37		X	Two Way	51.7
27	N37	N29	N28		X	Two Way	51.7
28	N28	N36	N37		X	Two Way	51.7
29	N28	N36	N35		X	Two Way	51.7
30	N28	N35	N27		X	Two Way	51.7
31	N27	N35	N34		X	Two Way	51.7
32	N27	N55	N34		X	Two Way	51.7
33	N28	N27	N26	N25	X	Two Way	51.7
34	N25	N28	N29	N24	X	Two Way	51.7

Member Area Loads (BLC 3 : Wind Load-Z LC1&2)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	PPT5	PPMA7	PPMA6		Z	Two Way	51.7
2	PPT5	PPMA6	PPT4		Z	Two Way	51.7
3	PPT4	PPMA6	PPMA5		Z	Two Way	51.7
4	PPT4	PPT3	PPMA5		Z	Two Way	51.7
5	PPT3	PPMA5	PPMA4		Z	Two Way	51.7
6	PPT3	PPMA4	PPT2		Z	Two Way	51.7
7	PPT2	PPMA4	PPMA3		Z	Two Way	51.7
8	PPMA7	PPB5	PPMA6		Z	Two Way	51.7
9	PPMA6	PPB5	PPB4		Z	Two Way	51.7
10	PPMA6	PPB4	PPMA5		Z	Two Way	51.7
11	PPB4	PPB3	PPMA5		Z	Two Way	51.7
12	PPMA5	PPB3	PPMA4		Z	Two Way	51.7
13	PPMA4	PPB3	PPB2		Z	Two Way	51.7
14	PPMA4	PPB2	PPMA3		Z	Two Way	51.7

Member Area Loads (BLC 3 : Wind Load-Z LC1&2) (Continued)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
15	N28	N36	N35		Z	Two Way	51.7
16	N28	N27	N35		Z	Two Way	51.7
17	N35	N27	N34		Z	Two Way	51.7
18	N34	N27	N26		Z	Two Way	51.7
19	N34	N26	N33		Z	Two Way	51.7
20	N26	N33	N25		Z	Two Way	51.7
21	N25	N33	N32		Z	Two Way	51.7
22	N36	N42	N35		Z	Two Way	51.7
23	N42	N35	N41		Z	Two Way	51.7
24	N41	N34	N35		Z	Two Way	51.7
25	N34	N41	N40		Z	Two Way	51.7
26	N40	N34	N33		Z	Two Way	51.7
27	N40	N33	N39		Z	Two Way	51.7
28	N39	N33	N32		Z	Two Way	51.7

Member Area Loads (BLC 4 : Wind Load-X LC3)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N51	PPB4	PPMA5		X	Two Way	19.1
2	PPMA5	PPB4	PPMA6		X	Two Way	19.1
3	PPB4	PPMA6	PPB5		X	Two Way	19.1
4	PPMA6	PPB5	PPMA7		X	Two Way	19.1
5	PPMA7	PPB5	PPMA8		X	Two Way	19.1
6	PPB5	PPMA8	PPB6		X	Two Way	19.1
7	PPMA8	PPMA1	PPB6		X	Two Way	19.1
8	N50	PPB6	PPMA1		X	Two Way	19.1
9	N48	PPMA1	PPT6		X	Two Way	19.1
10	PPMA1	PPMA8	PPT6		X	Two Way	19.1
11	PPT6	PPMA8	PPT5		X	Two Way	19.1
12	PPT5	PPMA8	PPMA7		X	Two Way	19.1
13	PPT5	PPMA7	PPMA6		X	Two Way	19.1
14	PPT5	PPMA6	PPT4		X	Two Way	19.1
15	PPT4	PPMA6	PPMA5		X	Two Way	19.1
16	N49	PPT4	PPMA5		X	Two Way	19.1
17	N52	N30	N43		X	Two Way	19.1
18	N30	N54	N29		X	Two Way	19.1
19	N43	N30	N37		X	Two Way	19.1
20	N37	N43	N42		X	Two Way	19.1
21	N37	N36	N42		X	Two Way	19.1
22	N42	N36	N35		X	Two Way	19.1
23	N35	N42	N41		X	Two Way	19.1
24	N35	N34	N41		X	Two Way	19.1
25	N53	N41	N34		X	Two Way	19.1
26	N29	N30	N37		X	Two Way	19.1
27	N37	N29	N28		X	Two Way	19.1
28	N28	N36	N37		X	Two Way	19.1
29	N28	N36	N35		X	Two Way	19.1
30	N28	N35	N27		X	Two Way	19.1
31	N27	N35	N34		X	Two Way	19.1
32	N27	N55	N34		X	Two Way	19.1
33	N28	N27	N26	N25	X	Two Way	19.1
34	N25	N28	N29	N24	X	Two Way	19.1

Member Area Loads (BLC 5 : Wind Load-Z LC3)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	PPT5	PPMA7	PPMA6		Z	Two Way	19.1
2	PPT5	PPMA6	PPT4		Z	Two Way	19.1
3	PPT4	PPMA6	PPMA5		Z	Two Way	19.1
4	PPT4	PPT3	PPMA5		Z	Two Way	19.1
5	PPT3	PPMA5	PPMA4		Z	Two Way	19.1
6	PPT3	PPMA4	PPT2		Z	Two Way	19.1
7	PPT2	PPMA4	PPMA3		Z	Two Way	19.1
8	PPMA7	PPB5	PPMA6		Z	Two Way	19.1
9	PPMA6	PPB5	PPB4		Z	Two Way	19.1
10	PPMA6	PPB4	PPMA5		Z	Two Way	19.1
11	PPB4	PPB3	PPMA5		Z	Two Way	19.1
12	PPMA5	PPB3	PPMA4		Z	Two Way	19.1
13	PPMA4	PPB3	PPB2		Z	Two Way	19.1
14	PPMA4	PPB2	PPMA3		Z	Two Way	19.1
15	N28	N36	N35		Z	Two Way	19.1
16	N28	N27	N35		Z	Two Way	19.1
17	N35	N27	N34		Z	Two Way	19.1
18	N34	N27	N26		Z	Two Way	19.1
19	N34	N26	N33		Z	Two Way	19.1
20	N26	N33	N25		Z	Two Way	19.1
21	N25	N33	N32		Z	Two Way	19.1
22	N36	N42	N35		Z	Two Way	19.1
23	N42	N35	N41		Z	Two Way	19.1
24	N41	N34	N35		Z	Two Way	19.1
25	N34	N41	N40		Z	Two Way	19.1
26	N40	N34	N33		Z	Two Way	19.1
27	N40	N33	N39		Z	Two Way	19.1
28	N39	N33	N32		Z	Two Way	19.1

Load Combinations

	Description	Solve	PDe...	SRSS	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	Strength III - LC1 +X	Yes	Y	+	1	1.25	2	1																		
2	Strength III - LC2 +X	Yes	Y	+	1	.9	2	1																		
3	Service I - LC3 +X	Yes	Y	+	1	1	2	1																		
4	Strength III - LC1 +Z	Yes	Y	+	1	1.25	3	1																		
5	Strength III - LC2 +Z	Yes	Y	+	1	.9	3	1																		
6	Services I - LC3 +Z	Yes	Y	+	1	1	3	1																		
7	Strength III - LC1 -X	Yes	Y	+	1	1.25	2	-1																		
8	Strength III - LC2 -X	Yes	Y	+	1	.9	2	-1																		
9	Service I - LC3 -X	Yes	Y	+	1	1	2	-1																		
10	Strength III - LC1 -Z	Yes	Y	+	1	1.25	3	-1																		
11	Strength III - LC2 -Z	Yes	Y	+	1	.9	3	-1																		
12	Service I - LC3 -Z	Yes	Y	+	1	1	3	-1																		

Joint Reactions (By Combination)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
1	1	N45	-543.622	1620.8	-1096.22	0	0	0
2	1	N46	146.281	1304.257	1092.281	0	0	0
3	1	N44	-2541.925	-2298.328	3.939	0	0	0

Joint Reactions (By Combination) (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
4	1	PPA2	-136.447	1713.001	-2992.222	0	0	0
5	1	PPA3	1607.992	1379.067	2871.71	0	0	0
6	1	PPA1	-4042.269	-2494.683	120.512	0	0	0
7	1	Totals:	-5509.99	1224.113	0			
8	1	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
9	2	N45	-477.767	1591.665	-1069.566	0	0	0
10	2	N46	192.533	1279.898	1057.909	0	0	0
11	2	N44	-2654.033	-2420.319	11.657	0	0	0
12	2	PPA2	-75.883	1642.916	-2901.617	0	0	0
13	2	PPA3	1606.399	1321.612	2782.528	0	0	0
14	2	PPA1	-4101.241	-2534.411	119.089	0	0	0
15	2	Totals:	-5509.99	881.361	0			
16	2	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
17	3	N45	-496.582	1599.99	-1077.181	0	0	0
18	3	N46	179.319	1286.858	1067.729	0	0	0
19	3	N44	-2622.004	-2385.465	9.452	0	0	0
20	3	PPA2	-93.187	1662.94	-2927.504	0	0	0
21	3	PPA3	1606.854	1338.028	2808.008	0	0	0
22	3	PPA1	-4084.392	-2523.06	119.496	0	0	0
23	3	Totals:	-5509.99	979.291	0			
24	3	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
25	4	N45	-2386.904	1561.778	-844.801	0	0	0
26	4	N46	947.123	-2153.926	-2184.557	0	0	0
27	4	N44	1439.78	1218.877	364.516	0	0	0
28	4	PPA2	-2345.293	1713.019	-1485.273	0	0	0
29	4	PPA3	756.953	-2045.095	-2900.901	0	0	0
30	4	PPA1	1588.339	929.461	1815.58	0	0	0
31	4	Totals:	0	1224.113	-5235.437			
32	4	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
33	5	N45	-2320.811	1532.602	-818.103	0	0	0
34	5	N46	993.324	-2178.305	-2218.806	0	0	0
35	5	N44	1327.487	1096.948	372.066	0	0	0
36	5	PPA2	-2284.472	1642.939	-1394.832	0	0	0
37	5	PPA3	755.441	-2102.402	-2989.702	0	0	0
38	5	PPA1	1529.032	889.58	1813.939	0	0	0
39	5	Totals:	0	881.361	-5235.437			
40	5	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
41	6	N45	-2339.694	1540.938	-825.731	0	0	0
42	6	N46	980.124	-2171.34	-2209.021	0	0	0
43	6	N44	1359.57	1131.785	369.91	0	0	0
44	6	PPA2	-2301.85	1662.962	-1420.672	0	0	0
45	6	PPA3	755.873	-2086.029	-2964.33	0	0	0
46	6	PPA1	1545.977	900.975	1814.408	0	0	0
47	6	Totals:	0	979.291	-5235.437			
48	6	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
49	7	N45	72.056	-1409.535	902.657	0	0	0
50	7	N46	-475.371	-1127.854	-843.981	0	0	0
51	7	N44	3342.581	3164.117	-58.676	0	0	0
52	7	PPA2	-301.291	-1211.751	2339.49	0	0	0
53	7	PPA3	-1597.8	-968.291	-2229.166	0	0	0
54	7	PPA1	4469.816	2777.427	-110.324	0	0	0
55	7	Totals:	5509.99	1224.113	0			

Worst Case Uplift Reaction Used for Bolt Analysis

Worst Case Lateral Reaction Used for Bolt Analysis

Joint Reactions (By Combination) (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
56	7	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
57	8	N45	138.156	-1438.798	929.491	0	0	0
58	8	N46	-429.1	-1152.282	-878.528	0	0	0
59	8	N44	3230.21	3042.325	-50.963	0	0	0
60	8	PPA2	-240.584	-1281.727	2429.696	0	0	0
61	8	PPA3	-1599.033	-1025.636	-2317.984	0	0	0
62	8	PPA1	4410.341	2737.48	-111.712	0	0	0
63	8	Totals:	5509.99	881.361	0			
64	8	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
65	9	N45	119.271	-1430.437	921.824	0	0	0
66	9	N46	-442.319	-1145.303	-868.658	0	0	0
67	9	N44	3262.314	3077.122	-53.166	0	0	0
68	9	PPA2	-257.929	-1261.734	2403.924	0	0	0
69	9	PPA3	-1598.681	-1009.252	-2292.608	0	0	0
70	9	PPA1	4427.333	2748.894	-111.316	0	0	0
71	9	Totals:	5509.99	979.291	0			
72	9	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
73	10	N45	1915.284	-1350.898	648.412	0	0	0
74	10	N46	-1274.49	2327.161	2437.439	0	0	0
75	10	N44	-640.794	-349.534	-421.008	0	0	0
76	10	PPA2	1907.092	-1211.486	832.303	0	0	0
77	10	PPA3	-747.315	2453.949	3544.35	0	0	0
78	10	PPA1	-1159.778	-645.079	-1806.059	0	0	0
79	10	Totals:	0	1224.113	5235.437			
80	10	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
81	11	N45	1981.147	-1380.12	675.204	0	0	0
82	11	N46	-1228.167	2302.753	2402.766	0	0	0
83	11	N44	-752.98	-471.388	-413.127	0	0	0
84	11	PPA2	1967.544	-1281.467	922.674	0	0	0
85	11	PPA3	-748.627	2396.457	3455.15	0	0	0
86	11	PPA1	-1218.917	-684.873	-1807.23	0	0	0
87	11	Totals:	0	881.361	5235.437			
88	11	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			
89	12	N45	1962.33	-1371.771	667.549	0	0	0
90	12	N46	-1241.401	2309.727	2412.671	0	0	0
91	12	N44	-720.929	-436.573	-415.378	0	0	0
92	12	PPA2	1950.272	-1261.472	896.854	0	0	0
93	12	PPA3	-748.252	2412.883	3480.636	0	0	0
94	12	PPA1	-1202.02	-673.503	-1806.895	0	0	0
95	12	Totals:	0	979.291	5235.437			
96	12	COG (in):	X: -13.903	Y: 30.19	Z: 61.161			

Envelope Member Section Stresses

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
1	M1	1	max	.883	4	.04	10	.011	2	0	12	0	12	0	12	0	12
2			min	-.859	11	-.016	5	-.015	7	0	1	0	1	0	1	0	1
3		2	max	.883	4	.036	10	.011	2	.154	10	.067	5	.044	2	.058	7
4			min	-.859	11	-.019	5	-.015	7	-.067	5	-.154	10	-.058	7	-.044	2
5		3	max	.949	5	.067	11	.006	10	.647	4	.449	11	.088	2	.116	7
6			min	-.965	10	-.068	4	-.002	5	-.449	11	-.647	4	-.116	7	-.088	2

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
7		4	max	.949	5	.055	11	.006	10	.347	4	.207	11	.006	5	.023	10
8			min	-.965	10	-.085	4	-.002	5	-.207	11	-.347	4	-.023	10	-.006	5
9		5	max	.949	5	.051	11	.006	10	0	12	0	12	0	12	0	12
10			min	-.965	10	-.089	4	-.002	5	0	1	0	1	0	1	0	1
11	M2	1	max	1.608	10	.075	7	.018	1	0	12	0	12	0	12	0	12
12			min	-1.512	5	-.045	2	-.018	8	0	1	0	1	0	1	0	1
13		2	max	1.608	10	.068	7	.018	1	.285	7	.187	2	.073	1	.072	8
14			min	-1.512	5	-.05	2	-.018	8	-.187	2	-.285	7	-.072	8	-.073	1
15		3	max	1.608	10	.065	11	.018	1	.581	4	.473	11	.176	1	.176	8
16			min	-1.512	5	-.067	4	-.018	8	-.473	11	-.581	4	-.176	8	-.176	1
17		4	max	1.555	10	.059	11	.022	8	.301	4	.229	11	.088	1	.088	8
18			min	-1.426	5	-.075	4	-.022	1	-.229	11	-.301	4	-.088	8	-.088	1
19		5	max	1.555	10	.057	11	.022	8	0	12	0	12	0	12	0	12
20			min	-1.426	5	-.077	4	-.022	1	0	1	0	1	0	1	0	1
21	M3	1	max	.462	11	.049	7	.021	5	0	12	0	12	0	12	0	12
22			min	-.481	4	-.006	2	-.028	10	0	1	0	1	0	1	0	1
23		2	max	.462	11	.032	7	.021	5	.161	7	.047	2	.082	5	.111	10
24			min	-.481	4	-.018	2	-.028	10	-.047	2	-.161	7	-.111	10	-.082	5
25		3	max	.883	11	.106	7	.029	10	.829	1	.756	8	.177	5	.231	10
26			min	-.887	4	-.095	2	-.022	5	-.756	8	-.829	1	-.231	10	-.177	5
27		4	max	.883	11	.095	8	.029	10	.436	1	.362	8	.088	5	.116	10
28			min	-.887	4	-.105	1	-.022	5	-.362	8	-.436	1	-.116	10	-.088	5
29		5	max	.883	11	.088	8	.029	10	0	12	0	12	0	12	0	12
30			min	-.887	4	-.115	1	-.022	5	0	1	0	1	0	1	0	1
31	M4	1	max	1.094	7	.165	4	.022	2	0	12	0	12	0	12	0	12
32			min	-.978	2	-.142	11	-.025	7	0	1	0	1	0	1	0	1
33		2	max	1.094	7	.16	4	.022	2	.646	4	.567	11	.086	2	.097	7
34			min	-.978	2	-.145	11	-.025	7	-.567	11	-.646	4	-.097	7	-.086	2
35		3	max	1.408	7	.146	5	.008	7	1.248	4	1.166	11	.171	2	.195	7
36			min	-1.315	2	-.159	10	-.006	4	-1.166	11	-1.248	4	-.195	7	-.171	2
37		4	max	1.408	7	.096	8	.013	10	.496	1	.372	8	.04	5	.051	10
38			min	-1.315	2	-.122	1	-.01	5	-.372	8	-.496	1	-.051	10	-.04	5
39		5	max	1.408	7	.093	8	.013	10	0	12	0	12	0	12	0	12
40			min	-1.315	2	-.127	1	-.01	5	0	1	0	1	0	1	0	1
41	M5	1	max	1.437	7	.123	1	.013	11	0	12	0	12	0	12	0	12
42			min	-1.347	2	-.093	8	-.014	4	0	1	0	1	0	1	0	1
43		2	max	1.437	7	.115	1	.013	11	.474	1	.379	8	.052	11	.056	4
44			min	-1.347	2	-.099	8	-.014	4	-.379	8	-.474	1	-.056	4	-.052	11
45		3	max	1.437	7	.107	1	.013	4	.914	1	.782	8	.104	11	.113	4
46			min	-1.347	2	-.105	8	-.012	11	-.782	8	-.914	1	-.113	4	-.104	11
47		4	max	1.257	7	.04	5	.013	4	.225	10	.152	5	.049	11	.053	4
48			min	-1.172	2	-.055	10	-.012	11	-.152	5	-.225	10	-.053	4	-.049	11
49		5	max	1.257	7	.037	5	.013	4	0	12	0	12	0	12	0	12
50			min	-1.172	2	-.058	10	-.012	11	0	1	0	1	0	1	0	1
51	M6	1	max	1.413	5	.12	1	.015	5	0	12	0	12	0	12	0	12
52			min	-1.422	10	-.077	8	-.02	10	0	1	0	1	0	1	0	1
53		2	max	1.413	5	.103	1	.015	5	.441	1	.329	8	.061	5	.081	10
54			min	-1.422	10	-.089	8	-.02	10	-.329	8	-.441	1	-.081	10	-.061	5
55		3	max	1.413	5	.091	2	.015	5	.82	1	.703	8	.145	5	.183	10
56			min	-1.422	10	-.102	7	-.02	10	-.703	8	-.82	1	-.183	10	-.145	5
57		4	max	1.389	4	.049	5	.023	10	.253	10	.177	5	.072	5	.092	10
58			min	-1.338	11	-.059	10	-.018	5	-.177	5	-.253	10	-.092	10	-.072	5

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
59		5	max	1.389	4	.041	5	.023	10	0	12	0	12	0	12	0	12
60			min	-1.338	11	-.069	10	-.018	5	0	1	0	1	0	1	0	1
61	M7	1	max	.023	1	.037	10	.156	10	0	12	0	12	0	12	0	12
62			min	-.018	8	-.028	5	-.155	5	0	1	0	1	0	1	0	1
63		2	max	.023	1	.034	10	.156	10	.141	10	.114	5	.618	10	.616	5
64			min	-.018	8	-.03	5	-.155	5	-.114	5	-.141	10	-.616	5	-.618	10
65		3	max	.03	1	.031	11	.156	10	.27	10	.237	5	1.236	10	1.231	5
66			min	-.025	5	-.033	4	-.155	5	-.237	5	-.27	10	-1.231	5	-1.236	10
67		4	max	.03	1	.023	2	.1	10	.114	7	.088	2	.394	5	.398	10
68			min	-.025	5	-.027	7	-.1	5	-.088	2	-.114	7	-.398	10	-.394	5
69		5	max	.03	1	.021	2	.1	10	0	12	0	12	0	12	0	12
70			min	-.025	5	-.03	7	-.1	5	0	1	0	1	0	1	0	1
71	M8	1	max	.168	1	.02	7	.059	5	0	12	0	12	0	12	0	12
72			min	-.165	8	-.011	2	-.06	10	0	1	0	1	0	1	0	1
73		2	max	.171	1	.017	7	.059	5	.074	7	.048	2	.231	5	.236	10
74			min	-.167	8	-.013	2	-.06	10	-.048	2	-.074	7	-.236	10	-.231	5
75		3	max	.177	1	.014	8	.059	5	.135	7	.106	2	.463	5	.473	10
76			min	-.174	8	-.016	1	-.06	10	-.106	2	-.135	7	-.473	10	-.463	5
77		4	max	.179	1	.012	2	.048	2	.072	7	.044	2	.195	7	.19	2
78			min	-.176	8	-.017	7	-.049	7	-.044	2	-.072	7	-.19	2	-.195	7
79		5	max	.179	1	.01	2	.048	2	0	12	0	12	0	12	0	12
80			min	-.176	8	-.02	7	-.049	7	0	1	0	1	0	1	0	1
81	M9	1	max	.054	7	.027	7	.09	7	0	12	0	12	0	12	0	12
82			min	-.052	2	-.017	2	-.088	2	0	1	0	1	0	1	0	1
83		2	max	.054	7	.024	7	.09	7	.1	7	.072	2	.355	7	.35	2
84			min	-.052	2	-.019	2	-.088	2	-.072	2	-.1	7	-.35	2	-.355	7
85		3	max	.064	7	.032	4	.156	8	.261	10	.229	5	1.237	1	1.236	8
86			min	-.062	2	-.03	11	-.156	1	-.229	5	-.261	10	-1.236	8	-1.237	1
87		4	max	.064	7	.029	5	.156	8	.137	10	.11	5	.618	1	.618	8
88			min	-.062	2	-.033	10	-.156	1	-.11	5	-.137	10	-.618	8	-.618	1
89		5	max	.064	7	.027	5	.156	8	0	12	0	12	0	12	0	12
90			min	-.062	2	-.036	10	-.156	1	0	1	0	1	0	1	0	1
91	M10	1	max	.127	4	.035	10	.159	10	0	12	0	12	0	12	0	12
92			min	-.122	11	-.025	5	-.158	5	0	1	0	1	0	1	0	1
93		2	max	.127	4	.031	10	.159	10	.131	10	.103	5	.629	10	.626	5
94			min	-.122	11	-.027	5	-.158	5	-.103	5	-.131	10	-.626	5	-.629	10
95		3	max	.127	4	.028	11	.159	10	.248	10	.216	5	1.258	10	1.253	5
96			min	-.122	11	-.03	4	-.158	5	-.216	5	-.248	10	-1.253	5	-1.258	10
97		4	max	.113	4	.019	2	.099	10	.098	7	.072	2	.387	5	.39	10
98			min	-.108	11	-.023	7	-.098	5	-.072	2	-.098	7	-.39	10	-.387	5
99		5	max	.113	4	.017	2	.099	10	0	12	0	12	0	12	0	12
100			min	-.108	11	-.026	7	-.098	5	0	1	0	1	0	1	0	1
101	M11	1	max	.179	1	.019	7	.066	5	0	12	0	12	0	12	0	12
102			min	-.176	8	-.01	2	-.068	10	0	1	0	1	0	1	0	1
103		2	max	.179	1	.016	7	.066	5	.069	7	.042	2	.263	5	.268	10
104			min	-.176	8	-.012	2	-.068	10	-.042	2	-.069	7	-.268	10	-.263	5
105		3	max	.177	1	.016	1	.066	5	.14	7	.108	2	.525	5	.535	10
106			min	-.174	8	-.015	8	-.068	10	-.108	2	-.14	7	-.535	10	-.525	5
107		4	max	.171	1	.014	2	.054	2	.077	7	.05	2	.217	7	.215	2
108			min	-.168	8	-.018	7	-.055	7	-.05	2	-.077	7	-.215	2	-.217	7
109		5	max	.168	1	.011	2	.054	2	0	12	0	12	0	12	0	12
110			min	-.165	8	-.021	7	-.055	7	0	1	0	1	0	1	0	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
111	M12	1	max	.159	4	.031	7	.089	7	0	12	0	12	0	12	0	12
112			min	-.156	11	-.021	2	-.089	2	0	1	0	1	0	1	0	1
113		2	max	.159	4	.028	7	.089	7	.116	7	.089	2	.352	7	.351	2
114			min	-.156	11	-.024	2	-.089	2	-.089	2	-.116	7	-.351	2	-.352	7
115		3	max	.172	4	.027	4	.151	8	.221	10	.19	5	1.2	1	1.192	8
116			min	-.169	11	-.025	11	-.152	1	-.19	5	-.221	10	-1.192	8	-1.2	1
117		4	max	.172	4	.024	5	.151	8	.117	10	.091	5	.6	1	.596	8
118			min	-.169	11	-.028	10	-.152	1	-.091	5	-.117	10	-.596	8	-.6	1
119		5	max	.172	4	.022	5	.151	8	0	12	0	12	0	12	0	12
120			min	-.169	11	-.031	10	-.152	1	0	1	0	1	0	1	0	1
121	M13	1	max	.247	7	.074	1	.022	5	0	12	0	12	0	12	0	12
122			min	-.231	2	-.072	8	-.022	10	0	1	0	1	0	1	0	1
123		2	max	.253	7	.051	2	.012	5	.758	1	.747	8	.219	5	.219	10
124			min	-.23	2	-.052	7	-.012	10	-.747	8	-.758	1	-.219	10	-.219	5
125		3	max	.298	7	.114	1	.049	5	.991	2	.994	7	.179	5	.179	10
126			min	-.265	2	-.112	8	-.049	10	-.994	7	-.991	2	-.179	10	-.179	5
127		4	max	.31	7	.013	4	.005	11	.566	1	.565	8	.375	4	.375	11
128			min	-.271	2	-.013	11	-.005	4	-.565	8	-.566	1	-.375	11	-.375	4
129		5	max	.32	7	.075	8	.046	11	0	12	0	12	0	12	0	12
130			min	-.276	2	-.077	1	-.046	4	0	1	0	1	0	1	0	1
131	M14	1	max	.478	1	.012	10	.022	10	0	12	0	12	0	12	0	12
132			min	-.463	8	-.01	5	-.022	4	0	1	0	1	0	1	0	1
133		2	max	.482	1	.011	11	.011	10	.127	10	.116	5	.216	10	.216	4
134			min	-.46	8	-.011	4	-.011	4	-.116	5	-.127	10	-.216	4	-.216	10
135		3	max	.543	1	.015	4	.048	11	.295	11	.306	4	.173	10	.173	4
136			min	-.511	8	-.012	11	-.048	4	-.306	4	-.295	11	-.173	4	-.173	10
137		4	max	.546	1	.014	4	.006	5	.152	10	.148	5	.39	10	.39	5
138			min	-.509	8	-.013	11	-.006	10	-.148	5	-.152	10	-.39	5	-.39	10
139		5	max	.55	1	.013	5	.048	5	0	12	0	12	0	12	0	12
140			min	-.506	8	-.014	10	-.048	10	0	1	0	1	0	1	0	1
141	M17	1	max	.216	10	.094	1	.037	2	0	12	0	12	0	12	0	12
142			min	-.207	5	-.093	8	-.037	7	0	1	0	1	0	1	0	1
143		2	max	.219	10	.013	5	.003	2	.44	1	.434	8	.224	2	.228	7
144			min	-.205	5	-.014	1	-.004	7	-.434	8	-.44	1	-.228	7	-.224	2
145		3	max	.222	10	.106	8	.026	8	.762	1	.753	8	.255	5	.267	10
146			min	-.203	5	-.109	1	-.026	1	-.753	8	-.762	1	-.267	10	-.255	5
147		4	max	.218	10	.037	8	.012	10	.799	1	.781	8	.127	5	.133	10
148			min	-.192	5	-.038	1	-.011	5	-.781	8	-.799	1	-.133	10	-.127	5
149		5	max	.222	10	.085	8	.012	10	0	12	0	12	0	12	0	12
150			min	-.19	5	-.088	1	-.011	5	0	1	0	1	0	1	0	1
151	M18	1	max	.546	4	.011	4	.044	8	0	12	0	12	0	12	0	12
152			min	-.527	11	-.006	11	-.045	1	0	1	0	1	0	1	0	1
153		2	max	.542	4	.008	5	.025	11	.109	4	.086	11	.381	8	.388	1
154			min	-.53	11	-.008	10	-.026	4	-.086	11	-.109	4	-.388	1	-.381	8
155		3	max	.538	4	.025	4	.08	2	.648	2	.651	7	1.106	8	1.127	1
156			min	-.533	11	-.021	11	-.08	7	-.651	7	-.648	2	-1.127	1	-1.106	8
157		4	max	.508	5	.027	7	.044	1	.357	1	.335	8	1.213	8	1.224	1
158			min	-.508	10	-.027	2	-.043	8	-.335	8	-.357	1	-1.224	1	-1.213	8
159		5	max	.506	5	.03	8	.167	1	0	12	0	12	0	12	0	12
160			min	-.511	10	-.033	1	-.166	8	0	1	0	1	0	1	0	1
161	M19	1	max	.254	10	.105	4	.166	8	0	12	0	12	0	12	0	12
162			min	-.254	5	-.102	11	-.166	1	0	1	0	1	0	1	0	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
163		2	max	.278	10	.027	2	.043	8	.53	4	.511	11	1.212	8	1.223	1
164			min	-.273	5	-.027	7	-.044	1	-.511	11	-.53	4	-1.223	1	-1.212	8
165		3	max	.366	10	.105	11	.081	7	.647	2	.65	7	1.105	8	1.127	1
166			min	-.356	5	-.109	4	-.08	2	-.65	7	-.647	2	-1.127	1	-1.105	8
167		4	max	.384	10	.023	10	.027	4	.606	4	.581	11	.375	8	.385	1
168			min	-.368	5	-.022	5	-.026	11	-.581	11	-.606	4	-.385	1	-.375	8
169		5	max	.395	10	.06	11	.045	1	0	12	0	12	0	12	0	12
170			min	-.372	5	-.064	4	-.044	8	0	1	0	1	0	1	0	1
171	M20	1	max	.18	7	.088	1	.053	11	0	12	0	12	0	12	0	12
172			min	-.145	2	-.085	8	-.053	4	0	1	0	1	0	1	0	1
173		2	max	.171	7	.038	1	.007	8	.799	1	.783	8	.412	11	.416	4
174			min	-.143	2	-.038	8	-.008	1	-.783	8	-.799	1	-.416	4	-.412	11
175		3	max	.159	7	.109	1	.08	5	.762	1	.757	8	.352	11	.365	4
176			min	-.137	2	-.107	8	-.081	10	-.757	8	-.762	1	-.365	4	-.352	11
177		4	max	.113	10	.021	10	.014	4	.439	1	.429	8	.752	11	.758	4
178			min	-.097	5	-.021	5	-.013	11	-.429	8	-.439	1	-.758	4	-.752	11
179		5	max	.106	10	.092	8	.123	4	0	12	0	12	0	12	0	12
180			min	-.096	5	-.094	1	-.122	11	0	1	0	1	0	1	0	1
181	M21	1	max	.463	1	.061	4	.125	11	0	12	0	12	0	12	0	12
182			min	-.456	8	-.059	11	-.125	4	0	1	0	1	0	1	0	1
183		2	max	.466	1	.027	5	.016	11	.494	4	.486	11	.781	11	.786	4
184			min	-.454	8	-.027	10	-.016	4	-.486	11	-.494	4	-.786	4	-.781	11
185		3	max	.489	1	.045	4	.082	10	.628	5	.636	10	.41	11	.419	4
186			min	-.471	8	-.043	11	-.081	5	-.636	10	-.628	5	-.419	4	-.41	11
187		4	max	.493	1	.018	5	.007	1	.182	1	.168	8	.401	11	.407	4
188			min	-.469	8	-.019	10	-.007	8	-.168	8	-.182	1	-.407	4	-.401	11
189		5	max	.496	1	.014	8	.052	4	0	12	0	12	0	12	0	12
190			min	-.466	8	-.017	1	-.052	11	0	1	0	1	0	1	0	1
191	M22	1	max	.267	10	.068	4	.031	11	0	12	0	12	0	12	0	12
192			min	-.251	5	-.064	11	-.031	4	0	1	0	1	0	1	0	1
193		2	max	.259	7	.026	5	.032	11	.651	4	.628	11	.366	11	.374	4
194			min	-.248	2	-.027	10	-.033	4	-.628	11	-.651	4	-.374	4	-.366	11
195		3	max	.256	7	.109	4	.028	2	.5	5	.51	10	.759	11	.774	4
196			min	-.25	2	-.105	11	-.029	7	-.51	10	-.5	5	-.774	4	-.759	11
197		4	max	.25	8	.014	7	.021	1	.533	4	.514	11	.239	8	.248	1
198			min	-.25	1	-.014	2	-.02	8	-.514	11	-.533	4	-.248	1	-.239	8
199		5	max	.248	8	.102	11	.023	10	0	12	0	12	0	12	0	12
200			min	-.253	1	-.105	4	-.022	5	0	1	0	1	0	1	0	1
201	M23	1	max	.455	5	.026	10	.028	5	0	12	0	12	0	12	0	12
202			min	-.455	10	-.022	5	-.029	10	0	1	0	1	0	1	0	1
203		2	max	.458	4	.024	11	.028	5	.291	10	.272	5	.332	5	.34	10
204			min	-.453	11	-.024	4	-.029	10	-.272	5	-.291	10	-.34	10	-.332	5
205		3	max	.489	4	.022	11	.029	7	.557	11	.564	4	.664	5	.681	10
206			min	-.479	11	-.026	4	-.029	10	-.564	4	-.557	11	-.681	10	-.664	5
207		4	max	.493	4	.015	1	.029	7	.195	7	.17	2	.327	2	.338	7
208			min	-.476	11	-.015	8	-.028	2	-.17	2	-.195	7	-.338	7	-.327	2
209		5	max	.497	4	.013	2	.029	7	0	12	0	12	0	12	0	12
210			min	-.473	11	-.018	7	-.028	2	0	1	0	1	0	1	0	1
211	M24	1	max	.495	1	.025	10	.01	5	0	12	0	12	0	12	0	12
212			min	-.459	8	-.022	5	-.01	10	0	1	0	1	0	1	0	1
213		2	max	.491	1	.023	10	.01	5	.271	10	.257	5	.112	5	.116	10
214			min	-.462	8	-.023	5	-.01	10	-.257	5	-.271	10	-.116	10	-.112	5

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
215		3	max	.488	1	.026	1	.01	5	.562	8	.561	1	.223	5	.233	10
216			min	-.464	8	-.025	4	-.01	10	-.561	1	-.562	8	-.233	10	-.223	5
217		4	max	.465	1	.025	1	.005	7	.288	7	.275	2	.053	2	.059	7
218			min	-.448	8	-.025	8	-.005	2	-.275	2	-.288	7	-.059	7	-.053	2
219		5	max	.462	1	.024	2	.005	7	0	12	0	12	0	12	0	12
220			min	-.45	8	-.026	7	-.005	2	0	1	0	1	0	1	0	1
221	M23A	1	max	.483	8	.011	7	.026	2	0	12	0	12	0	12	0	12
222			min	-.483	1	-.007	2	-.027	7	0	1	0	1	0	1	0	1
223		2	max	.486	7	.009	8	.026	2	.113	7	.094	2	.304	2	.313	7
224			min	-.481	2	-.009	1	-.027	7	-.094	2	-.113	7	-.313	7	-.304	2
225		3	max	.542	7	.008	8	.026	2	.205	8	.202	1	.608	2	.626	7
226			min	-.531	2	-.011	1	-.027	7	-.202	1	-.205	8	-.626	7	-.608	2
227		4	max	.545	7	.001	10	.016	7	.021	4	.005	11	.182	2	.188	7
228			min	-.528	2	0	5	-.016	2	-.005	11	-.021	4	-.188	7	-.182	2
229		5	max	.549	7	0	11	.016	7	0	12	0	12	0	12	0	12
230			min	-.526	2	-.003	4	-.016	2	0	1	0	1	0	1	0	1
231	M24A	1	max	.237	4	.046	7	.041	8	0	12	0	12	0	12	0	12
232			min	-.21	11	-.042	2	-.042	1	0	1	0	1	0	1	0	1
233		2	max	.233	4	.007	7	.005	5	.382	7	.361	2	.303	8	.314	1
234			min	-.213	11	-.007	2	-.006	10	-.361	2	-.382	7	-.314	1	-.303	8
235		3	max	.23	4	.051	7	.084	7	.217	8	.224	1	.269	2	.277	7
236			min	-.215	11	-.048	2	-.084	2	-.224	1	-.217	8	-.277	7	-.269	2
237		4	max	.209	4	.012	1	.011	4	.437	7	.423	2	.253	8	.258	1
238			min	-.2	11	-.012	8	-.01	11	-.423	2	-.437	7	-.258	1	-.253	8
239		5	max	.206	4	.055	2	.045	1	0	12	0	12	0	12	0	12
240			min	-.203	11	-.057	7	-.045	8	0	1	0	1	0	1	0	1
241	M25	1	max	.595	1	.012	4	.042	4	0	12	0	12	0	12	0	12
242			min	-.546	8	-.01	11	-.041	11	0	1	0	1	0	1	0	1
243		2	max	.599	1	.011	4	0	10	.13	4	.117	11	.323	4	.321	11
244			min	-.543	8	-.011	11	0	5	-.117	11	-.13	4	-.321	11	-.323	4
245		3	max	.645	1	.01	5	.054	10	.247	4	.243	11	.189	10	.181	5
246			min	-.586	8	-.012	10	-.054	5	-.243	11	-.247	4	-.181	5	-.189	10
247		4	max	.648	1	.003	10	.004	5	.018	5	.028	10	.04	4	.036	11
248			min	-.584	8	-.001	5	-.005	10	-.028	10	-.018	5	-.036	11	-.04	4
249		5	max	.65	1	.002	10	.006	11	0	12	0	12	0	12	0	12
250			min	-.582	8	-.002	5	-.006	4	0	1	0	1	0	1	0	1
251	M26	1	max	.269	8	.006	7	.06	5	0	12	0	12	0	12	0	12
252			min	-.294	1	0	2	-.061	10	0	1	0	1	0	1	0	1
253		2	max	.269	8	.004	7	.06	5	.021	7	.007	2	.264	5	.268	10
254			min	-.294	1	-.002	2	-.061	10	-.007	2	-.021	7	-.268	10	-.264	5
255		3	max	.272	8	.003	8	.06	5	.036	7	.019	2	.527	5	.537	10
256			min	-.299	1	-.003	1	-.061	10	-.019	2	-.036	7	-.537	10	-.527	5
257		4	max	.272	8	.002	2	.022	7	.021	7	.006	2	.095	2	.097	7
258			min	-.299	1	-.004	7	-.022	2	-.006	2	-.021	7	-.097	7	-.095	2
259		5	max	.272	8	0	2	.022	7	0	12	0	12	0	12	0	12
260			min	-.299	1	-.006	7	-.022	2	0	1	0	1	0	1	0	1
261	M27	1	max	.222	11	.014	10	.019	1	0	12	0	12	0	12	0	12
262			min	-.254	4	-.009	5	-.019	8	0	1	0	1	0	1	0	1
263		2	max	.222	11	.012	10	.019	1	.057	10	.045	5	.083	1	.084	8
264			min	-.254	4	-.011	5	-.019	8	-.045	5	-.057	10	-.084	8	-.083	1
265		3	max	.237	11	.012	4	.042	8	.108	10	.095	5	.38	1	.375	8
266			min	-.269	4	-.011	11	-.043	1	-.095	5	-.108	10	-.375	8	-.38	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
267		4	max	.237	11	.011	5	.042	8	.056	10	.044	5	.19	1	.187	8
268			min	-.269	4	-.012	10	-.043	1	-.044	5	-.056	10	-.187	8	-.19	1
269		5	max	.237	11	.009	5	.042	8	0	12	0	12	0	12	0	12
270			min	-.269	4	-.014	10	-.043	1	0	1	0	1	0	1	0	1
271	M28	1	max	.416	2	.016	10	.023	10	0	12	0	12	0	12	0	12
272			min	-.444	7	-.011	5	-.022	5	0	1	0	1	0	1	0	1
273		2	max	.389	2	.014	10	.023	10	.065	10	.051	5	.1	10	.097	5
274			min	-.418	7	-.012	5	-.022	5	-.051	5	-.065	10	-.097	5	-.1	10
275		3	max	.361	2	.012	11	.049	1	.124	10	.109	5	.2	10	.194	5
276			min	-.389	7	-.013	4	-.049	8	-.109	5	-.124	10	-.194	5	-.2	10
277		4	max	.329	2	.012	5	.022	5	.065	10	.052	5	.099	10	.096	5
278			min	-.356	7	-.014	10	-.022	10	-.052	5	-.065	10	-.096	5	-.099	10
279		5	max	.3	2	.011	5	.022	2	0	12	0	12	0	12	0	12
280			min	-.328	7	-.016	10	-.023	7	0	1	0	1	0	1	0	1
281	M29	1	max	.452	2	.005	1	.098	7	0	12	0	12	0	12	0	12
282			min	-.475	7	0	8	-.098	2	0	1	0	1	0	1	0	1
283		2	max	.442	2	.003	1	.05	7	.018	1	.004	8	.357	7	.354	2
284			min	-.465	7	-.002	8	-.05	2	-.004	8	-.018	1	-.354	2	-.357	7
285		3	max	.428	2	.004	7	.053	10	.036	1	.02	8	.771	8	.785	1
286			min	-.451	7	-.003	2	-.052	5	-.02	8	-.036	1	-.785	1	-.771	8
287		4	max	.407	2	.002	8	.089	1	.022	1	.007	8	.53	8	.537	1
288			min	-.429	7	-.004	1	-.087	8	-.007	8	-.022	1	-.537	1	-.53	8
289		5	max	.394	2	0	8	.151	1	0	12	0	12	0	12	0	12
290			min	-.416	7	-.006	1	-.149	8	0	1	0	1	0	1	0	1
291	M30	1	max	.394	2	.006	1	.149	8	0	12	0	12	0	12	0	12
292			min	-.416	7	0	8	-.151	1	0	1	0	1	0	1	0	1
293		2	max	.407	2	.004	1	.087	8	.022	1	.007	8	.53	8	.538	1
294			min	-.429	7	-.002	8	-.089	1	-.007	8	-.022	1	-.538	1	-.53	8
295		3	max	.429	2	.003	2	.057	5	.036	1	.02	8	.77	8	.785	1
296			min	-.452	7	-.003	7	-.059	10	-.02	8	-.036	1	-.785	1	-.77	8
297		4	max	.442	2	.002	8	.049	2	.018	1	.004	8	.353	7	.352	2
298			min	-.466	7	-.003	1	-.049	7	-.004	8	-.018	1	-.352	2	-.353	7
299		5	max	.452	2	0	8	.097	2	0	12	0	12	0	12	0	12
300			min	-.476	7	-.005	1	-.098	7	0	1	0	1	0	1	0	1
301	M31	1	max	.471	5	.018	4	.095	10	0	12	0	12	0	12	0	12
302			min	-.505	10	-.014	11	-.095	5	0	1	0	1	0	1	0	1
303		2	max	.459	5	.017	4	.038	10	.077	4	.064	11	.31	10	.311	5
304			min	-.494	10	-.015	11	-.038	5	-.064	11	-.077	4	-.311	5	-.31	10
305		3	max	.452	5	.015	5	.049	8	.157	4	.144	11	.743	10	.742	5
306			min	-.486	10	-.016	10	-.049	1	-.144	11	-.157	4	-.742	5	-.743	10
307		4	max	.438	5	.016	11	.085	5	.082	4	.07	11	.514	10	.513	5
308			min	-.473	10	-.018	4	-.085	10	-.07	11	-.082	4	-.513	5	-.514	10
309		5	max	.427	5	.015	11	.137	5	0	12	0	12	0	12	0	12
310			min	-.462	10	-.02	4	-.137	10	0	1	0	1	0	1	0	1
311	M32	1	max	.285	5	.014	4	.143	10	0	12	0	12	0	12	0	12
312			min	-.311	10	-.009	11	-.142	5	0	1	0	1	0	1	0	1
313		2	max	.296	5	.012	4	.09	10	.058	4	.045	11	.537	10	.536	5
314			min	-.322	10	-.011	11	-.09	5	-.045	11	-.058	4	-.536	5	-.537	10
315		3	max	.309	5	.011	5	.041	1	.11	4	.095	11	.79	10	.787	5
316			min	-.336	10	-.012	10	-.04	8	-.095	11	-.11	4	-.787	5	-.79	10
317		4	max	.315	5	.009	11	.052	5	.053	4	.039	11	.375	10	.371	5
318			min	-.341	10	-.011	4	-.052	10	-.039	11	-.053	4	-.371	5	-.375	10

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
319		5	max	.327	5	.008	11	.109	5	0	12	0	12	0	12	0	12
320			min	-.353	10	-.013	4	-.11	10	0	1	0	1	0	1	0	1
321	M33	1	max	.277	8	.015	4	.048	10	0	12	0	12	0	12	0	12
322			min	-.304	1	-.01	11	-.048	5	0	1	0	1	0	1	0	1
323		2	max	.277	8	.013	4	.028	10	.061	4	.048	11	.181	10	.178	5
324			min	-.304	1	-.011	11	-.028	5	-.048	11	-.061	4	-.178	5	-.181	10
325		3	max	.277	8	.016	10	.067	1	.141	4	.126	11	.587	8	.596	1
326			min	-.304	1	-.015	5	-.067	8	-.126	11	-.141	4	-.596	1	-.587	8
327		4	max	.271	8	.014	11	.067	1	.074	4	.06	11	.294	8	.298	1
328			min	-.297	1	-.016	4	-.067	8	-.06	11	-.074	4	-.298	1	-.294	8
329		5	max	.271	8	.013	11	.067	1	0	12	0	12	0	12	0	12
330			min	-.297	1	-.018	4	-.067	8	0	1	0	1	0	1	0	1
331	M34	1	max	.556	7	.054	4	.045	11	0	12	0	12	0	12	0	12
332			min	-.527	2	-.05	11	-.046	4	0	1	0	1	0	1	0	1
333		2	max	.552	7	.016	4	.016	2	.483	4	.463	11	.415	11	.425	4
334			min	-.53	2	-.016	11	-.017	7	-.463	11	-.483	4	-.425	4	-.415	11
335		3	max	.549	7	.046	11	.04	5	.66	5	.666	10	.66	11	.669	4
336			min	-.533	2	-.049	4	-.041	10	-.666	10	-.66	5	-.669	4	-.66	11
337		4	max	.493	7	.028	10	.028	4	.764	4	.75	11	.703	11	.707	4
338			min	-.483	2	-.027	5	-.028	11	-.75	11	-.764	4	-.707	4	-.703	11
339		5	max	.49	7	.104	11	.096	4	0	12	0	12	0	12	0	12
340			min	-.485	2	-.106	4	-.095	11	0	1	0	1	0	1	0	1
341	M35	1	max	.13	5	.097	4	.086	11	0	12	0	12	0	12	0	12
342			min	-.13	10	-.094	11	-.087	4	0	1	0	1	0	1	0	1
343		2	max	.124	4	.025	5	.025	11	.702	4	.684	11	.64	11	.648	4
344			min	-.118	11	-.025	10	-.026	4	-.684	11	-.702	4	-.648	4	-.64	11
345		3	max	.142	1	.05	4	.084	2	.581	5	.58	10	.576	11	.592	4
346			min	-.131	8	-.051	7	-.084	7	-.58	10	-.581	5	-.592	4	-.576	11
347		4	max	.154	1	.021	10	.019	4	.584	4	.569	11	.511	11	.517	4
348			min	-.137	8	-.021	5	-.019	11	-.569	11	-.584	4	-.517	4	-.511	11
349		5	max	.163	1	.063	11	.058	4	0	12	0	12	0	12	0	12
350			min	-.139	8	-.067	4	-.057	11	0	1	0	1	0	1	0	1
351	M36	1	max	1.641	10	.008	7	.013	8	0	12	0	12	0	12	0	12
352			min	-1.623	5	-.006	2	-.013	1	0	1	0	1	0	1	0	1
353		2	max	1.638	10	.006	8	.013	8	.087	7	.074	2	.152	8	.156	1
354			min	-1.625	5	-.007	1	-.013	1	-.074	2	-.087	7	-.156	1	-.152	8
355		3	max	1.634	10	.005	8	.013	8	.151	8	.171	1	.303	8	.312	1
356			min	-1.628	5	-.01	1	-.013	1	-.171	1	-.151	8	-.312	1	-.303	8
357		4	max	1.533	10	.003	7	.004	8	.049	1	.024	8	.063	1	.053	8
358			min	-1.531	4	-.003	2	-.005	1	-.024	8	-.049	1	-.053	8	-.063	1
359		5	max	1.53	11	0	8	.004	8	0	12	0	12	0	12	0	12
360			min	-1.535	4	-.006	1	-.005	1	0	1	0	1	0	1	0	1
361	M37	1	max	1.746	4	.204	10	.007	12	0	12	0	12	0	12	0	12
362			min	-1.706	11	-.192	5	-.007	4	0	1	0	1	0	1	0	1
363		2	max	1.72	4	.086	10	.003	12	1.691	10	1.589	5	.055	12	.055	6
364			min	-1.688	11	-.08	5	-.003	4	-1.589	5	-1.691	10	-.055	4	-.055	10
365		3	max	1.698	4	.013	6	0	6	2.103	10	1.966	5	.069	12	.069	6
366			min	-1.674	11	-.013	10	0	10	-1.966	5	-2.103	10	-.069	4	-.069	10
367		4	max	1.679	4	.088	5	.003	6	1.457	10	1.355	5	.047	12	.047	6
368			min	-1.663	11	-.094	10	-.003	10	-1.355	5	-1.457	10	-.047	4	-.047	10
369		5	max	1.667	4	.125	5	.004	6	0	12	0	12	0	12	0	12
370			min	-1.659	11	-.137	10	-.004	10	0	1	0	1	0	1	0	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
371	M38	1	max	1.824	10	.023	1	.053	5	0	12	0	12	0	12	0	12
372			min	-1.78	5	-.021	8	-.054	10	0	1	0	1	0	1	0	1
373		2	max	1.826	10	.022	1	.004	5	.256	1	.244	8	.417	5	.425	10
374			min	-1.776	5	-.022	8	-.005	10	-.244	8	-.256	1	-.425	10	-.417	5
375		3	max	1.915	10	.031	10	.094	5	.501	1	.494	8	.083	4	.078	11
376			min	-1.859	5	-.027	5	-.094	10	-.494	8	-.501	1	-.078	11	-.083	4
377		4	max	1.915	10	.003	1	.002	8	.184	11	.189	4	.618	4	.615	11
378			min	-1.854	5	0	8	-.003	1	-.189	4	-.184	11	-.615	11	-.618	4
379		5	max	1.915	10	.033	5	.11	11	0	12	0	12	0	12	0	12
380			min	-1.848	5	-.034	10	-.11	4	0	1	0	1	0	1	0	1
381	M39	1	max	2.052	1	.086	10	.072	4	0	12	0	12	0	12	0	12
382			min	-2.021	8	-.084	5	-.072	11	0	1	0	1	0	1	0	1
383		2	max	2.048	1	.011	8	.004	4	.528	10	.521	5	.436	4	.43	11
384			min	-2.023	8	-.012	1	-.004	11	-.521	5	-.528	10	-.43	11	-.436	4
385		3	max	2.045	1	.061	5	.058	10	.508	10	.499	5	.566	5	.593	10
386			min	-2.026	8	-.065	10	-.057	5	-.499	5	-.508	10	-.593	10	-.566	5
387		4	max	1.905	1	.025	5	.029	10	.585	10	.563	5	.564	5	.578	10
388			min	-1.892	8	-.025	10	-.027	5	-.563	5	-.585	10	-.578	10	-.564	5
389		5	max	1.901	1	.059	5	.059	10	0	12	0	12	0	12	0	12
390			min	-1.895	8	-.062	10	-.058	5	0	1	0	1	0	1	0	1
391	M40	1	max	2.312	7	.07	10	.062	5	0	12	0	12	0	12	0	12
392			min	-2.258	2	-.065	5	-.064	10	0	1	0	1	0	1	0	1
393		2	max	2.32	7	.023	10	.024	5	.618	10	.593	5	.569	5	.583	10
394			min	-2.261	2	-.023	5	-.025	10	-.593	5	-.618	10	-.583	10	-.569	5
395		3	max	2.444	7	.065	10	.06	5	.483	10	.473	5	.498	5	.526	10
396			min	-2.374	2	-.062	5	-.081	1	-.473	5	-.483	10	-.526	10	-.498	5
397		4	max	2.456	7	.007	4	.003	2	.479	10	.471	5	.366	4	.362	11
398			min	-2.38	2	-.006	11	-.004	7	-.471	5	-.479	10	-.362	11	-.366	4
399		5	max	2.465	7	.075	5	.062	11	0	12	0	12	0	12	0	12
400			min	-2.384	2	-.077	10	-.062	4	0	1	0	1	0	1	0	1
401	M41	1	max	2.653	10	.106	7	.107	4	0	12	0	12	0	12	0	12
402			min	-2.547	5	-.106	2	-.107	11	0	1	0	1	0	1	0	1
403		2	max	2.653	10	.006	5	.001	10	.581	8	.588	1	.585	4	.586	11
404			min	-2.552	5	-.007	10	-.001	5	-.588	1	-.581	8	-.586	11	-.585	4
405		3	max	2.653	10	.093	2	.097	10	.271	7	.254	2	.154	2	.176	7
406			min	-2.557	5	-.096	7	-.097	5	-.254	2	-.271	7	-.176	7	-.154	2
407		4	max	2.483	10	.015	2	.009	10	.553	7	.531	2	.455	5	.47	10
408			min	-2.399	5	-.016	7	-.007	5	-.531	2	-.553	7	-.47	10	-.455	5
409		5	max	2.481	10	.063	2	.058	10	0	12	0	12	0	12	0	12
410			min	-2.403	5	-.066	7	-.057	5	0	1	0	1	0	1	0	1
411	M42	1	max	2.09	5	.044	10	.073	2	0	12	0	12	0	12	0	12
412			min	-2.105	10	-.039	5	-.074	7	0	1	0	1	0	1	0	1
413		2	max	2.101	5	.015	8	.031	2	.365	10	.342	5	.716	2	.735	7
414			min	-2.108	10	-.016	1	-.033	7	-.342	5	-.365	10	-.735	7	-.716	2
415		3	max	2.288	5	.108	10	.089	2	.361	8	.365	1	.61	2	.648	7
416			min	-2.291	10	-.102	5	-.088	7	-.365	1	-.361	8	-.648	7	-.61	2
417		4	max	2.309	4	.011	1	.013	8	.551	10	.543	5	.854	1	.856	8
418			min	-2.306	11	-.01	8	-.013	1	-.543	5	-.551	10	-.856	8	-.854	1
419		5	max	2.333	4	.104	5	.135	8	0	12	0	12	0	12	0	12
420			min	-2.325	11	-.107	10	-.135	1	0	1	0	1	0	1	0	1
421	M43	1	max	.419	7	.039	7	.013	4	0	12	0	12	0	12	0	12
422			min	-.348	2	-.038	2	-.013	11	0	1	0	1	0	1	0	1

M41 Worst case stress reversal for all vertical members.

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
423		2	max	.417	7	.017	8	.002	4	.368	8	.366	1	.115	4	.115	11
424			min	-.352	2	-.018	1	-.002	11	-.366	1	-.368	8	-.115	11	-.115	4
425		3	max	.419	7	.095	7	.053	5	.49	5	.493	10	.031	10	.03	5
426			min	-.361	2	-.093	2	-.053	10	-.493	10	-.49	5	-.03	5	-.031	10
427		4	max	.366	7	.022	10	0	11	.782	7	.774	2	.333	4	.333	11
428			min	-.311	2	-.022	5	0	4	-.774	2	-.782	7	-.333	11	-.333	4
429		5	max	.369	7	.094	2	.043	11	0	12	0	12	0	12	0	12
430			min	-.32	2	-.096	7	-.043	4	0	1	0	1	0	1	0	1
431	M44	1	max	1.687	10	.016	7	.135	1	0	12	0	12	0	12	0	12
432			min	-1.658	5	-.013	2	-.135	8	0	1	0	1	0	1	0	1
433		2	max	1.684	10	.01	8	.013	1	.149	7	.136	2	.854	1	.854	8
434			min	-1.66	5	-.011	1	-.013	8	-.136	2	-.149	7	-.854	8	-.854	1
435		3	max	1.68	10	.005	8	.089	7	.362	8	.364	1	.606	2	.642	7
436			min	-1.662	5	-.01	1	-.089	2	-.364	1	-.362	8	-.642	7	-.606	2
437		4	max	1.564	10	.016	1	.032	7	.209	7	.182	2	.714	2	.732	7
438			min	-1.552	5	-.015	8	-.031	2	-.182	2	-.209	7	-.732	7	-.714	2
439		5	max	1.56	10	.015	2	.074	7	0	12	0	12	0	12	0	12
440			min	-1.555	5	-.02	7	-.073	2	0	1	0	1	0	1	0	1
441	M45	1	max	1.825	4	.065	7	.009	8	0	12	0	12	0	12	0	12
442			min	-1.772	11	-.062	2	-.01	1	0	1	0	1	0	1	0	1
443		2	max	1.829	4	.015	7	.006	2	.544	7	.523	2	.04	8	.05	1
444			min	-1.769	11	-.014	2	-.007	7	-.523	2	-.544	7	-.05	1	-.04	8
445		3	max	1.938	4	.097	7	.029	8	.253	7	.237	2	.161	2	.182	7
446			min	-1.869	11	-.093	2	-.029	1	-.237	2	-.253	7	-.182	7	-.161	2
447		4	max	1.941	4	.006	4	.003	11	.577	8	.581	1	.194	7	.191	2
448			min	-1.867	11	-.005	11	-.003	4	-.581	1	-.577	8	-.191	2	-.194	7
449		5	max	1.944	4	.105	2	.034	2	0	12	0	12	0	12	0	12
450			min	-1.865	11	-.106	7	-.034	7	0	1	0	1	0	1	0	1
451	M46	1	max	2.384	7	.05	1	.05	1	0	12	0	12	0	12	0	12
452			min	-2.344	2	-.048	8	-.049	8	0	1	0	1	0	1	0	1
453		2	max	2.375	7	.005	2	.004	7	.351	1	.345	8	.308	1	.303	8
454			min	-2.34	2	-.006	7	-.004	2	-.345	8	-.351	1	-.303	8	-.308	1
455		3	max	2.363	7	.055	1	.083	1	.186	4	.176	11	.283	8	.311	1
456			min	-2.334	2	-.052	8	-.082	8	-.176	11	-.186	4	-.311	1	-.283	8
457		4	max	2.246	7	.008	11	.011	1	.359	1	.338	8	.228	2	.242	7
458			min	-2.224	2	-.008	4	-.01	8	-.338	8	-.359	1	-.242	7	-.228	2
459		5	max	2.237	7	.04	8	.036	7	0	12	0	12	0	12	0	12
460			min	-2.222	2	-.044	1	-.034	2	0	1	0	1	0	1	0	1
461	M47	1	max	1.87	1	.011	4	.014	8	0	12	0	12	0	12	0	12
462			min	-1.826	8	-.007	11	-.015	1	0	1	0	1	0	1	0	1
463		2	max	1.874	1	.009	4	.014	8	.112	4	.087	11	.156	8	.169	1
464			min	-1.823	8	-.008	11	-.015	1	-.087	11	-.112	4	-.169	1	-.156	8
465		3	max	2.011	1	.007	5	.014	8	.227	8	.252	1	.312	8	.338	1
466			min	-1.951	8	-.01	10	-.015	1	-.252	1	-.227	8	-.338	1	-.312	8
467		4	max	2.015	1	.011	1	.004	2	.122	7	.117	2	.049	7	.041	2
468			min	-1.948	8	-.01	8	-.004	7	-.117	2	-.122	7	-.041	2	-.049	7
469		5	max	2.018	1	.01	2	.004	2	0	12	0	12	0	12	0	12
470			min	-1.946	8	-.011	7	-.004	7	0	1	0	1	0	1	0	1
471	M48	1	max	1.798	4	.006	1	.003	4	0	12	0	12	0	12	0	12
472			min	-1.698	11	-.006	8	-.003	11	0	1	0	1	0	1	0	1
473		2	max	1.795	4	.005	2	.003	4	.065	2	.07	7	.034	4	.031	11
474			min	-1.701	11	-.007	7	-.003	11	-.07	7	-.065	2	-.031	11	-.034	4

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
475		3	max	1.792	4	.02	7	.006	1	.44	1	.427	8	.109	8	.13	1
476			min	-1.703	11	-.018	2	-.005	8	-.427	8	-.44	1	-.13	1	-.109	8
477		4	max	1.702	4	.019	8	.006	1	.228	1	.208	8	.055	8	.065	1
478			min	-1.623	11	-.019	1	-.005	8	-.208	8	-.228	1	-.065	1	-.055	8
479		5	max	1.698	4	.018	8	.006	1	0	12	0	12	0	12	0	12
480			min	-1.626	11	-.021	1	-.005	8	0	1	0	1	0	1	0	1
481	M49	1	max	1.127	5	.052	7	.044	5	0	12	0	12	0	12	0	12
482			min	-1.247	10	-.009	2	-.073	10	0	1	0	1	0	1	0	1
483		2	max	1.125	5	.037	7	.044	5	.175	7	.059	2	.176	5	.288	10
484			min	-1.25	10	-.02	2	-.073	10	-.059	2	-.175	7	-.288	10	-.176	5
485		3	max	1.165	5	.112	10	.077	4	.91	4	.82	11	.311	2	.608	4
486			min	-1.252	10	-.106	5	-.067	7	-.82	11	-.91	4	-.608	4	-.311	2
487		4	max	1.164	5	.103	11	.077	4	.474	4	.396	11	.207	11	.304	4
488			min	-1.232	10	-.115	4	-.052	11	-.396	11	-.474	4	-.304	4	-.207	11
489		5	max	1.163	5	.097	11	.077	4	0	12	0	12	0	12	0	12
490			min	-1.233	10	-.124	4	-.052	11	0	1	0	1	0	1	0	1
491	M50	1	max	1.665	10	.034	4	.025	2	0	12	0	12	0	12	0	12
492			min	-1.534	5	.001	11	-.045	7	0	1	0	1	0	1	0	1
493		2	max	1.667	10	.02	4	.025	2	.106	4	.016	11	.1	2	.179	7
494			min	-1.533	5	-.009	11	-.045	7	-.016	11	-.106	4	-.179	7	-.1	2
495		3	max	1.67	10	.047	10	.085	4	.401	4	.304	11	.522	11	.67	4
496			min	-1.531	5	-.041	5	-.066	11	-.304	11	-.401	4	-.67	4	-.522	11
497		4	max	1.551	10	.038	11	.085	4	.22	4	.138	11	.261	11	.335	4
498			min	-1.521	5	-.051	4	-.066	11	-.138	11	-.22	4	-.335	4	-.261	11
499		5	max	1.553	10	.032	11	.085	4	0	12	0	12	0	12	0	12
500			min	-1.519	5	-.06	4	-.066	11	0	1	0	1	0	1	0	1
501	M51	1	max	.774	7	.016	1	.029	5	0	12	0	12	0	12	0	12
502			min	-.595	2	.004	8	-.033	10	0	1	0	1	0	1	0	1
503		2	max	.775	7	.013	1	.029	5	.059	1	-.013	8	.113	5	.132	10
504			min	-.594	2	.002	8	-.033	10	.013	8	-.059	1	-.132	10	-.113	5
505		3	max	.884	7	.066	10	.028	11	.385	5	.482	10	.225	5	.265	10
506			min	-.602	2	-.045	5	-.028	4	-.482	10	-.385	5	-.265	10	-.225	5
507		4	max	.888	7	.061	10	.028	11	.204	2	.234	7	.111	4	.111	11
508			min	-.602	2	-.049	5	-.028	4	-.234	7	-.204	2	-.111	11	-.111	4
509		5	max	.892	7	.059	7	.028	11	0	12	0	12	0	12	0	12
510			min	-.602	2	-.054	2	-.028	4	0	1	0	1	0	1	0	1
511	M52	1	max	.717	10	.115	4	.087	5	0	12	0	12	0	12	0	12
512			min	-.626	5	-.085	11	-.088	10	0	1	0	1	0	1	0	1
513		2	max	.72	10	.1	4	.087	5	.427	4	.361	11	.344	5	.348	10
514			min	-.623	5	-.096	11	-.088	10	-.361	11	-.427	4	-.348	10	-.344	5
515		3	max	.722	10	.09	5	.087	5	1.047	7	.761	11	.688	5	.696	10
516			min	-.622	5	-.122	7	-.088	10	-.761	11	-1.047	7	-.696	10	-.688	5
517		4	max	.455	10	.077	2	.044	2	.542	7	.294	2	.325	7	.174	2
518			min	-.356	5	-.133	7	-.082	7	-.294	2	-.542	7	-.174	2	-.325	7
519		5	max	.456	10	.071	2	.044	2	0	12	0	12	0	12	0	12
520			min	-.355	5	-.141	7	-.082	7	0	1	0	1	0	1	0	1
521	M53	1	max	.418	4	.133	7	.082	7	0	12	0	12	0	12	0	12
522			min	-.302	11	-.059	2	-.041	2	0	1	0	1	0	1	0	1
523		2	max	.416	4	.118	7	.082	7	.497	7	.257	2	.323	7	.163	2
524			min	-.304	11	-.07	2	-.041	2	-.257	2	-.497	7	-.163	2	-.323	7
525		3	max	.413	4	.105	7	.082	7	.939	7	.553	2	.646	7	.327	2
526			min	-.306	11	-.079	2	-.041	2	-.553	2	-.939	7	-.327	2	-.646	7

M50 Worst case stress reversal for all ring members.

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
527		4	max	.239	4	.011	7	.03	7	.042	1	.028	8	.109	2	.119	7
528			min	-.118	11	-.007	2	-.028	2	-.028	8	-.042	1	-.119	7	-.109	2
529		5	max	.237	4	.004	8	.03	7	0	12	0	12	0	12	0	12
530			min	-.119	11	-.015	1	-.028	2	0	1	0	1	0	1	0	1
531	M54	1	max	.691	4	.072	2	.018	8	0	12	0	12	0	12	0	12
532			min	-.633	11	-.083	7	-.019	1	0	1	0	1	0	1	0	1
533		2	max	.69	4	.066	2	.018	8	.273	2	.326	7	.07	8	.073	1
534			min	-.634	11	-.083	7	-.019	1	-.326	7	-.273	2	-.073	1	-.07	8
535		3	max	.687	4	.099	5	.018	8	.917	10	.752	5	.141	8	.146	1
536			min	-.636	11	-.111	10	-.019	1	-.752	5	-.917	10	-.146	1	-.141	8
537		4	max	.422	7	.095	5	.007	1	.468	10	.369	5	.009	8	.029	1
538			min	-.358	2	-.116	10	-.002	8	-.369	5	-.468	10	-.029	1	-.009	8
539		5	max	.421	7	.092	5	.007	1	0	12	0	12	0	12	0	12
540			min	-.359	2	-.12	10	-.002	8	0	1	0	1	0	1	0	1
541	M55	1	max	.043	2	.086	4	.152	10	0	12	0	12	0	12	0	12
542			min	-.05	7	-.082	11	-.143	5	0	1	0	1	0	1	0	1
543		2	max	.052	2	.083	5	.152	10	.335	4	.329	11	.602	10	.567	5
544			min	-.06	7	-.084	10	-.143	5	-.329	11	-.335	4	-.567	5	-.602	10
545		3	max	.059	2	.081	5	.152	10	.661	5	.668	10	1.204	10	1.134	5
546			min	-.068	7	-.087	10	-.143	5	-.668	10	-.661	5	-1.134	5	-1.204	10
547		4	max	.065	2	.046	5	.086	10	.214	10	.178	5	.323	5	.34	10
548			min	-.073	7	-.053	10	-.082	5	-.178	5	-.214	10	-.34	10	-.323	5
549		5	max	.068	2	.044	5	.086	10	0	12	0	12	0	12	0	12
550			min	-.077	7	-.056	10	-.082	5	0	1	0	1	0	1	0	1
551	M56	1	max	.18	10	.015	1	.045	5	0	12	0	12	0	12	0	12
552			min	-.168	5	-.008	8	-.047	10	0	1	0	1	0	1	0	1
553		2	max	.179	10	.008	4	.045	5	.043	1	.025	8	.179	5	.186	10
554			min	-.169	5	-.006	11	-.047	10	-.025	8	-.043	1	-.186	10	-.179	5
555		3	max	.178	10	.014	8	.056	10	.077	4	.06	11	.414	5	.446	10
556			min	-.17	5	-.015	1	-.052	5	-.06	11	-.077	4	-.446	10	-.414	5
557		4	max	.177	10	.008	11	.056	10	.046	1	.03	8	.207	5	.223	10
558			min	-.171	5	-.01	4	-.052	5	-.03	8	-.046	1	-.223	10	-.207	5
559		5	max	.176	10	.008	8	.056	10	0	12	0	12	0	12	0	12
560			min	-.172	5	-.014	1	-.052	5	0	1	0	1	0	1	0	1
561	M57	1	max	.092	7	.085	4	.099	8	0	12	0	12	0	12	0	12
562			min	-.075	2	-.079	11	-.101	1	0	1	0	1	0	1	0	1
563		2	max	.082	7	.082	4	.065	5	.332	4	.319	11	.29	8	.299	1
564			min	-.066	2	-.082	11	-.067	10	-.319	11	-.332	4	-.299	1	-.29	8
565		3	max	.084	7	.141	5	.108	5	1.164	10	1.095	5	.892	10	.858	5
566			min	-.068	2	-.144	10	-.113	10	-1.095	5	-1.164	10	-.858	5	-.892	10
567		4	max	.077	7	.138	5	.108	5	.588	10	.543	5	.446	10	.429	5
568			min	-.063	2	-.147	10	-.113	10	-.543	5	-.588	10	-.429	5	-.446	10
569		5	max	.073	7	.136	5	.108	5	0	12	0	12	0	12	0	12
570			min	-.059	2	-.15	10	-.113	10	0	1	0	1	0	1	0	1
571	M58	1	max	.147	4	.146	10	.113	10	0	12	0	12	0	12	0	12
572			min	-.14	11	-.133	5	-.11	5	0	1	0	1	0	1	0	1
573		2	max	.147	4	.143	10	.113	10	.571	10	.531	5	.449	10	.435	5
574			min	-.14	11	-.135	5	-.11	5	-.531	5	-.571	10	-.435	5	-.449	10
575		3	max	.148	4	.14	10	.113	10	1.13	10	1.071	5	.899	10	.871	5
576			min	-.139	11	-.137	5	-.11	5	-1.071	5	-1.13	10	-.871	5	-.899	10
577		4	max	.134	4	.078	11	.062	2	.333	4	.306	11	.301	7	.299	2
578			min	-.124	11	-.082	4	-.063	7	-.306	11	-.333	4	-.299	2	-.301	7

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
579		5	max	.134	4	.076	11	.088	2	0	12	0	12	0	12	0	12
580			min	-.124	11	-.086	4	-.089	7	0	1	0	1	0	1	0	1
581	M59	1	max	.121	1	.011	1	.059	4	0	12	0	12	0	12	0	12
582			min	-.117	8	-.004	8	-.057	11	0	1	0	1	0	1	0	1
583		2	max	.12	1	.006	4	.059	4	.034	1	.014	8	.232	4	.227	11
584			min	-.114	8	-.003	11	-.057	11	-.014	8	-.034	1	-.227	11	-.232	4
585		3	max	.114	1	.014	8	.059	4	.047	4	.034	8	.465	4	.454	11
586			min	-.106	8	-.015	1	-.057	11	-.034	8	-.047	4	-.454	11	-.465	4
587		4	max	.107	1	.005	8	.051	10	.055	1	.042	8	.174	5	.202	10
588			min	-.096	8	-.007	1	-.044	5	-.042	8	-.055	1	-.202	10	-.174	5
589		5	max	.104	1	.012	8	.051	10	0	12	0	12	0	12	0	12
590			min	-.091	8	-.018	1	-.044	5	0	1	0	1	0	1	0	1
591	M60	1	max	.14	5	.05	10	.075	5	0	12	0	12	0	12	0	12
592			min	-.142	10	-.036	5	-.083	10	0	1	0	1	0	1	0	1
593		2	max	.141	5	.047	10	.075	5	.193	10	.148	5	.297	5	.329	10
594			min	-.141	10	-.038	5	-.083	10	-.148	5	-.193	10	-.329	10	-.297	5
595		3	max	.154	5	.09	10	.139	5	.672	5	.685	10	1.182	10	1.102	5
596			min	-.155	10	-.083	5	-.149	10	-.685	10	-.672	5	-1.102	5	-1.182	10
597		4	max	.155	5	.086	10	.139	5	.341	4	.337	11	.591	10	.551	5
598			min	-.155	10	-.085	5	-.149	10	-.337	11	-.341	4	-.551	5	-.591	10
599		5	max	.155	4	.084	11	.139	5	0	12	0	12	0	12	0	12
600			min	-.154	11	-.088	4	-.149	10	0	1	0	1	0	1	0	1
601	M61	1	max	.662	7	.06	7	.022	11	0	12	0	12	0	12	0	12
602			min	-.469	2	-.048	2	-.022	4	0	1	0	1	0	1	0	1
603		2	max	.659	7	.037	7	.012	11	.587	7	.509	2	.217	11	.218	4
604			min	-.46	2	-.034	2	-.012	4	-.509	2	-.587	7	-.218	4	-.217	11
605		3	max	.709	7	.081	7	.049	11	.702	7	.635	2	.176	11	.176	4
606			min	-.481	2	-.08	2	-.049	4	-.635	2	-.702	7	-.176	4	-.176	11
607		4	max	.68	7	.011	11	.005	5	.66	7	.566	2	.38	10	.379	5
608			min	-.448	2	-.016	4	-.005	10	-.566	2	-.66	7	-.379	5	-.38	10
609		5	max	.658	7	.07	2	.047	5	0	12	0	12	0	12	0	12
610			min	-.422	2	-.082	7	-.047	10	0	1	0	1	0	1	0	1
611	M62	1	max	.388	11	.021	10	.022	10	0	12	0	12	0	12	0	12
612			min	-.456	4	-.005	5	-.022	5	0	1	0	1	0	1	0	1
613		2	max	.39	11	.014	10	.012	10	.19	10	.087	5	.219	10	.218	5
614			min	-.453	4	-.01	5	-.012	5	-.087	5	-.19	10	-.218	5	-.219	10
615		3	max	.43	2	.018	4	.049	10	.308	10	.288	4	.178	10	.177	5
616			min	-.498	7	-.009	11	-.049	5	-.288	4	-.308	10	-.177	5	-.178	10
617		4	max	.431	2	.013	4	.005	4	.164	10	.123	5	.379	11	.38	4
618			min	-.496	7	-.012	11	-.005	11	-.123	5	-.164	10	-.38	4	-.379	11
619		5	max	.433	2	.009	5	.047	4	0	12	0	12	0	12	0	12
620			min	-.494	7	-.018	10	-.047	11	0	1	0	1	0	1	0	1
621	M63	1	max	.33	10	.089	7	.008	2	0	12	0	12	0	12	0	12
622			min	-.249	5	-.081	2	-.008	7	0	1	0	1	0	1	0	1
623		2	max	.333	10	.013	10	.003	8	.447	7	.395	2	.023	2	.027	7
624			min	-.247	5	-.012	5	-.004	1	-.395	2	-.447	7	-.027	7	-.023	2
625		3	max	.335	10	.089	2	.02	4	.475	4	.436	11	.442	11	.447	4
626			min	-.245	5	-.094	7	-.02	11	-.436	11	-.475	4	-.447	4	-.442	11
627		4	max	.336	10	.022	2	.02	4	.605	7	.549	2	.223	2	.224	7
628			min	-.236	5	-.023	7	-.02	11	-.549	2	-.605	7	-.224	7	-.223	2
629		5	max	.339	10	.061	2	.022	7	0	12	0	12	0	12	0	12
630			min	-.234	5	-.07	7	-.022	2	0	1	0	1	0	1	0	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
631	M64	1	max	.476	5	.046	7	.027	7	0	12	0	12	0	12	0	12
632			min	-.561	10	-.033	2	-.024	2	0	1	0	1	0	1	0	1
633		2	max	.474	5	.024	10	.018	10	.422	7	.327	2	.252	7	.211	2
634			min	-.564	10	-.021	5	-.014	5	-.327	2	-.422	7	-.211	2	-.252	7
635		3	max	.472	5	.044	7	.035	1	.565	10	.561	1	.751	4	.745	11
636			min	-.567	10	-.017	5	-.032	4	-.561	1	-.565	10	-.745	11	-.751	4
637		4	max	.449	5	.022	2	.032	11	.698	7	.652	2	.553	7	.554	2
638			min	-.537	10	-.021	7	-.032	4	-.652	2	-.698	7	-.554	2	-.553	7
639		5	max	.448	5	.091	2	.076	2	0	12	0	12	0	12	0	12
640			min	-.539	10	-.099	7	-.076	7	0	1	0	1	0	1	0	1
641	M65	1	max	.292	2	.099	7	.091	10	0	12	0	12	0	12	0	12
642			min	-.397	7	-.091	2	-.09	5	0	1	0	1	0	1	0	1
643		2	max	.333	2	.022	7	.019	7	.7	7	.654	2	.556	7	.556	2
644			min	-.435	7	-.022	2	-.019	2	-.654	2	-.7	7	-.556	2	-.556	7
645		3	max	.417	2	.013	11	.108	4	.594	10	.565	1	.718	10	.625	5
646			min	-.526	7	-.043	7	-.107	11	-.565	1	-.594	10	-.625	5	-.718	10
647		4	max	.446	2	.02	5	.031	5	.441	7	.341	2	.722	10	.676	5
648			min	-.551	7	-.023	10	-.035	10	-.341	2	-.441	7	-.676	5	-.722	10
649		5	max	.462	2	.034	2	.068	5	0	12	0	12	0	12	0	12
650			min	-.562	7	-.048	7	-.072	10	0	1	0	1	0	1	0	1
651	M66	1	max	.119	10	.068	7	.046	4	0	12	0	12	0	12	0	12
652			min	-.03	5	-.06	2	-.046	11	0	1	0	1	0	1	0	1
653		2	max	.13	7	.022	7	.015	1	.586	7	.535	2	.331	4	.328	11
654			min	-.046	2	-.021	2	-.014	8	-.535	2	-.586	7	-.328	11	-.331	4
655		3	max	.152	7	.091	7	.093	10	.456	4	.425	11	.56	5	.581	10
656			min	-.073	5	-.087	2	-.092	5	-.425	11	-.456	4	-.581	10	-.56	5
657		4	max	.154	7	.017	5	.023	10	.478	7	.418	2	.88	5	.89	10
658			min	-.083	2	-.019	10	-.022	5	-.418	2	-.478	7	-.89	10	-.88	5
659		5	max	.183	7	.084	2	.137	10	0	12	0	12	0	12	0	12
660			min	-.117	2	-.092	7	-.136	5	0	1	0	1	0	1	0	1
661	M67	1	max	.393	2	.032	4	.135	11	0	12	0	12	0	12	0	12
662			min	-.437	7	-.023	11	-.136	4	0	1	0	1	0	1	0	1
663		2	max	.394	2	.023	4	.021	11	.311	4	.25	11	.869	11	.877	4
664			min	-.435	7	-.022	11	-.022	4	-.25	11	-.311	4	-.877	4	-.869	11
665		3	max	.411	2	.029	4	.091	10	.517	4	.343	2	.534	11	.55	4
666			min	-.454	7	-.021	11	-.09	5	-.343	2	-.517	4	-.55	4	-.534	11
667		4	max	.412	2	.02	5	.007	1	.27	10	.19	5	.347	11	.36	4
668			min	-.452	7	-.022	10	-.006	8	-.19	5	-.27	10	-.36	4	-.347	11
669		5	max	.414	2	.014	5	.049	4	0	12	0	12	0	12	0	12
670			min	-.45	7	-.027	10	-.048	11	0	1	0	1	0	1	0	1
671	M68	1	max	.272	10	.06	4	.05	5	0	12	0	12	0	12	0	12
672			min	-.205	5	-.047	11	-.05	10	0	1	0	1	0	1	0	1
673		2	max	.262	10	.041	4	.013	5	.627	4	.537	11	.464	5	.468	10
674			min	-.2	5	-.039	11	-.013	10	-.537	11	-.627	4	-.468	10	-.464	5
675		3	max	.249	7	.058	4	.095	5	.937	4	.877	11	.197	5	.204	10
676			min	-.192	2	-.054	11	-.095	10	-.877	11	-.937	4	-.204	10	-.197	5
677		4	max	.245	7	.023	5	.005	5	.204	1	.099	8	.564	4	.562	11
678			min	-.194	2	-.028	10	-.005	10	-.099	8	-.204	1	-.562	11	-.564	4
679		5	max	.243	7	.007	8	.104	11	0	12	0	12	0	12	0	12
680			min	-.195	2	-.02	1	-.104	4	0	1	0	1	0	1	0	1
681	M69	1	max	.582	4	.045	10	.013	10	0	12	0	12	0	12	0	12
682			min	-.549	11	-.032	5	-.012	5	0	1	0	1	0	1	0	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
683		2	max	.584	4	.04	10	.013	10	.502	10	.4	5	.149	10	.146	5
684			min	-.547	11	-.036	5	-.012	5	-.4	5	-.502	10	-.146	5	-.149	10
685		3	max	.621	4	.036	11	.013	10	.945	10	.841	5	.298	10	.293	5
686			min	-.577	11	-.04	4	-.012	5	-.841	5	-.945	10	-.293	5	-.298	10
687		4	max	.624	4	.029	11	.002	1	.393	4	.312	11	.023	8	.028	1
688			min	-.575	11	-.03	4	-.002	8	-.312	11	-.393	4	-.028	1	-.023	8
689		5	max	.627	4	.024	11	.002	1	0	12	0	12	0	12	0	12
690			min	-.573	11	-.037	4	-.002	8	0	1	0	1	0	1	0	1
691	M70	1	max	.453	2	.031	10	.017	5	0	12	0	12	0	12	0	12
692			min	-.503	7	-.018	5	-.019	10	0	1	0	1	0	1	0	1
693		2	max	.451	2	.025	10	.017	5	.312	10	.227	5	.192	5	.21	10
694			min	-.505	7	-.022	5	-.019	10	-.227	5	-.312	10	-.21	10	-.192	5
695		3	max	.45	2	.02	11	.017	5	.558	10	.502	5	.384	5	.419	10
696			min	-.507	7	-.027	4	-.019	10	-.502	5	-.558	10	-.419	10	-.384	5
697		4	max	.431	2	.014	11	.006	7	.188	4	.135	11	.065	2	.066	7
698			min	-.485	7	-.014	4	-.006	2	-.135	11	-.188	4	-.066	7	-.065	2
699		5	max	.43	2	.01	11	.006	7	0	12	0	12	0	12	0	12
700			min	-.487	7	-.019	4	-.006	2	0	1	0	1	0	1	0	1
701	M71	1	max	.477	7	.019	7	.013	4	0	12	0	12	0	12	0	12
702			min	-.409	2	-.01	2	-.013	10	0	1	0	1	0	1	0	1
703		2	max	.479	7	.015	7	.013	4	.194	7	.137	2	.153	4	.152	10
704			min	-.407	2	-.013	2	-.013	10	-.137	2	-.194	7	-.152	10	-.153	4
705		3	max	.519	7	.012	8	.013	4	.341	7	.308	2	.307	4	.305	10
706			min	-.433	2	-.017	1	-.013	10	-.308	2	-.341	7	-.305	10	-.307	4
707		4	max	.522	7	.011	2	.006	2	.174	7	.112	2	.074	7	.064	2
708			min	-.431	2	-.013	7	-.006	7	-.112	2	-.174	7	-.064	2	-.074	7
709		5	max	.525	7	.008	2	.006	2	0	12	0	12	0	12	0	12
710			min	-.429	2	-.018	7	-.006	7	0	1	0	1	0	1	0	1
711	M72	1	max	.362	2	.044	7	.01	8	0	12	0	12	0	12	0	12
712			min	-.431	7	-.032	2	-.01	1	0	1	0	1	0	1	0	1
713		2	max	.337	2	.005	7	.004	2	.342	7	.276	2	.058	8	.062	1
714			min	-.41	7	-.005	2	-.005	7	-.276	2	-.342	7	-.062	1	-.058	8
715		3	max	.298	2	.053	7	.028	8	.076	7	.061	2	.316	10	.284	5
716			min	-.374	7	-.045	2	-.029	1	-.061	2	-.076	7	-.284	5	-.316	10
717		4	max	.248	5	.005	2	.012	5	.348	7	.286	2	.158	10	.142	5
718			min	-.321	10	-.006	7	-.014	10	-.286	2	-.348	7	-.142	5	-.158	10
719		5	max	.247	5	.039	2	.013	2	0	12	0	12	0	12	0	12
720			min	-.323	10	-.049	7	-.014	7	0	1	0	1	0	1	0	1
721	M73	1	max	.466	2	.029	10	.041	11	0	12	0	12	0	12	0	12
722			min	-.531	7	-.021	5	-.042	4	0	1	0	1	0	1	0	1
723		2	max	.468	2	.025	10	0	5	.301	10	.256	5	.321	11	.322	4
724			min	-.528	7	-.024	5	0	10	-.256	5	-.301	10	-.322	4	-.321	11
725		3	max	.492	2	.022	11	.054	5	.563	10	.54	5	.026	5	.031	10
726			min	-.558	7	-.027	4	-.054	10	-.54	5	-.563	10	-.031	10	-.026	5
727		4	max	.494	2	.002	11	.003	4	.069	4	.008	11	.115	11	.117	4
728			min	-.555	7	-.004	4	-.002	11	-.008	11	-.069	4	-.117	4	-.115	11
729		5	max	.497	2	-.001	11	.013	4	0	12	0	12	0	12	0	12
730			min	-.552	7	-.009	4	-.013	11	0	1	0	1	0	1	0	1
731	M74	1	max	.262	7	.044	10	.045	5	0	12	0	12	0	12	0	12
732			min	-.217	2	-.038	5	-.045	10	0	1	0	1	0	1	0	1
733		2	max	.262	7	.042	10	.045	5	.19	10	.172	5	.197	5	.199	10
734			min	-.217	2	-.039	5	-.045	10	-.172	5	-.19	10	-.199	10	-.197	5

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
735		3	max	.269	7	.041	10	.045	5	.373	10	.348	5	.394	5	.398	10
736			min	-.222	2	-.041	5	-.045	10	-.348	5	-.373	10	-.398	10	-.394	5
737		4	max	.269	7	.019	11	.023	4	.105	4	.082	11	.094	11	.101	4
738			min	-.222	2	-.023	4	-.021	11	-.082	11	-.105	4	-.101	4	-.094	11
739		5	max	.27	7	.018	11	.023	4	0	12	0	12	0	12	0	12
740			min	-.222	2	-.025	4	-.021	11	0	1	0	1	0	1	0	1
741	M75	1	max	.352	10	.009	10	.025	10	0	12	0	12	0	12	0	12
742			min	-.319	5	-.005	5	-.025	5	0	1	0	1	0	1	0	1
743		2	max	.352	10	.008	10	.025	10	.038	10	.025	5	.111	10	.111	5
744			min	-.318	5	-.006	5	-.025	5	-.025	5	-.038	10	-.111	5	-.111	10
745		3	max	.367	10	.011	1	.025	5	.087	7	.083	2	.251	10	.225	5
746			min	-.334	5	-.009	8	-.028	10	-.083	2	-.087	7	-.225	5	-.251	10
747		4	max	.367	10	.009	2	.025	5	.046	7	.04	2	.126	10	.112	5
748			min	-.334	5	-.01	7	-.028	10	-.04	2	-.046	7	-.112	5	-.126	10
749		5	max	.368	10	.008	2	.025	5	0	12	0	12	0	12	0	12
750			min	-.334	5	-.011	7	-.028	10	0	1	0	1	0	1	0	1
751	M76	1	max	.242	11	.067	1	.037	7	0	12	0	12	0	12	0	12
752			min	-.32	4	-.065	8	-.033	2	0	1	0	1	0	1	0	1
753		2	max	.242	11	.034	2	.018	10	.237	1	.233	8	.113	7	.095	2
754			min	-.32	4	-.034	7	-.014	5	-.233	8	-.237	1	-.095	2	-.113	7
755		3	max	.243	11	.021	4	.032	1	.298	2	.313	7	.16	10	.125	5
756			min	-.319	4	-.008	1	-.028	8	-.313	7	-.298	2	-.125	5	-.16	10
757		4	max	.227	11	.036	7	.014	5	.239	2	.242	7	.129	7	.122	2
758			min	-.305	4	-.034	2	-.015	10	-.242	7	-.239	2	-.122	2	-.129	7
759		5	max	.227	11	.069	8	.041	2	0	12	0	12	0	12	0	12
760			min	-.304	4	-.07	1	-.043	7	0	1	0	1	0	1	0	1
761	M77	1	max	.167	5	.024	10	.115	7	0	12	0	12	0	12	0	12
762			min	-.203	10	-.018	5	-.107	2	0	1	0	1	0	1	0	1
763		2	max	.167	5	.022	10	.065	7	.1	10	.084	5	.429	7	.393	2
764			min	-.203	10	-.02	5	-.057	2	-.084	5	-.1	10	-.393	2	-.429	7
765		3	max	.167	5	.041	10	.043	11	.378	4	.355	11	.81	7	.769	2
766			min	-.204	10	-.041	5	-.048	4	-.355	11	-.378	4	-.769	2	-.81	7
767		4	max	.164	5	.04	11	.087	2	.193	4	.175	11	.557	7	.536	2
768			min	-.203	10	-.043	4	-.092	7	-.175	11	-.193	4	-.536	2	-.557	7
769		5	max	.164	5	.039	11	.152	2	0	12	0	12	0	12	0	12
770			min	-.203	10	-.044	4	-.157	7	0	1	0	1	0	1	0	1
771	M78	1	max	.083	5	.031	7	.158	7	0	12	0	12	0	12	0	12
772			min	-.122	10	-.026	2	-.153	2	0	1	0	1	0	1	0	1
773		2	max	.088	2	.034	7	.093	7	.144	7	.126	2	.562	7	.54	2
774			min	-.128	7	-.032	2	-.088	2	-.126	2	-.144	7	-.54	2	-.562	7
775		3	max	.098	2	.043	4	.05	4	.304	7	.282	2	.821	7	.777	2
776			min	-.137	7	-.043	11	-.044	11	-.282	2	-.304	7	-.777	2	-.821	7
777		4	max	.083	2	.011	5	.06	2	.104	10	.085	5	.446	7	.406	2
778			min	-.118	7	-.014	10	-.069	7	-.085	5	-.104	10	-.406	2	-.446	7
779		5	max	.09	2	.023	5	.11	2	0	12	0	12	0	12	0	12
780			min	-.125	7	-.03	10	-.119	7	0	1	0	1	0	1	0	1
781	M79	1	max	.395	5	.067	1	.101	10	0	12	0	12	0	12	0	12
782			min	-.456	10	-.065	8	-.099	5	0	1	0	1	0	1	0	1
783		2	max	.383	5	.031	2	.048	10	.225	1	.223	8	.344	10	.334	5
784			min	-.444	10	-.031	7	-.045	5	-.223	8	-.225	1	-.334	5	-.344	10
785		3	max	.374	5	.018	5	.027	8	.276	1	.276	7	.779	10	.743	5
786			min	-.435	10	-.008	8	-.031	1	-.276	7	-.276	1	-.743	5	-.779	10

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
787		4	max	.36	5	.031	8	.085	5	.228	1	.221	8	.522	10	.505	5
788			min	-.422	10	-.032	1	-.089	10	-.221	8	-.228	1	-.505	5	-.522	10
789		5	max	.349	5	.062	8	.134	5	0	12	0	12	0	12	0	12
790			min	-.412	10	-.065	1	-.138	10	0	1	0	1	0	1	0	1
791	M80	1	max	.309	4	.061	4	.128	10	0	12	0	12	0	12	0	12
792			min	-.292	11	-.058	11	-.126	5	0	1	0	1	0	1	0	1
793		2	max	.319	4	.041	5	.079	10	.233	4	.227	11	.479	10	.47	5
794			min	-.304	11	-.041	10	-.077	5	-.227	11	-.233	4	-.47	5	-.479	10
795		3	max	.332	4	.016	5	.025	1	.358	4	.356	11	.692	10	.675	5
796			min	-.318	11	-.018	10	-.022	8	-.356	11	-.358	4	-.675	5	-.692	10
797		4	max	.343	4	.025	11	.044	4	.173	4	.161	11	.319	11	.326	4
798			min	-.327	11	-.027	4	-.042	11	-.161	11	-.173	4	-.326	4	-.319	11
799		5	max	.354	4	.045	11	.097	4	0	12	0	12	0	12	0	12
800			min	-.339	11	-.049	4	-.096	11	0	1	0	1	0	1	0	1
801	M81	1	max	.264	7	.035	4	.029	11	0	12	0	12	0	12	0	12
802			min	-.218	2	-.027	11	-.031	4	0	1	0	1	0	1	0	1
803		2	max	.264	7	.019	4	.014	11	.127	4	.101	11	.104	11	.115	4
804			min	-.218	2	-.015	11	-.017	4	-.101	11	-.127	4	-.115	4	-.104	11
805		3	max	.264	7	.042	5	.048	10	.224	10	.197	5	.237	5	.246	10
806			min	-.219	2	-.042	10	-.047	5	-.197	5	-.224	10	-.246	10	-.237	5
807		4	max	.259	7	.022	5	.028	10	.105	1	.085	8	.11	8	.114	1
808			min	-.215	2	-.025	10	-.027	5	-.085	8	-.105	1	-.114	1	-.11	8
809		5	max	.259	7	.019	8	.026	1	0	12	0	12	0	12	0	12
810			min	-.216	2	-.025	1	-.025	8	0	1	0	1	0	1	0	1
811	M82	1	max	.48	7	.025	4	.068	5	0	12	0	12	0	12	0	12
812			min	-.398	2	-.016	11	-.069	10	0	1	0	1	0	1	0	1
813		2	max	.477	7	.012	7	.023	5	.217	4	.16	11	.633	5	.635	10
814			min	-.4	2	-.01	2	-.024	10	-.16	11	-.217	4	-.635	10	-.633	5
815		3	max	.475	7	.018	1	.057	11	.365	7	.326	2	.893	4	.874	11
816			min	-.402	2	-.02	4	-.057	4	-.326	2	-.365	7	-.874	11	-.893	4
817		4	max	.434	7	.014	2	.036	11	.355	4	.296	11	.989	4	.98	11
818			min	-.375	2	-.016	7	-.037	4	-.296	11	-.355	4	-.98	11	-.989	4
819		5	max	.431	7	.039	11	.135	11	0	12	0	12	0	12	0	12
820			min	-.377	2	-.047	4	-.136	4	0	1	0	1	0	1	0	1
821	M83	1	max	.165	2	.049	7	.133	10	0	12	0	12	0	12	0	12
822			min	-.225	7	-.039	2	-.13	5	0	1	0	1	0	1	0	1
823		2	max	.194	2	.005	7	.041	10	.344	7	.283	2	.999	10	.973	5
824			min	-.251	7	-.005	2	-.038	5	-.283	2	-.344	7	-.973	5	-.999	10
825		3	max	.266	2	.052	7	.066	10	.083	7	.068	2	.939	10	.888	5
826			min	-.329	7	-.042	2	-.065	5	-.068	2	-.083	7	-.888	5	-.939	10
827		4	max	.306	2	.005	2	.025	4	.347	7	.28	2	.72	11	.737	4
828			min	-.365	7	-.005	7	-.024	11	-.28	2	-.347	7	-.737	4	-.72	11
829		5	max	.331	2	.032	2	.083	4	0	12	0	12	0	12	0	12
830			min	-.387	7	-.044	7	-.082	11	0	1	0	1	0	1	0	1
831	M84	1	max	2.015	11	.019	10	.01	5	0	12	0	12	0	12	0	12
832			min	-2.169	4	-.01	5	-.012	10	0	1	0	1	0	1	0	1
833		2	max	2.013	11	.015	10	.01	5	.201	10	.14	5	.117	5	.14	10
834			min	-2.171	4	-.014	5	-.012	10	-.14	5	-.201	10	-.14	10	-.117	5
835		3	max	2.012	11	.011	11	.01	5	.345	10	.321	5	.234	5	.28	10
836			min	-2.173	4	-.018	4	-.012	10	-.321	5	-.345	10	-.28	10	-.234	5
837		4	max	1.878	11	.005	5	.004	10	.11	10	.034	5	.02	5	.047	10
838			min	-2.031	4	-.006	10	-.002	5	-.034	5	-.11	10	-.047	10	-.02	5

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
839		5	max	1.876	11	0	5	.004	10	0	12	0	12	0	12	0	12
840			min	-2.034	4	-.013	10	-.002	5	0	1	0	1	0	1	0	1
841	M85	1	max	1.552	5	.044	10	.098	4	0	12	0	12	0	12	0	12
842			min	-1.752	10	-.036	5	-.096	11	0	1	0	1	0	1	0	1
843		2	max	1.529	5	.008	1	.013	10	.264	10	.207	5	.496	4	.471	11
844			min	-1.733	10	-.007	8	-.011	5	-.207	5	-.264	10	-.471	11	-.496	4
845		3	max	1.51	5	.028	5	.103	10	.248	4	.228	11	.234	10	.184	5
846			min	-1.718	10	-.035	10	-.101	5	-.228	11	-.248	4	-.184	5	-.234	10
847		4	max	1.375	5	.008	11	.006	11	.05	10	-.018	5	.401	4	.375	11
848			min	-1.571	10	-.009	4	-.008	4	.018	5	-.05	10	-.375	11	-.401	4
849		5	max	1.366	5	0	5	.043	11	0	12	0	12	0	12	0	12
850			min	-1.566	10	-.011	10	-.045	4	0	1	0	1	0	1	0	1
851	M86	1	max	1.754	10	.012	7	.066	11	0	12	0	12	0	12	0	12
852			min	-1.54	5	-.003	2	-.067	4	0	1	0	1	0	1	0	1
853		2	max	1.756	10	.007	4	.015	11	.105	7	.054	2	.555	11	.559	4
854			min	-1.536	5	-.006	11	-.015	4	-.054	2	-.105	7	-.559	4	-.555	11
855		3	max	1.864	10	.009	10	.097	11	.176	4	.153	11	.241	11	.248	4
856			min	-1.637	5	-.01	1	-.097	4	-.153	11	-.176	4	-.248	4	-.241	11
857		4	max	1.864	10	.003	5	.002	5	.108	10	.069	5	.657	10	.652	5
858			min	-1.632	5	-.003	10	-.003	10	-.069	5	-.108	10	-.652	5	-.657	10
859		5	max	1.863	10	.01	5	.116	5	0	12	0	12	0	12	0	12
860			min	-1.627	5	-.016	10	-.116	10	0	1	0	1	0	1	0	1
861	M87	1	max	1.116	2	.022	10	.11	5	0	12	0	12	0	12	0	12
862			min	-1.438	7	-.014	5	-.111	10	0	1	0	1	0	1	0	1
863		2	max	1.115	2	.003	11	.009	5	.14	10	.099	5	.677	5	.686	10
864			min	-1.44	7	-.004	4	-.009	10	-.099	5	-.14	10	-.686	10	-.677	5
865		3	max	1.113	2	.006	5	.083	11	.063	11	.089	4	.637	5	.746	10
866			min	-1.442	7	-.016	10	-.084	4	-.089	4	-.063	11	-.746	10	-.637	5
867		4	max	1.06	2	.003	1	.037	10	.094	10	.05	5	.741	5	.795	10
868			min	-1.38	7	-.002	8	-.032	5	-.05	5	-.094	10	-.795	10	-.741	5
869		5	max	1.058	2	.004	5	.083	10	0	12	0	12	0	12	0	12
870			min	-1.382	7	-.014	10	-.078	5	0	1	0	1	0	1	0	1
871	M88	1	max	1.412	7	.039	7	.089	10	0	12	0	12	0	12	0	12
872			min	-1.059	2	-.031	2	-.084	5	0	1	0	1	0	1	0	1
873		2	max	1.398	7	.012	11	.033	10	.286	10	.245	5	.807	10	.745	5
874			min	-1.041	2	-.012	4	-.027	5	-.245	5	-.286	10	-.745	5	-.807	10
875		3	max	1.401	7	.031	10	.081	11	.288	2	.288	7	.683	10	.559	5
876			min	-1.025	2	-.085	7	-.084	4	-.288	7	-.288	2	-.559	5	-.683	10
877		4	max	1.376	7	.004	7	.011	2	.331	7	.295	2	.613	10	.569	5
878			min	-.995	2	-.003	2	-.015	7	-.295	2	-.331	7	-.569	5	-.613	10
879		5	max	1.359	7	.047	2	.094	5	0	12	0	12	0	12	0	12
880			min	-.973	2	-.053	7	-.098	10	0	1	0	1	0	1	0	1
881	M89	1	max	2.214	10	.073	7	.106	5	0	12	0	12	0	12	0	12
882			min	-2.137	5	-.064	2	-.116	10	0	1	0	1	0	1	0	1
883		2	max	2.216	10	.006	4	.029	2	.428	7	.379	2	.539	5	.658	10
884			min	-2.141	5	-.005	11	-.039	7	-.379	2	-.428	7	-.658	10	-.539	5
885		3	max	2.217	10	.051	7	.099	11	.218	10	.198	5	.887	2	1.234	7
886			min	-2.145	5	-.042	2	-.109	4	-.198	5	-.218	10	-1.234	7	-.887	2
887		4	max	2.057	10	.009	5	.054	7	.291	7	.226	2	.416	5	.595	10
888			min	-2.033	5	-.01	10	-.039	2	-.226	2	-.291	7	-.595	10	-.416	5
889		5	max	2.056	10	.027	2	.07	10	0	12	0	12	0	12	0	12
890			min	-2.037	5	-.039	7	-.054	5	0	1	0	1	0	1	0	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
891	M90	1	max	1.744	5	.059	7	.042	10	0	12	0	12	0	12	0	12
892			min	-1.781	10	-.043	2	-.029	5	0	1	0	1	0	1	0	1
893		2	max	1.753	5	.029	7	.055	7	.577	7	.455	2	.493	7	.338	2
894			min	-1.786	10	-.024	2	-.042	2	-.455	2	-.577	7	-.338	2	-.493	7
895		3	max	1.883	5	.135	7	.096	11	1.142	2	1.622	7	1.363	7	1.053	2
896			min	-1.97	10	-.106	2	-.107	4	-1.622	7	-1.142	2	-1.053	2	-1.363	7
897		4	max	1.903	5	.071	7	.039	2	.207	2	.397	7	.576	10	.451	5
898			min	-1.985	10	-.05	2	-.05	7	-.397	7	-.207	2	-.451	5	-.576	10
899		5	max	1.925	5	.045	4	.094	5	0	12	0	12	0	12	0	12
900			min	-2.004	10	-.032	11	-.105	10	0	1	0	1	0	1	0	1
901	M91	1	max	.39	10	.11	2	.015	5	0	12	0	12	0	12	0	12
902			min	-.231	5	-.143	7	-.016	10	0	1	0	1	0	1	0	1
903		2	max	.388	10	.118	2	.005	5	1.244	2	1.682	7	.141	5	.143	10
904			min	-.232	5	-.162	7	-.005	10	-1.682	7	-1.244	2	-.143	10	-.141	5
905		3	max	.671	7	.404	7	.051	4	5.526	2	7.546	7	.066	5	.068	10
906			min	-.383	2	-.305	2	-.051	11	-7.546	7	-5.526	2	-.068	10	-.066	5
907		4	max	.712	7	.336	7	.003	10	2.407	2	3.371	7	.355	5	.356	10
908			min	-.428	2	-.246	2	-.003	5	-3.371	7	-2.407	2	-.356	10	-.355	5
909		5	max	.744	7	.282	7	.045	10	0	12	0	12	0	12	0	12
910			min	-.463	2	-.202	2	-.045	5	0	1	0	1	0	1	0	1
911	M92	1	max	1.755	11	.008	8	.019	1	0	12	0	12	0	12	0	12
912			min	-1.878	4	-.02	1	-.009	8	0	1	0	1	0	1	0	1
913		2	max	1.754	11	.05	2	.049	7	.204	2	.393	7	.253	7	.131	2
914			min	-1.88	4	-.07	7	-.038	2	-.393	7	-.204	2	-.131	2	-.253	7
915		3	max	1.752	11	.106	2	.095	7	1.136	2	1.614	7	1.343	7	1.037	2
916			min	-1.882	4	-.135	7	-.085	2	-1.614	7	-1.136	2	-1.037	2	-1.343	7
917		4	max	1.64	11	.024	2	.042	2	.582	7	.459	2	.484	7	.331	2
918			min	-1.714	4	-.029	7	-.054	7	-.459	2	-.582	7	-.331	2	-.484	7
919		5	max	1.638	11	.044	2	.022	2	0	12	0	12	0	12	0	12
920			min	-1.717	4	-.06	7	-.035	7	0	1	0	1	0	1	0	1
921	M93	1	max	1.849	4	.038	7	.035	2	0	12	0	12	0	12	0	12
922			min	-1.755	11	-.027	2	-.05	7	0	1	0	1	0	1	0	1
923		2	max	1.851	4	.004	10	.039	2	.286	7	.223	2	.409	2	.582	7
924			min	-1.753	11	-.004	5	-.054	7	-.223	2	-.286	7	-.582	7	-.409	2
925		3	max	1.987	4	.043	2	.045	2	.09	10	.094	1	.88	2	1.225	7
926			min	-1.835	11	-.052	7	-.06	7	-.094	1	-.09	10	-1.225	7	-.88	2
927		4	max	1.989	4	.004	4	.037	7	.406	7	.363	2	.267	2	.375	7
928			min	-1.833	11	-.004	11	-.027	2	-.363	2	-.406	7	-.375	7	-.267	2
929		5	max	1.991	4	.063	2	.029	7	0	12	0	12	0	12	0	12
930			min	-1.832	11	-.071	7	-.02	2	0	1	0	1	0	1	0	1
931	M94	1	max	1.759	7	.051	7	.015	1	0	12	0	12	0	12	0	12
932			min	-1.268	2	-.045	2	-.012	8	0	1	0	1	0	1	0	1
933		2	max	1.776	7	.005	2	.013	7	.299	7	.272	2	.052	1	.017	8
934			min	-1.289	2	-.006	7	-.01	2	-.272	2	-.299	7	-.017	8	-.052	1
935		3	max	1.8	7	.088	7	.038	2	.323	2	.34	7	.378	4	.261	11
936			min	-1.319	2	-.08	2	-.043	1	-.34	7	-.323	2	-.261	11	-.378	4
937		4	max	1.77	7	.012	7	.011	11	.231	7	.198	2	.189	4	.13	11
938			min	-1.315	2	-.011	2	-.016	4	-.198	2	-.231	7	-.13	11	-.189	4
939		5	max	1.784	7	.03	2	.011	11	0	12	0	12	0	12	0	12
940			min	-1.334	2	-.037	7	-.016	4	0	1	0	1	0	1	0	1
941	M95	1	max	1.334	2	.007	7	.012	11	0	12	0	12	0	12	0	12
942			min	-1.755	7	.002	2	-.017	4	0	1	0	1	0	1	0	1

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
943		2	max	1.335	2	0	8	.012	11	.043	7	.003	2	.132	11	.19	4
944			min	-1.753	7	-.003	1	-.017	4	-.003	2	-.043	7	-.19	4	-.132	11
945		3	max	1.409	2	.008	1	.012	11	.033	5	.063	10	.264	11	.379	4
946			min	-1.842	7	-.009	10	-.017	4	-.063	10	-.033	5	-.379	4	-.264	11
947		4	max	1.41	2	.003	10	.006	7	.045	4	.006	11	.06	2	.074	7
948			min	-1.84	7	-.001	5	-.005	2	-.006	11	-.045	4	-.074	7	-.06	2
949		5	max	1.411	2	-.001	11	.006	7	0	12	0	12	0	12	0	12
950			min	-1.839	7	-.007	4	-.005	2	0	1	0	1	0	1	0	1
951	M96	1	max	2.403	4	.009	4	.007	10	0	12	0	12	0	12	0	12
952			min	-2.239	11	-.003	11	-.006	5	0	1	0	1	0	1	0	1
953		2	max	2.401	4	.006	4	.007	10	.083	4	.046	11	.078	10	.071	5
954			min	-2.241	11	-.005	11	-.006	5	-.046	11	-.083	4	-.071	5	-.078	10
955		3	max	2.398	4	.01	1	.007	10	.169	7	.144	2	.155	10	.144	7
956			min	-2.243	11	-.009	10	-.006	5	-.144	2	-.169	7	-.144	7	-.155	10
957		4	max	2.271	4	.006	2	.006	7	.107	7	.056	2	.063	2	.072	7
958			min	-2.117	11	-.007	7	-.006	2	-.056	2	-.107	7	-.072	7	-.063	2
959		5	max	2.268	4	.003	2	.006	7	0	12	0	12	0	12	0	12
960			min	-2.119	11	-.012	7	-.006	2	0	1	0	1	0	1	0	1
961	M97	1	max	1.244	7	.032	1	.04	12	0	12	0	12	0	12	0	12
962			min	-1.081	2	-.015	8	-.04	4	0	1	0	1	0	1	0	1
963		2	max	1.235	7	.016	1	.02	12	.181	1	.082	8	.222	12	.222	6
964			min	-1.074	2	-.007	8	-.02	4	-.082	8	-.181	1	-.222	4	-.222	10
965		3	max	1.225	7	0	12	0	12	.241	1	.109	8	.296	12	.296	6
966			min	-1.067	2	0	1	0	1	-.109	8	-.241	1	-.296	4	-.296	10
967		4	max	1.215	7	.007	8	.02	6	.181	1	.082	8	.222	12	.222	6
968			min	-1.06	2	-.016	1	-.02	10	-.082	8	-.181	1	-.222	4	-.222	10
969		5	max	1.205	7	.015	8	.04	6	0	12	0	12	0	12	0	12
970			min	-1.053	2	-.032	1	-.04	10	0	1	0	1	0	1	0	1
971	M98	1	max	1.252	7	.042	1	.04	6	0	12	0	12	0	12	0	12
972			min	-.932	2	-.037	8	-.04	10	0	1	0	1	0	1	0	1
973		2	max	1.257	7	.021	1	.02	6	.24	1	.214	8	.23	6	.23	12
974			min	-.932	2	-.019	8	-.02	10	-.214	8	-.24	1	-.23	10	-.23	4
975		3	max	1.263	7	0	12	0	12	.32	1	.285	8	.307	6	.307	12
976			min	-.932	2	0	1	0	1	-.285	8	-.32	1	-.307	10	-.307	4
977		4	max	1.268	7	.019	8	.02	12	.24	1	.214	8	.23	6	.23	12
978			min	-.932	2	-.021	1	-.02	4	-.214	8	-.24	1	-.23	10	-.23	4
979		5	max	1.273	7	.037	8	.04	12	0	12	0	12	0	12	0	12
980			min	-.932	2	-.042	1	-.04	4	0	1	0	1	0	1	0	1
981	M99	1	max	3.183	4	.041	7	.05	6	0	12	0	12	0	12	0	12
982			min	-2.251	11	-.014	2	-.05	10	0	1	0	1	0	1	0	1
983		2	max	3.174	4	.02	7	.025	6	.331	7	.116	2	.403	6	.403	12
984			min	-2.247	11	-.007	2	-.025	10	-.116	2	-.331	7	-.403	10	-.403	4
985		3	max	3.166	4	0	12	0	12	.442	7	.155	2	.537	6	.537	12
986			min	-2.242	11	0	1	0	1	-.155	2	-.442	7	-.537	10	-.537	4
987		4	max	3.157	4	.007	2	.025	12	.331	7	.116	2	.403	6	.403	12
988			min	-2.237	11	-.02	7	-.025	4	-.116	2	-.331	7	-.403	10	-.403	4
989		5	max	3.149	4	.014	2	.05	12	0	12	0	12	0	12	0	12
990			min	-2.233	11	-.041	7	-.05	4	0	1	0	1	0	1	0	1
991	M100	1	max	3.338	5	.045	7	.043	12	0	12	0	12	0	12	0	12
992			min	-3.611	10	-.024	2	-.043	4	0	1	0	1	0	1	0	1
993		2	max	3.346	5	.022	7	.022	12	.364	7	.201	2	.352	12	.352	6
994			min	-3.614	10	-.012	2	-.022	4	-.201	2	-.364	7	-.352	4	-.352	10

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
995		3	max	3.355	5	0	12	0	12	.486	7	.267	2	.469	12	.469	6
996			min	-3.616	10	0	1	0	1	-.267	2	-.486	7	-.469	4	-.469	10
997		4	max	3.364	5	.012	2	.022	6	.364	7	.201	2	.352	12	.352	6
998			min	-3.619	10	-.022	7	-.022	10	-.201	2	-.364	7	-.352	4	-.352	10
999		5	max	3.373	5	.024	2	.043	6	0	12	0	12	0	12	0	12
1000			min	-3.622	10	-.045	7	-.043	10	0	1	0	1	0	1	0	1
1001	M101	1	max	4.781	10	.039	4	.045	3	0	12	0	12	0	12	0	12
1002			min	-3.727	5	-.019	11	-.045	7	0	1	0	1	0	1	0	1
1003		2	max	4.77	10	.02	4	.023	3	.268	4	.129	11	.307	3	.307	9
1004			min	-3.72	5	-.009	11	-.023	7	-.129	11	-.268	4	-.307	7	-.307	1
1005		3	max	4.759	10	0	12	0	12	.358	4	.172	11	.409	3	.409	9
1006			min	-3.713	5	0	1	0	1	-.172	11	-.358	4	-.409	7	-.409	1
1007		4	max	4.748	10	.009	11	.023	9	.268	4	.129	11	.307	3	.307	9
1008			min	-3.706	5	-.02	4	-.023	1	-.129	11	-.268	4	-.307	7	-.307	1
1009		5	max	4.737	10	.019	11	.045	9	0	12	0	12	0	12	0	12
1010			min	-3.698	5	-.039	4	-.045	1	0	1	0	1	0	1	0	1
1011	M102	1	max	2.972	11	.055	4	.057	3	0	12	0	12	0	12	0	12
1012			min	-3.037	4	-.036	11	-.057	7	0	1	0	1	0	1	0	1
1013		2	max	2.961	11	.028	4	.028	3	.445	4	.291	11	.457	3	.457	9
1014			min	-3.031	4	-.018	11	-.028	7	-.291	11	-.445	4	-.457	7	-.457	1
1015		3	max	2.949	11	0	12	0	12	.593	4	.388	11	.609	3	.609	9
1016			min	-3.026	4	0	1	0	1	-.388	11	-.593	4	-.609	7	-.609	1
1017		4	max	2.938	11	.018	11	.028	9	.445	4	.291	11	.457	3	.457	9
1018			min	-3.02	4	-.028	4	-.028	1	-.291	11	-.445	4	-.457	7	-.457	1
1019		5	max	2.927	11	.036	11	.057	9	0	12	0	12	0	12	0	12
1020			min	-3.015	4	-.055	4	-.057	1	0	1	0	1	0	1	0	1
1021	M103	1	max	2.862	10	.035	1	.048	12	0	12	0	12	0	12	0	12
1022			min	-2.734	5	-.01	8	-.048	4	0	1	0	1	0	1	0	1
1023		2	max	2.865	10	.017	1	.024	12	.257	1	.072	8	.352	12	.352	6
1024			min	-2.74	5	-.005	8	-.024	4	-.072	8	-.257	1	-.352	4	-.352	10
1025		3	max	2.868	10	0	12	0	12	.342	1	.096	8	.469	12	.469	6
1026			min	-2.746	5	0	1	0	1	-.096	8	-.342	1	-.469	4	-.469	10
1027		4	max	2.871	10	.005	8	.024	6	.257	1	.072	8	.352	12	.352	6
1028			min	-2.751	5	-.017	1	-.024	10	-.072	8	-.257	1	-.352	4	-.352	10
1029		5	max	2.874	10	.01	8	.048	6	0	12	0	12	0	12	0	12
1030			min	-2.757	5	-.035	1	-.048	10	0	1	0	1	0	1	0	1
1031	M104	1	max	4.148	4	.035	1	.048	12	0	12	0	12	0	12	0	12
1032			min	-3.99	11	-.01	8	-.048	4	0	1	0	1	0	1	0	1
1033		2	max	4.151	4	.017	1	.024	12	.257	1	.072	8	.352	12	.352	6
1034			min	-3.996	11	-.005	8	-.024	4	-.072	8	-.257	1	-.352	4	-.352	10
1035		3	max	4.154	4	0	12	0	12	.342	1	.096	8	.469	12	.469	6
1036			min	-4.002	11	0	1	0	1	-.096	8	-.342	1	-.469	4	-.469	10
1037		4	max	4.157	4	.005	8	.024	6	.257	1	.072	8	.352	12	.352	6
1038			min	-4.008	11	-.017	1	-.024	10	-.072	8	-.257	1	-.352	4	-.352	10
1039		5	max	4.16	4	.01	8	.048	6	0	12	0	12	0	12	0	12
1040			min	-4.013	11	-.035	1	-.048	10	0	1	0	1	0	1	0	1
1041	M105	1	max	4.342	10	.033	4	.041	9	0	12	0	12	0	12	0	12
1042			min	-3.917	5	-.013	11	-.041	1	0	1	0	1	0	1	0	1
1043		2	max	4.353	10	.016	4	.021	9	.2	4	.078	11	.253	9	.253	3
1044			min	-3.925	5	-.006	11	-.021	1	-.078	11	-.2	4	-.253	1	-.253	7
1045		3	max	4.363	10	0	12	0	12	.266	4	.104	11	.338	9	.338	3
1046			min	-3.932	5	0	1	0	1	-.104	11	-.266	4	-.338	1	-.338	7

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
1047		4	max	4.374	10	.006	11	.021	3	.2	4	.078	11	.253	9	.253	3
1048			min	-3.94	5	-.016	4	-.021	7	-.078	11	-.2	4	-.253	1	-.253	7
1049		5	max	4.385	10	.013	11	.041	3	0	12	0	12	0	12	0	12
1050			min	-3.948	5	-.033	4	-.041	7	0	1	0	1	0	1	0	1
1051	M106	1	max	2.911	1	.039	4	.058	3	0	12	0	12	0	12	0	12
1052			min	-2.789	8	-.008	11	-.058	7	0	1	0	1	0	1	0	1
1053		2	max	2.915	1	.019	4	.029	3	.337	4	.066	11	.504	3	.504	9
1054			min	-2.795	8	-.004	11	-.029	7	-.066	11	-.337	4	-.504	7	-.504	1
1055		3	max	2.918	1	0	12	0	12	.449	4	.088	11	.672	3	.672	9
1056			min	-2.802	8	0	1	0	1	-.088	11	-.449	4	-.672	7	-.672	1
1057		4	max	2.922	1	.004	11	.029	9	.337	4	.066	11	.504	3	.504	9
1058			min	-2.808	8	-.019	4	-.029	1	-.066	11	-.337	4	-.504	7	-.504	1
1059		5	max	2.926	1	.008	11	.058	9	0	12	0	12	0	12	0	12
1060			min	-2.815	8	-.039	4	-.058	1	0	1	0	1	0	1	0	1
1061	M107	1	max	3.695	1	.035	10	.048	3	0	12	0	12	0	12	0	12
1062			min	-3.35	8	-.012	5	-.048	7	0	1	0	1	0	1	0	1
1063		2	max	3.699	1	.018	10	.024	3	.246	10	.082	5	.336	3	.336	9
1064			min	-3.351	8	-.006	5	-.024	7	-.082	5	-.246	10	-.336	7	-.336	1
1065		3	max	3.703	1	0	12	0	12	.328	10	.109	5	.448	3	.448	9
1066			min	-3.351	8	0	1	0	1	-.109	5	-.328	10	-.448	7	-.448	1
1067		4	max	3.707	1	.006	5	.024	9	.246	10	.082	5	.336	3	.336	9
1068			min	-3.352	8	-.018	10	-.024	1	-.082	5	-.246	10	-.336	7	-.336	1
1069		5	max	3.71	1	.012	5	.048	9	0	12	0	12	0	12	0	12
1070			min	-3.353	8	-.035	10	-.048	1	0	1	0	1	0	1	0	1
1071	M108	1	max	3.662	4	.027	10	.031	9	0	12	0	12	0	12	0	12
1072			min	-3.245	11	-.011	5	-.031	1	0	1	0	1	0	1	0	1
1073		2	max	3.654	4	.014	10	.015	9	.148	10	.058	5	.165	9	.165	3
1074			min	-3.24	11	-.005	5	-.015	1	-.058	5	-.148	10	-.165	1	-.165	7
1075		3	max	3.646	4	0	12	0	12	.197	10	.077	5	.22	9	.22	3
1076			min	-3.235	11	0	1	0	1	-.077	5	-.197	10	-.22	1	-.22	7
1077		4	max	3.638	4	.005	5	.015	3	.148	10	.058	5	.165	9	.165	3
1078			min	-3.23	11	-.014	10	-.015	7	-.058	5	-.148	10	-.165	1	-.165	7
1079		5	max	3.63	4	.011	5	.031	3	0	12	0	12	0	12	0	12
1080			min	-3.225	11	-.027	10	-.031	7	0	1	0	1	0	1	0	1
1081	M109	1	max	2.062	7	.041	1	.048	12	0	12	0	12	0	12	0	12
1082			min	-1.515	2	-.017	8	-.048	4	0	1	0	1	0	1	0	1
1083		2	max	2.05	7	.02	1	.024	12	.305	1	.127	8	.364	12	.364	6
1084			min	-1.506	2	-.008	8	-.024	4	-.127	8	-.305	1	-.364	4	-.364	10
1085		3	max	2.038	7	0	12	0	12	.407	1	.169	8	.485	12	.485	6
1086			min	-1.498	2	0	1	0	1	-.169	8	-.407	1	-.485	4	-.485	10
1087		4	max	2.025	7	.008	8	.024	6	.305	1	.127	8	.364	12	.364	6
1088			min	-1.489	2	-.02	1	-.024	10	-.127	8	-.305	1	-.364	4	-.364	10
1089		5	max	2.013	7	.017	8	.048	6	0	12	0	12	0	12	0	12
1090			min	-1.481	2	-.041	1	-.048	10	0	1	0	1	0	1	0	1
1091	M110	1	max	1.841	7	.041	1	.048	12	0	12	0	12	0	12	0	12
1092			min	-1.471	2	-.017	8	-.048	4	0	1	0	1	0	1	0	1
1093		2	max	1.828	7	.02	1	.024	12	.305	1	.127	8	.364	12	.364	6
1094			min	-1.463	2	-.008	8	-.024	4	-.127	8	-.305	1	-.364	4	-.364	10
1095		3	max	1.816	7	0	12	0	12	.407	1	.169	8	.485	12	.485	6
1096			min	-1.455	2	0	1	0	1	-.169	8	-.407	1	-.485	4	-.485	10
1097		4	max	1.803	7	.008	8	.024	6	.305	1	.127	8	.364	12	.364	6
1098			min	-1.446	2	-.02	1	-.024	10	-.127	8	-.305	1	-.364	4	-.364	10

Envelope Member Section Stresses (Continued)

	Member	Sec		Axial[ksi]	LC	y Shear[...	LC	z Shear[...	LC	y-Top[ksi]	LC	y-Bot[ksi]	LC	z-Top[ksi]	LC	z-Bot[ksi]	LC
1099		5	max	1.791	7	.017	8	.048	6	0	12	0	12	0	12	0	12
1100			min	-1.438	2	-.041	1	-.048	10	0	1	0	1	0	1	0	1
1101	M111	1	max	2.655	7	.033	7	.044	6	0	12	0	12	0	12	0	12
1102			min	-2.351	2	-.008	2	-.044	10	0	1	0	1	0	1	0	1
1103		2	max	2.663	7	.017	7	.022	6	.242	7	.059	2	.319	6	.319	12
1104			min	-2.362	2	-.004	2	-.022	10	-.059	2	-.242	7	-.319	10	-.319	4
1105		3	max	2.671	7	0	12	0	12	.323	7	.079	2	.425	6	.425	12
1106			min	-2.374	2	0	1	0	1	-.079	2	-.323	7	-.425	10	-.425	4
1107		4	max	2.68	7	.004	2	.022	12	.242	7	.059	2	.319	6	.319	12
1108			min	-2.385	2	-.017	7	-.022	4	-.059	2	-.242	7	-.319	10	-.319	4
1109		5	max	2.688	7	.008	2	.044	12	0	12	0	12	0	12	0	12
1110			min	-2.396	2	-.033	7	-.044	4	0	1	0	1	0	1	0	1
1111	M112	1	max	2.818	11	.062	10	.064	9	0	12	0	12	0	12	0	12
1112			min	-2.925	4	-.036	5	-.064	1	0	1	0	1	0	1	0	1
1113		2	max	2.826	11	.031	10	.032	9	.613	10	.359	5	.634	9	.634	3
1114			min	-2.94	4	-.018	5	-.032	1	-.359	5	-.613	10	-.634	1	-.634	7
1115		3	max	2.834	11	0	12	0	12	.818	10	.478	5	.845	9	.845	3
1116			min	-2.955	4	0	1	0	1	-.478	5	-.818	10	-.845	1	-.845	7
1117		4	max	2.842	11	.018	5	.032	3	.613	10	.359	5	.634	9	.634	3
1118			min	-2.97	4	-.031	10	-.032	7	-.359	5	-.613	10	-.634	1	-.634	7
1119		5	max	2.85	11	.036	5	.064	3	0	12	0	12	0	12	0	12
1120			min	-2.985	4	-.062	10	-.064	7	0	1	0	1	0	1	0	1
1121	M113	1	max	3.227	10	.033	4	.041	3	0	12	0	12	0	12	0	12
1122			min	-2.908	5	-.013	11	-.041	7	0	1	0	1	0	1	0	1
1123		2	max	3.216	10	.016	4	.021	3	.2	4	.078	11	.253	3	.253	9
1124			min	-2.901	5	-.006	11	-.021	7	-.078	11	-.2	4	-.253	7	-.253	1
1125		3	max	3.206	10	0	12	0	12	.266	4	.104	11	.338	3	.338	9
1126			min	-2.893	5	0	1	0	1	-.104	11	-.266	4	-.338	7	-.338	1
1127		4	max	3.195	10	.006	11	.021	9	.2	4	.078	11	.253	3	.253	9
1128			min	-2.885	5	-.016	4	-.021	1	-.078	11	-.2	4	-.253	7	-.253	1
1129		5	max	3.184	10	.013	11	.041	9	0	12	0	12	0	12	0	12
1130			min	-2.878	5	-.033	4	-.041	1	0	1	0	1	0	1	0	1
1131	M114	1	max	5.008	7	.032	1	.04	12	0	12	0	12	0	12	0	12
1132			min	-4.71	2	-.015	8	-.04	4	0	1	0	1	0	1	0	1
1133	M114 Worst case stress reversal for all leg members.	2	max	4.998	7	.016	1	.02	12	.181	1	.082	8	.222	12	.222	6
1134			min	-4.703	2	-.007	8	-.02	4	-.082	8	-.181	1	-.222	4	-.222	10
1135		3	max	4.988	7	0	12	0	12	.241	1	.109	8	.296	12	.296	6
1136			min	-4.696	2	0	1	0	1	-.109	8	-.241	1	-.296	4	-.296	10
1137		4	max	4.978	7	.007	8	.02	6	.181	1	.082	8	.222	12	.222	6
1138			min	-4.689	2	-.016	1	-.02	10	-.082	8	-.181	1	-.222	4	-.222	10
1139		5	max	4.968	7	.015	8	.04	6	0	12	0	12	0	12	0	12
1140			min	-4.682	2	-.032	1	-.04	10	0	1	0	1	0	1	0	1
1141	M115	1	max	2.623	5	.068	4	.074	9	0	12	0	12	0	12	0	12
1142			min	-3.265	10	-.039	11	-.074	1	0	1	0	1	0	1	0	1
1143		2	max	2.612	5	.034	4	.037	9	.723	4	.412	11	.788	9	.788	3
1144			min	-3.247	10	-.019	11	-.037	1	-.412	11	-.723	4	-.788	1	-.788	7
1145		3	max	2.602	5	0	12	0	12	.963	4	.55	11	1.051	9	1.051	3
1146			min	-3.23	10	0	1	0	1	-.55	11	-.963	4	-1.051	1	-1.051	7
1147		4	max	2.591	5	.019	11	.037	3	.723	4	.412	11	.788	9	.788	3
1148			min	-3.212	10	-.034	4	-.037	7	-.412	11	-.723	4	-.788	1	-.788	7
1149		5	max	2.581	5	.039	11	.074	3	0	12	0	12	0	12	0	12
1150			min	-3.195	10	-.068	4	-.074	7	0	1	0	1	0	1	0	1

STARLING MADISON
LOFQUIST INC.
5224 S. 39th STEET
PHOENIX, ARIZONA 85040
(602) 438-2500

Sheet No.: 74

Job No.: 1018-19

Date: 12/18/2019 BY: J. Light,

Fatigue Analysis per AASHTO Section 6.6:

Check Worst Case Tube Section:

Table 6.6.1.2.3-1; 1.1 Base Metal:

Category 'A' $A := 25000000000$ $\Delta F_{1.1} := 24ksi$

Worst Case Stress Reversal Leg Member M114:

Note: Leg Members are M97-M115.

$\Delta f_{M114} := 5.008ksi + 4.71ksi = 9.7\,ksi$

$\frac{\Delta f_{M114}}{\Delta F_{1.1}} = 0.405$ < 1.0 Therefore OK

Use HSS2.375"x0.109" Thick A500 Gr. B Typical Leg Members

Check Required Fillet Weld Size Leg Member M114 per Table 6.6.1.2.3-1;5.3 Weld Metal:

$\Delta F_{5.3} := 10ksi$ $D_{act} := \frac{3}{16}in = 0.187\,in$ $t_{leg} := 0.109in$

$D_{reqd} := \frac{\Delta f_{M114}}{\Delta F_{5.3}} \cdot t_{leg} \cdot \frac{2}{\sqrt{2}} = 0.150\,in$

Note: Leg Members are M97-M115.

$\frac{D_{reqd}}{D_{act}} = 0.80$ < 1.0 Therefore OK

Use 3/16" Fillet Weld All-Around Typical All Leg Members Each End

Worst Case Stress Reversal Ring Member M50:

Note: Bottom Ring Members are M1-M6 & M49-M54. Bottom Ring Highest Stress Reversal of Rings.

$\Delta f_{M50} := 1.67ksi + 1.534ksi = 3.2\,ksi$

$\frac{\Delta f_{M50}}{\Delta F_{1.1}} = 0.133$ < 1.0 Therefore OK

Use HSS2.375"x0.109" Thick A500 Gr. B Typical Ring Members

Check Required Fillet Weld Size Leg Member M50 per Table 6.6.1.2.3-1;5.3 Weld Metal:

$\Delta F_{5.3} := 10ksi$ $D_{act} := \frac{1}{16}in = 0.063\,in$ $t_{ring} := 0.109in$

$D_{reqd} := \frac{\Delta f_{M50}}{\Delta F_{5.3}} \cdot t_{ring} \cdot \frac{2}{\sqrt{2}} = 0.049\,in$

Note: Bottom Ring Members are M1-M6 & M49-M54. Bottom Ring Highest Stress Reversal of Rings.

$\frac{D_{reqd}}{D_{act}} = 0.790$ < 1.0 Therefore OK

Use 1/16" Square Groove Weld All-Around Typical All Ring Members Each End

STARLING MADISON
LOFQUIST INC.
5224 S. 39th STEET
PHOENIX, ARIZONA 85040
(602) 438-2500

Sheet No.: 75

Job No.: 1018-19

Date: 12/18/2019 BY: J. Light,

Worst Case Stress Reversal Vertical Member M41:

$\Delta f_{M41} := 2.653ksi + 2.547ksi = 5.2\,ksi$

$\frac{\Delta f_{M41}}{\Delta F_{1.1}} = 0.217$ < 1.0 Therefore OK

Use HSS2.375"x0.109" Thick A500 Gr. B Typical Vertical Members

Check Required Fillet Weld Size Leg Member M50
per Table 6.6.1.2.3-1;5.3 Weld Metal:

$\Delta F_{5.3} := 10ksi$ $D_{act} := \frac{1}{16}in = 0.063\,in$ $t_{ring} := 0.109in$

$dia := 2.375in$ $C := dia \cdot \pi = 7.461\,in$ $L_w := 9.125in$

$D_{reqd} := \frac{\Delta f_{M41}}{\Delta F_{5.3}} \cdot t_{ring} \cdot \frac{2}{\sqrt{2}} \cdot \frac{C}{L_w} = 0.066\,in$

$\frac{D_{reqd}}{D_{act}} = 1.049$ ≈ 1.0 Therefore OK

Use 1/16" Square Groove Weld All-Around
Typical All Vertical Members Each End

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C10x30 Steel Channel to Steel Truss Tube - Bolt Analysis:

Worst Uplift Reaction Load Case & Lateral Load Case Combined for Joint PPA1:

Try (2) 3/4" Dia. 18-8 SS Thru-Bolts:

$V_{x_up} := -4101lb$ $V_{y_up} := -2534lb$ $V_{z_up} := 119lb$ Joint PPA1 LC2

$V_{x_Xlat} := 4470lb$ $V_{y_Xlat} := 2777lb$ $V_{z_Xlat} := -110lb$ Joint PPA1 LC2

$V_{x_diff} := V_{x_Xlat} - V_{x_up} = 8571.0\,lb$

$V_{z_diff} := V_{z_Xlat} - V_{z_up} = -229.0\,lb$

$n_{bolts} := 2$ $n_{shearplanes} := 2$

$A_{root} := 0.309in^2$ $R := \sqrt{V_{x_diff}^2 + V_{y_up}^2 + V_{z_diff}^2} = 8940.7\,lb$

$\Delta f_{PPA1} := \frac{R}{n_{bolts} \cdot n_{shearplanes} \cdot A_{root}} = 7.2\,ksi$ $\Delta F_{9.2} := 7ksi$

$\frac{\Delta f_{PPA1}}{\Delta F_{9.2}} = 1.033$ ≈ 1.0 Therefore OK

Use (2) 3/4" Dia. 18-8 SS Thru-Bolts