Implementing FHWA's INVEST Round 3 Project and 3rd Annual Arizona Department of Transportation Sustainable Transportation Program Final Report

Arizona Department of Transportation

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List of Acronyms

Alternatives Selection Report (ASR)

Arizona Department of Transportation (ADOT)

Arizona Department of Environmental Quality (ADEQ)

Arizona Department of Water Resources (ADWR)

Arizona Management System (AMS)

American Association of State Highway and Transportation Officials (AASHTO)

Bureau of Land Management (BLM)

Benefit Cost Analysis (BCA)

Collector-distributor roads (C-D)

Correlated color temperature (CCT)

Closed circuit television cameras (CCTV)

Council of governments (COG)

Corridor Selection Report (CSR)

Crumb Rubber Asphalt (CRA)

Design Concept Report (DCR)

Environmental Assessment (EA)

Environmental Protection Agency (EPA)

Environmental Product Declaration (EPD)

Environmental Impact Statement (EIS)

Federal Highway Administration (FHWA)

Finding of No Significant Impact (FONSI)

Federal Transit Administration (FTA)

Fiber Reinforced Asphalt Concrete (FRAC)

High-occupancy vehicle lanes (HOV)

High Pressure Sodium (HPS)

Interstate 11 (I-11)

Interstate 10 (I-10)

Interstate 19 (I-19)

Integrated Roadside Vegetation Management (IRVM)

Life Cycle Assessment (LCA)

Life Cycle Cost Analysis (LCCA)

Light Emitting Diode (LED)

Maricopa Association of Governments (MAG)

Metropolitan Planning Organization (MPO)

Mile post (MP)

Municipal Separate Storm Sewer System (MS4 Permit)

Multimodal Planning Division (MPD)

National Environmental Policy Act (NEPA)

Operational Focus Areas (OFA)

Project Development Criteria (PD)

Portland cement concrete (PCC)

Return on Investment (ROI)

Right-of-way (ROW)

Storm Water Outreach for Regional Municipalities (STORM)

State Route (SR)

Strategic Focus Areas (SFA)

System Planning for States (SPS)

System Planning for Regions (SPR)

Surface Transportation Program (STP)

Sustainable Development Goals (SDGs)

Texas Transportation Institute (TTI)

Traffic interchanges (TI)

United States Highway (US)

United States Geological Survey (USGS)

Upper Agua Fria Watershed Partnership (UAFWP)

White Mountain Apache Tribe (WMAT)

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Executive Summary

Sustainable Transportation

Planning, Developing, and Maintaining for the Public Good

Sustainability best management practices can help state and local public agencies improve the use of their economic, social, and environmental resources. The Arizona Department of Transportation (ADOT) has pursued gentle and persistent adoption of sustainability principles for a decade – dating back to ADOT's participation in the 2010 FHWA Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) pilot testing. Implementing sustainability concepts does not always fit into the conventional DOT project delivery and system operating process of plan, design, bid, build, and maintain and more recently, the use of alternative delivery methods. ADOT has continued to grow its sustainable transportation program to meet these challenges choosing to focus on design engineering, project development, construction, and statewide maintenance and operations. In fact, many of our recent sustainable transportation achievements have come in connection with ADOT's use of alternative delivery methods.

Two recent achievements of note include the national award winning Williams, Arizona Interstate 40 Portland Cement Concrete Pavement project that addressed both sustainable transportation program life cycle adoption goals and long standing freeze-thaw issues. ADOT also received a Metis Center for Infrastructure and Sustainable Engineering award recognizing the State Route 160 Laguna Creek bridge and bank protection project that used cutting-edge data collection and modeling tools to assist in advancing a sustainable, resilient solution to erosion from a meandering creek on the Navajo Nation.

A major cornerstone during the development of the sustainable transportation program was the agency's participation in the INVEST pilot testing and ADOT's own implementation phases between 2011 and 2016. As a result of this involvement, and to strengthen ADOT's alignment with the State of Arizona Management System's continuous improvement program initiatives, Operating Focus Areas are identified every two years. ADOT chooses each focus area on the following basis: (1) addresses a true operational need, (2) aligns with continuous improvement and performance-based practical design goals, (3) furthers environmental, economic, social, and environmental stewardship and improves environmental risk management overall.

The current 2020/2021 focus areas are further discussed in this report. A few of the project level goals include further adoption of LED lighting, exploring solar energy on ADOT right-of-way, and linking sustainability, National Environmental Policy Act (NEPA), public involvement, and planning. At the program level, a large focus has been placed on continuing the introduction and adoption of life cycle assessment (LCA) and life cycle cost

analysis (LCCA) especially as it pertains to ADOT's Sustainable Pavement Systems Program and agency asset management reporting needs.

We also want to recognize industry and academia for their major contributions. ADOT currently benefits from numerous innovation, sustainability, and resilience partnerships.

Through continuous improvement practices ADOT strives to strategically invest resources to achieve the highest possible return. ADOT also recognizes, in relation to investment and return dynamics, the importance of delivering transportation solutions in a more sustainable manner to achieve the State's economic, social, and environmental goals.

Sincerely,

Dallas Hammit

State Engineer and Deputy Director for Transportation

Introduction

How is Sustainable Transportation defined at ADOT?

ADOT Sustainable Transportation Program

Arizona's transportation infrastructure is spread over 114,000 square miles, operates from sea level to 8,000 feet and withstands temperatures that range from below 0°F to over 120°F. Maintaining optimum health and performance of this infrastructure is critical to Arizona's economic vitality, quality of life, and natural and built environments. ADOT recognizes the critical need to plan and prioritize resources more efficiently in order to maintain and operate a robust, economically beneficial transportation network. Through continuous improvement practices and the Arizona Management System (AMS) process, ADOT strives to strategically invest resources to achieve the highest possible return. ADOT also recognizes, in relation to investment and return dynamics, the importance of delivering transportation solutions in a more sustainable manner to achieve economic, social, and environmental goals. ADOT has moved from the early stages of identifying sustainable strategies in 2014 to operationalizing a sustainable transportation program into core administrative, planning, design, construction, operations and maintenance activities. As seen in the 2020/2021 Operational Focus Areas in Appendix C of this document, ADOT plans to further continue this process by incorporating elements of training, resources, and sustainable long range planning.

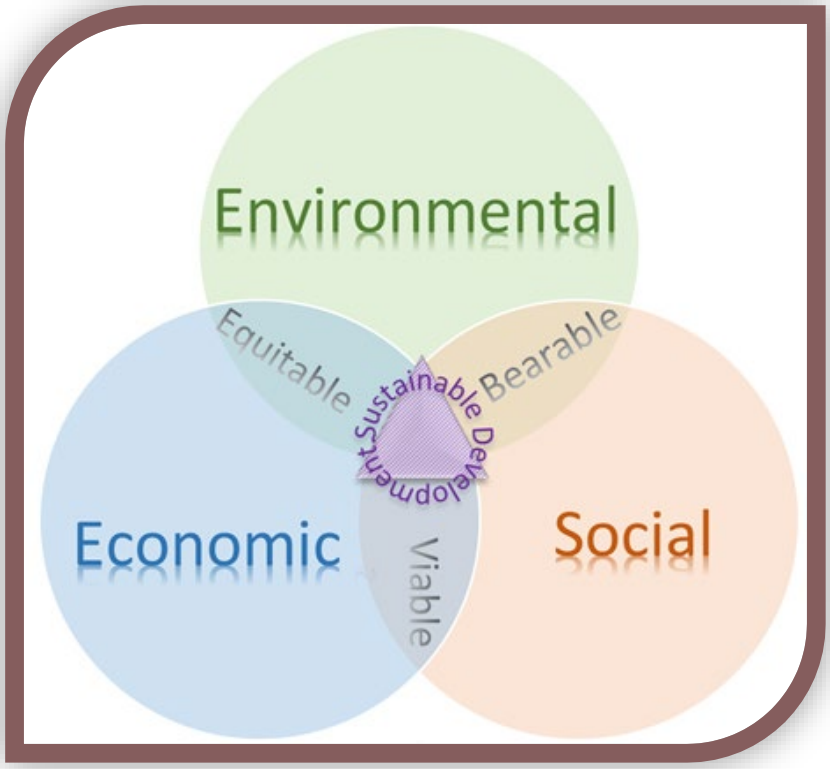


Figure 1 - Sustainability Process Identification

ADOT Sustainability Process Identification

As seen in Figure 1, the three primary principles of sustainability revolve around achieving an efficient, well-balanced use of economic, social, and environmental resources commonly known as the triple bottom line. In theory, this will allow for proper use of funding while attaining all potential project needs and objectives. A sustainable highway, for example, will not only

incorporate the need for mobility and transportation alternatives but also consider safety, accessibility, livability, asset management, and environmental stewardship.

Achieving sustainable development in a large transportation agency is an ambitious goal that takes a considerable amount of effort from different technical and engineering disciplines. The window of opportunity to fulfill all that is desired before a project's completion requires coordination not only within a core group of individuals delivering the project but also those who are considered stakeholders during the project development process. With multiple driving forces influencing any given transportation project, including fiscal responsibility, ensuring all essential aspects within the context of the project are addressed early in design and thoroughly is ultimately the desired outcome. This requirement to achieve so much with so little will encourage sustainable transportation aspects to be implemented across all aspects of the agency from administration, planning to programming, design, construction, operations, maintenance, and end of life in the full cycle of the transportation system.

As stated in the *Guidebook for Sustainability Performance Measurement for Transportation Agencies:*

> Often, a goal will support more than one principle. Yet no one goal in itself is sufficient to achieve sustainability - it takes multiple goals, pursued in concert, to promote sustainability. When a final set of goals is defined, it's important to crosscheck the package of goals to ensure that all of the principles are well addressed. In doing so, take care not to force-fit the goals to make them map to the principles. A balanced goal set, however, achieves comprehensive coverage of the basic principles of sustainability . . .[1]

[1] Transportation Research Board National Cooperative Highway Research Program (NCHRP) *Report 708: A Guidebook for Sustainability Performance Measurement for Transportation Agencies*. National Academies Press. 2011

PART I: The Collaborative Benefits of Using FHWA's INVEST

I. FHWA and ADOT INVEST Round 3 Summary

ADOT, through collaboration with a number of universities and stakeholders, proposed a work plan in 2017 to further accelerate a number of relevant INVEST Project Development module topics through the agency in a variety of ways:

- Develop sustainable transportation design, engineering, and construction LEAN performance measures, and metrics that utilize the three INVEST modules
- Establish a path through projects and case studies that use the design, engineering, and construction LEAN performance benefits identified above to frame the basis of sustainable transportation project level quantitative methodology for economic analysis, benefit cost analysis (BCA)/life cycle cost analysis (LCCA), and return on investment (ROI)
- Leverage ADOT's Sustainable Transportation Program, design, engineering, and construction, ADOT's INVEST history, and decision-making to help further the INVEST sustainability framework for work on indicators, frameworks and performance management

Through continuous improvement practices, ADOT strives to strategically invest resources to achieve the highest possible return. ADOT also recognizes, in relation to investment and return dynamics, the importance of delivering transportation solutions in a more sustainable manner to achieve economic, social, and environmental goals. The Round 3 grant award afforded ADOT an opportunity to institutionalize multiple considerations of sustainable transportation and move the foundation of this topic forward at the agency and transportation community level.

i. 2017-2019 ADOT INVEST Round 3 Work Plan

The objective of the Round 3 Work Plan was to develop a family of practices and measures for sustainable transportation as it relates to civil engineering design and construction within the transportation setting. The work plan was to define and connect to an overall goal of creating an agency foundation of quantitative project level economic analysis, benefit cost analysis, life cycle analysis, and return of investment when it came to the full sustainability picture. This work was to be completed in collaboration not just with ADOT technical groups, but with university research contacts, and other civil engineering companies.

As a goal, ADOT sought to complete the following efforts through this grant and collaboration with stakeholders:

- Delineate the components inside each INVEST module criteria that need to be taken into account, including as it relates to; guidelines on incorporating the quantified aspect of the triple bottom line; both public and private sector valuation strategies (i.e. procurement realities, materials approved products list for DOTs,

environmental, economic, and social valuating); as well as qualitative and quantitative industry standards on data and methods
- Identify and explain the role of key data and assumptions as well as the environmental and social costs and benefits as input to the analytical process
- Establish quantitative end-of-life sustainable options and identify the types of civil infrastructure project activities, costs, that the INVEST module criteria connect to within these tasks

ii. Methodology and Assumptions

ADOT predominately focused on the current agency construction and operations activities to develop these case studies, and invited collaboration into these processes with external university and stakeholders. ADOT's final work plan consisted of using five core strategies:

- Develop an assessment that looks at the impact of each applicable criteria in the INVEST modules to the sustainability of a project. The goal of this investigation is to determine if the relative INVEST criteria are linked to the magnitude of defined sustainable savings from one project to another. Specifically, is the INVEST tool effectively promoting decisions that lead to significant environmental benefits? Additionally, are benefits achieved across all environmental impact categories or do INVEST criteria mask tradeoffs?
- Develop quantitative results using life cycle assessment (LCA -full environmental burden) methodologies to investigate the performance of design alternatives compared to commonly-used engineering standards. The detailed full life cycle impacts can be compared directly with INVEST scoring to develop an understanding of the true costs and benefits of a project and how well INVEST captures those savings.
- Focus on case studies using a small number of System Planning, Operations and Maintenance, and extensive Project Development module criteria
- Investigate whether there are significant tradeoffs between construction and use phase benefits of alternative materials including recycled asphalt pavement and energy efficient lighting
- Develop a Sustainable Pavement Systems Program effort that champions the EDC-4 Pavement Initiative

II. Life Cycles – Arizona State - School of Sustainable Engineering & the Built Environment

In relation to the aforementioned work plan, five core strategies were identified. The goal of developing overarching performance measures, indicators, and metrics is further discussed in the TTI section below. A big part of the strategies revolves around adoption of LCA, LCCA, and Environmental Product Declarations (EPDs). The following summarizes this effort and is an excerpt from a 2017 FHWA Success in Stewardship article;

ADOT was an early champion of INVEST, and one of the few transportation agencies to use all of the INVEST modules to address sustainability goals across the entire transportation life cycle.

ADOT is currently building upon prior sustainability efforts, including the previous use of INVEST, to develop quantitative measures for sustainability as a prioritization tool. As the transportation planning and development process becomes more focused on performance measures for project prioritization, there is a need to quantitatively measure the outputs of sustainability practices in order to have a more holistic view when conducting analyses. The initial measures ADOT's Sustainable Transportation Program is currently developing will enable practitioners to see the outputs of sustainability practices in terms of cost savings and use in accelerated project delivery, while also being able to report to the public and other stakeholders on the improved social and environmental conditions. In addition to new measures, metrics, and indicators, ADOT is further integrating sustainability into its work with the use of a project development checklist and improved education and outreach.

Economic analyses, such as benefit-cost analysis, have long been used by State DOTs as a tool for prioritizing proposed programs and projects. These economic analyses allow practitioners to quantitatively show senior-level management, as well as the public, the value of proposed programs and projects, increasing buy-in from all stakeholders. ADOT has proposed using INVEST to introduce LCA into project and program development and connect sustainability to LCCA as an additional prioritization tool through the LCA PD criteria (PD-02). As described in FHWA's *A Primer On Pavement LCA*, LCA provides a comprehensive approach to evaluating the total environmental burden of a particular product (such as a ton of aggregate) or more complex systems of products or processes (such as a transportation facility or network), examining all the inputs and outputs over its life cycle, from raw material production to the end of the product's life. LCCA evaluates agency expenditures throughout the life of the expenditure, rather than only considering the initial investment. The goal of the LCCA is to promote the efficient use of materials and resources through the informed cost of using a product or implementing a program. LCCA can be viewed as the economic component of both LCA analysis and the three pillars of sustainability. ADOT hopes connecting sustainability to the traditional prioritization tools will launch the discussion of sustainable considerations sooner in the project development process. In addition, improved development of benefit-cost analysis, LCA, and LCCA should form the foundation to explore sustainable return on investment dynamics.

Of the five core strategies that make up the aforementioned work plan, the following one strategy best describes the methodology to encourage and experiment with LCA, LCCA, and EPDs. That strategy is:

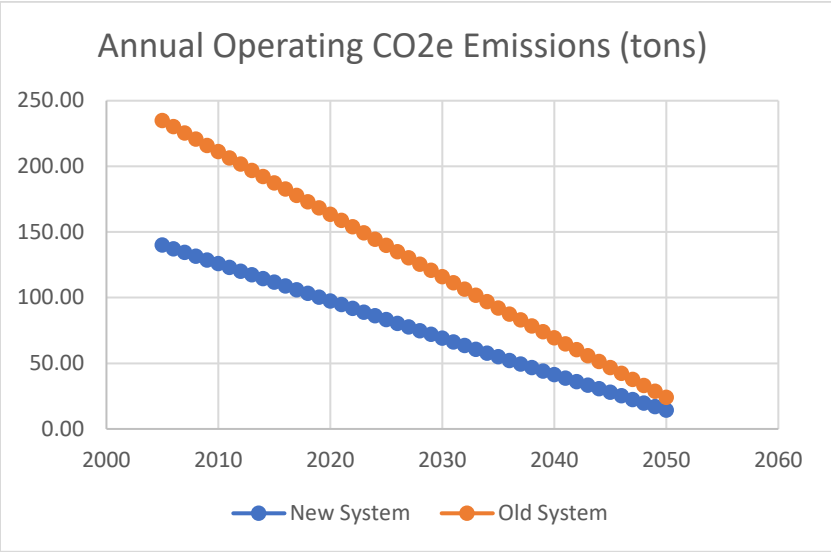
- Develop **quantitative** results using LCA methodologies to investigate the performance of design alternatives compared to commonly-used engineering standards such as FHWA and AASHTO (American Association of State Highway and Transportation Officials) Design guidance, ADOT Standard Specifications for Road and Bridge Construction, ADOT Construction Manual, Project Plans, Project Special Provisions, or other contract documents. The detailed full life cycle impacts can be compared directly with INVEST scoring to develop an understanding of the true costs/benefits of a project and how well INVEST captures those savings (e.g. a 10% improvement in the INVEST score leads to an X% improvement in life cycle savings).

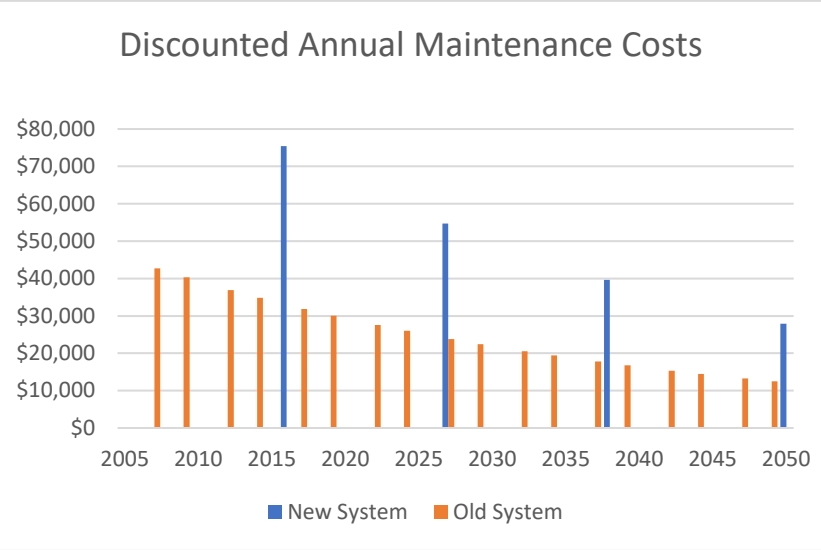
Additional discussion in connection with LCA, LCCA, and EPDs can be found in PART II: ADOT Black & Green Sustainable Pavements Systems Program. The following Case Study summary was the first LCA / LCCA effort undertaken by ADOT. The initial intent was to conduct LCA and LCCA modeling against a series of pavement surface treatments and add EPD efforts as the industry developed them. The long lead time in developing a pavement project caused the project team to identify a different operational category to develop the first effort. LED was a logical next candidate as it was both under current adoption especially in the urban regional freeway system.

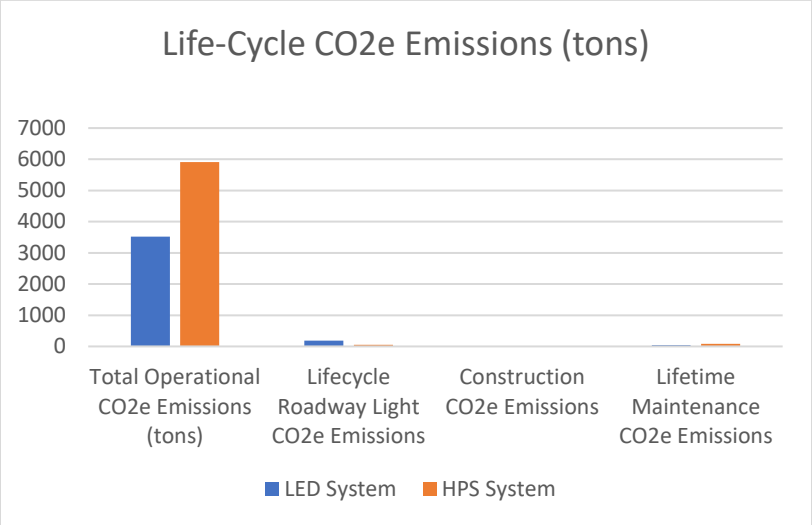
i. Case Study: ADOT Queen Creek Tunnel LCA and LCCA

In 2016, Arizona Department of Transportation (ADOT) installed a Light-emitting Diode (LED) lighting system in the Queen Creak Tunnel along the US 60 east of Superior, Arizona. It was the first tunnel in Arizona to feature LED technologies that would provide energy and cost savings. While LED are known to provide energy and cost savings relative to other technologies, the system is also supported by control systems that adjusts lighting levels and electricity demand based upon ambient light and weather conditions. The new system has significantly improved visibility in the tunnel and lowered operational electricity use and costs relative to the previous system that featured high pressure sodium (HPS) luminaries. The project cost $4.3 million dollars and was partially supported by a federal $1 million-dollar Accelerated Innovation Deployment grant.

Completed in 1952, Queen Creek Tunnel had undergone several lighting improvements over its lifetime. The last upgrade occurred in 1974 when 144 400 watt HPS sodium lights were installed with 72 lining each side. Near the end of its life cycle, the system was faced with increasing maintenance and repair requirements and the system no longer met modern tunnel lighting requirements. Additionally, the configuration of the luminaries along the sides of the tunnel was no longer conducive to large truck traffic. In 2007, ADOT began exploring alternatives to replace the existing system. LED was not yet a viable or cost-effective technology and configurations of HPS fixtures were considered. Due to a lack of funding, the upgrade was shelved for six (6) years. In 2013, ADOT revisited the tunnel lighting project and considered LED technology for the first time. LED offered a number of benefits relative to HPS or other lighting technologies including increase lamp efficacy (lumen/watt), rated service life, and increased correlated color temperature (CCT) resulting in a whiter light improving driver visibility. The design process produced several options based on LED and HPS technologies. Ultimately, an LED design was selected, and construction began in January 2016 and finished in December. The full LCA / LCCA report has been produced and a few results are provided here with further context of each chart available in the report in Appendix A.







Figures 2 - Excerpts of data from Queen Creek LCA and LCCA Case Study

Life Cycle Assessment and Life Cycle Cost Analysis

The benefits provided by LED road lighting systems produce long-term cost savings through reduced electricity demand and maintenance commitments. A reduction in electricity use and maintenance activities also produces environmental co-benefits reducing emissions associated with these elements. However, there are also impacts associated with other phases of the lighting systems light cycle that create non-trivial costs and environmental impacts. LCA and LCCA are approaches used to examine the net effects of policies, services, and products. The holistic approach provided by these two methodologies can better describe the efficacy of LED roadway lighting in producing economic and environmental savings. Life cycle costing focuses on upfront, future, and avoided monetary costs while considering the time value of money. Life cycle assessment focuses on the environmental impacts including impacts associated with material extraction, processing and production, use phase, and end-of-life. The usefulness of these methodologies is that they provide a holistic accounting of potential impacts and can identify costs/impacts and potential tradeoffs that are not obvious. LCA and LCCA can help practitioners identify and select strategies that offer long-term economic and environmental benefits. LCA and LCCA are distinct in their approaches but can be complimentary. There is clear overlap between the methodologies and required inputs, especially for systems that require significant and near-continuous energy use. Using established LCA and LCCA guidelines and methods a tool was developed to provide quantitative results to measure life-cycle costs and emissions of roadway lighting systems and evaluate the efficacy of technology transitions in producing long-term savings and environmental benefits. Appendix A includes:

Life Cycle Assessment and Life Cycle Cost Analysis of the Roadway Lighting Conversion in Queen Creek Tunnel – Action Plan

In order to establish the first ever agency LCA that also included an LCCA component a 90-day action plan was developed at the outset. The plan describes the data requirements and workflow for completing the assessment of the Queen Creek Tunnel roadway lighting system. The assessment relied on the generalized LCA and LCCA model developed for assessing roadway lighting systems but used project specific data. The data requirements and workflow described is applicable for all other roadway lighting analyses.

LED LCA LCCA Lighting Pilot – Case Study

Converting LED technologies for roadway lighting can produce economic and environmental savings through the use phase of the system. However, there are also impacts associated with other phases of the lighting systems light-cycle that create non-trivial costs and environmental impacts. LCA and LCCA are approaches used to examine the net effects of policies, services, and products. ADOT is engaged in the early stages of converting existing High Pressure Sodium (HPS) roadway lighting system to LED. The existing roadway lighting

system operated and maintained by ADOT features more than 28,000 luminaries with an operating cost of approximately $4 million dollars (2015). The conversion is expected to produce energy, greenhouse gas emission, and cost savings over the lifespan of the LED system due to reductions in electricity demand and maintenance. Project Development 17 (PD-17) of FHWA's INVEST tool is specifically designed to promote economic and environmental gains through lighting conversion or on-site renewable power sources. A case study was developed to give an introduction to the topic and address deliverables in the grant work plan.

Queen Creek Tunnel LCA LCCA Final Report

The objective of the final report is twofold: 1) Assess the long-term costs and emissions (CO_2e) benefits of the transition to LED lights in the Queen Creek Tunnel and 2) Develop a simple tool that can be used to estimate costs and emissions associated with other roadway lighting systems. While the specifics of roadway lighting systems are likely to vary from one system to another there are principal components that are expected to have significant impact on the results of LCA and LCCA assessments. The use phase is generally considered to be the most impactful phase both in terms of cost and environmental impacts across lighting technologies. The principle components are discussed in the final report and are ordered based on their expected relative impact on the results.

ADOT considered several options to upgrade the Queen Creek Tunnel lighting system. The options included both HPS and LED technologies and a variety of luminary placement options. The installed LED system was compared with the lowest cost HPS system. In addition to significant upfront cost savings (approximately $1.2 million) it is estimated that the LED system will yield long-term cost and environmental benefits. The life cycle cost savings (out to 2050) of the LED system when compared with the HPS alternative is $2.8 million and saves 3654 tons of CO_2e emissions. While life cycle CO_2e savings are dominated by savings in operational electricity usage (97%), cost savings are more evenly distributed across upfront (41%), maintenance (37%), and operational (22%) savings More information on the results and this information is available in Appendix A.

LED LCA and LCCA Estimator Tool Presentation

As part of the LED LCA LCCA project was the development of a Lighting LCA and LCCA Estimator Tool which was created using the Queen Creek Tunnel lighting project. The tool uses basic inputs describing roadway lighting systems to estimate Life Cycle Emissions and Life Cycle Costs. It is designed to directly compare LED and HPS lighting technologies or analyze each separately. The tools inputs, outputs, interface, and results graphing are described in a presentation found in Appendix A.

III. Sustainability Indicators, Performance Measurements, and Executive Decision Maker Dashboard Project – Texas Transportation Institute (TTI) - Center for Advancing Research in Transportation Emissions, Energy, and Health

One of the most progressive and forward thinking efforts of this grant opportunity and a large part of ADOT's Sustainable Transportation Program goals is this partnership. In fact, the original one year pilot agreement has now been extended to 2025. One of the progressive goals is to map the local, state, and regional ADOT Sustainable Transportation Program responsibilities to national transportation activities and the United Nations Sustainable Development Goals (SDGs). The partnership will provide sustainable transportation program level quantitative methodology for the development of indicators, performance measures, and an executive decision maker dashboard that leverages existing ADOT Sustainable Transportation Program material; and the economic analysis, benefit cost analysis (BCA), LCA, LCCA, and return on investment (ROI) methodologies and capabilities being developed by other parties on the project. The program level indicators, performance measures, and an executive decision maker dashboard are developed to contribute to expediting and improving ADOT's overall efforts in developing a family of measures and metrics for sustainable transportation civil engineering infrastructure projects. This TTI effort will have a particular overall focus on establishing indicators, performance measures, and an executive decision maker dashboard for the ADOT Sustainable Transportation Program, quantitatively contribute to the FHWA INVEST Program, and leverage TTI's excellence in the area of emission, energy, and health.

IV. Case Study: Use of Invest Scoring for ADOT I-11 Tier 1 Environmental Impact Statement (EIS)

ADOT, in partnership with the FHWA utilized the latest version of INVEST (1.3) on numerous agency projects and programs in varying stages of development to document, explore, and identify sustainability elements of projects for incorporation for multiple years. ADOT and FHWA are currently conducting the environmental review process for the Interstate 11 (I-11) Corridor from Nogales to Wickenburg, in various counties within Arizona. An Alternatives Selection Report (ASR) and Tier 1 Environmental Impact Statement (EIS) are being prepared as part of this process in accordance with NEPA and other regulatory requirements.

The study is unique in that a "tiered EIS" process has been used to assess a study area that expands approximately 280-miles. Initially, the ASR assessed a range of corridor alternatives through programmatic level evaluation process that used extensive public and agency input, innovative public outreach methods, previous studies, and various topographical, environmental, and other planning information to help identify opportunities and constraints. The study also used a software program called Quantm, which is used to design roadway and railway alignments. The software uses topographic information, engineering design criteria, and environmental constrains to generate a list of optimized alignments.

These were reduced to a reasonable range and carried forward into the Draft Tier 1 EIS for more detailed environmental review, as further explained in the memorandum in Appendix B.

The goal of this specific I-11 INVEST memorandum was to document and complete a case study that focused on the use of INVEST with three Build Corridor Alternatives currently under an environmental study as part of the FHWA and the ADOT Interstate 11 (I-11) Tier 1 EIS. Additionally, ADOT sought to complete this effort through a process that explored and identified innovation through potential ways the INVEST tool can link sustainability and the NEPA process, inform future Tier 2 design efforts, and influence overall ADOT sustainable transportation program implementation processes. Because the study is 280-mile in length, the corridor alternatives were assessed using the Project Development (PD) – Urban Extended scorecard, System Planning for State (SPS) and Innovative Criteria. Combining the criteria of these two modules and the innovative criteria for this case study was done due to the length of this project extending through multiple major metropolitan and planning organizations, to identify the "above and beyond" aspects of the project that should be highlighted, and to identify through this case study if there were opportunities within the INVEST tool to incorporate higher level sustainable planning considerations into the traditional project development framework for large NEPA studies.

As mentioned, considering opportunities to link sustainability and NEPA through the INVEST tool was valuable for this case study, and as a result the evaluation included not only Project Development criteria, but also System Planning for States criteria, and three additional innovative criteria identified as part of the Tier 1 EIS study. Based on the qualitative assessment and corridor evaluation being done at this Tier 1 level, each of the three Build Corridor Alternatives scored the same. This was due to the fact that the NEPA evaluation focused on a broad assessment of all three corridors at a high programmatic level and the project development information was the same at the corridor planning level. The three innovative criteria provided additional potential points for the scoring assessment. This cross-utilization of criteria from different modules allowed for the Tier 1 EIS study to identify the relevant sustainability considerations at this Tier 1 level, and allowed for more flexibility in scoring than was provided in the Project Development module only.

Some of the key takeaways from this unique INVEST case study evaluation was:

- **The need in future INVEST versions to include a new dedicated "Corridor Planning" and/or "Environmental Study" module**. All three I-11 Build Corridor Alternatives received the same scoring for the Project Development Module for each criterion because the INVEST scorecard is structured based on the process followed, not a comparative evaluation of the results of the process. Therefore, since all three were compared using the same process as part of the I-11 Tier 1 EIS, the use of one single module does not provide enough detailed differentiation measures to contribute to a decision on an alternative. If a new module could incorporate elements of the Project Development criteria that are still relevant in early design, along with larger

System Planning and innovative criteria that could be applicable to larger environmental NEPA studies that are at a conceptual or pre-design stage, it is anticipated that some differentiation of alternatives could be identified that could help with a comparison of alternatives in the environmental analysis process. Alternatively, a flexible criteria approach could be created to allow INVEST users to create their own project criteria for certain projects at different design or study stages.

- **Incorporating INVEST into the pre-design and environmental study process identified opportunities for discussion on sustainable design practices that can inform future design phases**. The cross-utilization of criteria from different modules allowed for the Tier 1 EIS study to identify the relevant sustainability considerations that could be followed up on in future Tier 2 studies and final design stages of the project. Some of these elements included more construction related criteria such as construction environmental training, noise mitigation, and infrastructure resiliency and design. This information was captured in the appendix of each case study in the criteria application notes, and was documented as being an item to follow up on in later design stages.
- **Cross utilization of criteria in the INVEST tool allowed for education on sustainable practices that could be incorporated at a high level planning and project development stage.** While ADOT has many different transportation project studies and evaluations at different levels, the cross utilization of criteria in this case study allowed the project team to identify sustainability elements that could be or were incorporated as part of the Tier 1 process as well. This not only allowed us to identify successes in the Tier 1 process, but also allowed ADOT to identify new standard practices that could be incorporated into future studies as well. For example, criteria such as "Integrated Planning" that is System Planning for States module was relevant and appropriate for this large corridor EIS for ADOT to consider coordination with local and regional planning entities when considering the Tier 1 effort and future Tier 2 projects.

In conclusion, regardless of the type of planning/environmental review process, revisiting the INVEST criteria at the start of each project phase is ideal to continue to integrate sustainability elements into a project and maintain sight on the goals and potential sustainability solutions. Combining the elements of planning, programming, and project development design with NEPA in this INVEST tool created an evaluation that considered the NEPA and sustainability linkage process from the first step to a second step lifecycle process of a project.

V. Case Study: Use of INVEST Scoring for ADOT State Route 30 Environmental Assessment (EA)

Since 2005, ADOT has been studying State Route 30, a proposed new freeway corridor that would serve as an alternate route to Interstate 10. The study area extends through the city of Goodyear, Avondale, Phoenix, and portions of unincorporated Maricopa County for about

13-miles along the Gila and Salt Rivers to the north and south. In early 2019, after carefully considering the findings from the multi-year screening process that evaluated twenty-four (24) environmental and engineering criteria, eight (8) cost and right of way criteria, and the public and agency feedback received during a Spring 2019 Public Hearing, ADOT identified a Recommended Alternative. A Final EA and finding of no significant impact (FONSI) was completed in 2019.

For SR 30, the INVEST PD module was used to score its current level of sustainability because it is a transportation project. The PD module includes criteria that span the entire project development process from early planning, alternatives analysis, environmental documentation, preliminary and final design, to construction. The SR 30 study area is located in a rapidly growing and urbanizing area in the western part of Phoenix and the adjacent towns of Avondale and Goodyear. Agricultural land currently exists within the SR 30 study area, but it is rapidly transitioning to residential subdivision and commercial land uses. By the proposed SR 30 design year in 2040, the general plans for Phoenix, Avondale, and Goodyear anticipate that much of the existing agricultural land will have been developed into urban land uses. The scorecard that best meets the needs of the SR 30 project is Urban Extended. The Urban Extended scorecard requires that all thirty-three (33) criteria of the PD module be evaluated and scored. The score for the SR 30 project was fifty-seven (57) points, which was Silver on the INVEST Achievement Level, which is detailed in Appendix B as part of the SR 30 INVEST memorandum.

Several key outcomes and points were noted as part of the preliminary design stage of this project:

- **Context Sensitive Project Development**: Context-sensitive solution principles were incorporated into the SR 30 preliminary design to address identified constraints to the extent possible
- **Habitat Restoration**: The Salt, Gila, and Agua Fria Rivers are within the SR 30 study area but have only intermittent annual flow. Much of the natural riparian habitat has been disturbed by other uses, such as quarry operations. The Tres Rios Flow Regulated Wetlands Complex is a High Quality Aquatic Resource located between 99th and 91st Avenues and adjacent to the City of Phoenix 91st Avenue Wastewater Treatment Plant. The SR 30 Recommended Alternative was aligned to avoid impacts on this complex and is located within 100 feet of its boundary. Additionally, the preliminary design includes a drainage facility to drain stormwater away from the complex to prevent potential freeway runoff from affecting the complex.
- **Stormwater Quality and Flow Control:** Given the location of SR 30 in relation to the Salt, Gila, and Agua Fria Rivers and other resources that include the Tres Rios wetlands and levee in the SR 30 study area, drainage was an important consideration in the study. The flow control was developed using a peak flow basis, using a worst-case scenario of a 100-year flood, although the ADOT standard is a 50-year flood. For water quality, the on-site stormwater collection system was developed based on ADOT Best Management Practices. With regard to managing

the runoff volume, this project is managing 100 percent of the flows from the project site and, in addition, is collecting and managing the off-site flows that cross the corridor.

- **Ecological Connectivity**: The Recommended Alternative was selected over the Southern Alternative, which would have been located in close proximity to the Salt River. Wildlife connectivity was evaluated in the Biological Evaluation and Draft Environmental Assessment.
- **Transit and HOV Facilities**: The third phase of the SR 30 project implementation would widen the 3+0 section (three general purpose lanes in each direction) constructed in the second phase to a 4+1 section (four general purpose lanes and one HOV lane in each direction) in the median of SR 30 when travel demand warrants it, and when funding is available. The fourth and final phase would involve a high-capacity transit corridor, the space for which is being preserved inside the SR 30 right-of-way footprint for some future date and future mode.
- **Freight Mobility**: SR 30 would increase the movement of freight because this is a new limited-access freeway and would reduce truck traffic on the local arterial street system and would provide an alternative route to Interstate 10, which currently accommodates a high percentage of trucks with a poor level of service during peak travel times
- **ITS for System Operations**: This score is based on the ITS applications typically used on the Phoenix freeway system that are constructed, operated, and maintained by ADOT
- **Site Vegetation, Maintenance and Irrigation**: ADOT has a native plant-only seeding policy within right-of-way areas. ADOT requires contract specifications for the control of noxious and invasive plant species. Additionally, these requirements have been diversified from just grass seeding for erosion control to now include annual and perennial wildflowers, forbs, and shrubs to more closely resemble Arizona's diversified native roadside vegetation.
- **Long Life Pavement**: The SR 30 Design Concept Report has a roadway typical section that would be paved with long-lasting Portland cement concrete pavement (PCCP) and overlaid with a rubber asphalt friction course. ADOT standard specifications include a pay incentive for pavement smoothness as well.
- **Construction Quality Control Plan**: ADOT construction contracts pay for a contractor quality control item to ensure quality compliance beyond field inspection. ADOT will also pay premiums for material quality that far exceeds the minimum.
- **Educational Outreach**: ADOT incorporated sustainable transportation language into the NEPA process as part of the public hearing for the EA through a presentation and public involvement effort

SR 30 is currently in the preliminary design phase and future studies will be in determined at later stages. In the future programming stages, ADOT will re-evaluate this assessment as the project progresses through the various stages of design and public involvement through

final design and construction. It is possible that the SR 30 project may achieve a higher sustainability score through the use of current INVEST PD best practices such as pedestrian facilities, bicycle facilities, or other sustainable goals such as energy efficiency.

VI. Case Study: Use of INVEST Scoring for Sonoran Corridor Tier 1 EIS

In February 2017, FHWA and ADOT initiated an environmental review process for the Sonoran Corridor, which would connect Interstate 19 and Interstate 10 south of the Tucson International Airport in Pima County, Arizona. A Corridor Selection Report (CSR), which evaluates a range of reasonable alternatives and Tier 1 EIS were prepared as part of this process in accordance with the National Environmental Policy Act (NEPA) and other regulatory requirements. The project objective is to identify an appropriate and approximate 2000-foot corridor for a future roadway that would be subject to a detailed design and a Tier 2 environmental review to identify a final roadway alignment and necessary project mitigation treatments.

ADOT used this case study evaluation processes and the INVEST tool for the development of the Sonoran Corridor Tier 1 EIS and for comparison to INVEST guiding principles, as shown in Appendix B. In addition, this specific analysis of INVEST related to the Sonoran Corridor Tier 1 EIS was used to determine the suitability of applying INVEST at varying stages of project development for future transportation projects in Arizona. The overall goal from an agency perspective is to incorporate these elements into early planning and development efforts to position projects to address critical triple bottom line elements of sustainability. For this specific evaluation, the alternatives were evaluated against a mix of System Planning for Regions (SPR) INVEST criteria and PD –Rural Extended criteria that were most applicable to the high level NEPA planning process. This evaluation of a mix of criteria allowed for an evaluation that helped define sustainability expectations and potential improvements for further Tier 2 studies, explore the potential linkages between NEPA studies and the INVEST tool, and allowed ADOT to evaluate the range of capabilities that is available at a Tier 1 level, as well as other criteria that can be identified for further evaluation in future studies at Tier 2.

Some of the key takeaways from this unique INVEST case study evaluation was:

- **Incorporating INVEST into the high level environmental study process at Tier 1 identified successes at the early Tier 1 stage and opportunities for further advancement in Tier 2.** While some criteria scoring had minimal points due to the fact that the INVEST criteria were not directly applicable to the Tier 1 EIS process, this effort showed that at a high level NEPA study phase, opportunities for incorporation of sustainability INVEST criteria generated a total of over 60 points from a range of different modules and INVEST criteria. This results show that early use of the INVEST tool is advantageous to the Tier 1 process for identifying the triple bottom line principles of sustainability early on, and identifying where potential strong points can be built upon in Tier 2. Multiple criteria within the evaluation were noted as being applicable and beneficial to the design process in Tier 2.

- **Cross utilization of criteria in the INVEST tool allowed more flexible scoring than the traditional PD module for transportation projects does, and more applicable considerations from a high level NEPA study viewpoint.** Planning considerations under the SPR module for criteria such as Planning and Environmental Linkages (SPR-17) and Access and Affordability (SPR-05) were regarded as highlights at this Tier 1 level of study and were identified as noteworthy criteria to follow up with in later Tier 2 project stages. Although these criteria are normally suited for metropolitan area planning efforts or long range planning, the high level NEPA study process that was undertaken for the Sonoran Corridor showed that there were relevant planning linkages that could be applied in the INVEST tool to these types of projects as well.
- **The case study INVEST evaluation presented opportunities for improvement in future ADOT NEPA planning studies and best practices for methodology assessments.** Although some criteria in the evaluation were found not to be applicable to a Tier 1 EIS due to the high level preliminary design NEPA stage of the study and the 2,000-foot-wide corridor, opportunities were identified for ADOT that could be considered in high level detail in future NEPA studies. For example, some criteria such as PD Criteria-31 for Infrastructure Resiliency for planning and design were not considered as applicable to the Sonoran Corridor Tier 1 EIS process, but could be at a high level in future NEPA study in a qualitative manner according to the criteria requirements. This kind of criteria would help not only inform agency risk, but also cost considerations and other environmental factors relevant to the Tier 1 NEPA process.

VII. Use of INVEST Scoring for ADOT Project on Interstate 17, Anthem Way to State Route 69

ADOT has completed a design concept report and environmental documentation for improvements to a segment of Interstate 17 (I-17). This section of I-17, designated the "Arizona Veteran's Highway" in 2004, currently consists of two lanes in each direction, traversing rolling terrain in the southern and northern segments and mountainous terrain in the middle segment. I-17 is part of the National Highway System and connects I-10 with I-40, two of the nation's principal east-west interstate highways. I-17 also provides the major connection between Phoenix and communities in northern Arizona. This project is exploring various means of adding capacity and improving operational safety to I-17. The goal of this evaluation was to document the use of the INVEST scoring application on I- 17 – Anthem Way to State Route 69 project, as seen in Appendix B of the I-17 INVEST Memorandum.

The Project Development – Rural Extended Scorecard was used for the INVEST scoring of this project. The Urban Extended scorecard is for rural projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of I-17 and include some new right-of-way, temporary construction easements, or major construction work needed, ADOT evaluated this based off the thirty-

three (33) criteria available for the scorecard. Based on the assessment completed for the INVEST scoring in Appendix B, the project received a score of eighty-eight (88) points, which identifies the project as a gold rating.

Several key outcomes and points were noted as part of the preliminary design stage of this project:

- **Economic Analysis**: With planned Interstate 17 improvements for some parts of the study set for construction starting by 2021, the state budget approved by state lawmakers and signed by Governor Doug Ducey provides the additional funding needed to also additional improvements for the project. This $130 million investment to complete new third lanes in both directions of I-17 between Anthem and Black Canyon City is one of many in the budget that will expand and preserve transportation infrastructure across Arizona. More than $190 million was already committed the project, and investing an additional $130 million over three years will allow ADOT to complete all sections of new third lanes between Anthem and Black Canyon City. This increased capacity will enhance safety and help address traffic flow challenges and backups that occur due to crashes and when many drivers are traveling to or from Arizona's high country on summer weekends. In order to facilitate the projected $330 million cost extensive cost benefit and due diligence was completed. The Maricopa Association of Governments (MAG) is providing $50 million in regional funds to help fund the widening of I-17 between Black Canyon City and Anthem.
- **Context Sensitive Project Development:** Due to the fact that the project occurs on Bureau Land Management (BLM) land, context sensitive project development was needed to ensure the quality, cohesion, and character remained. The project required the ADOT and BLM participation and partnering. The Agua Fria National Monument, administered by the BLM, is located within the study area. In addition, the Upper Agua Fria Watershed Partnership (UAFWP) and the Arizona Department of Water Resources (ADWR) began encouraging rural areas to form grassroots regional watershed groups to function as water study and management units outside the Active Management Areas (which are mostly urban). Coordination with this group is also ongoing as it relates to future construction phase water use.
- **Highway and Traffic Safety:** The mountainous terrain presents challenges related to steep grades and horizontal curves with limited sight distance in this project area. In addition, crashes can result in closures of I-17 that cause lengthy travel delays along the route. I-17 experiences heavy volumes during weekends and holidays as the main route for traffic between the Phoenix metropolitan area, Flagstaff, and recreational destinations to the north. The combination of large volumes of passenger cars, trucks, and recreational vehicles results in a substantial speed differential condition on the steep grades of the Black Canyon Hill. This condition affects the operational capacity of the interstate and results in congestion and long traffic back-ups. There are distant detour options for long-term closures; however, there are no alternate routes in the area for short-term closures. As a result of these

conditions, a comprehensive highway and traffic analysis safety analysis was completed for many years to assess the traffic projections and necessary improvements.

- **Site Vegetation, Maintenance and Irrigation**: The native plants surrounding the I-17 corridor are a significant resource that provide soil stabilization and wildlife habitat, and act as visual interest. During final design, efforts will be made in areas of disturbance to salvage and replant suitable species. In addition, a native plant inventory will be completed, as well as a noxious and invasive species control plan.
- **Energy Efficiency**: Light Emitting Diode (LED) luminaires with a correlated color temperature of 3,000k and zero uplight should be used on this project to be in accordance with the Dark Skies recommendations. As part of the ADOT Sustainable Transportation Program Life Cycle Assessment (LCA) and Life Cycle Cost Analysis (LCCA) and the recent INVEST grant an LED LCA LCCA was executed to form the basis of all future LCA and LCCA lightning.
- **ITS for System Operations**: The design concept report outlines the ADOT Prescott District's main traffic management concerns. These include interagency communications, real-time traffic monitoring for the I-17 corridor, traveler information systems, and weather forecasting to give the driver real-time accurate information. In addition, other ITS improvements such as CCTV monitoring, wildlife presence detection, flood detection sensors, portable DMS signage, and bridge deck icing monitors were also considered.

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area for ADOT. Some opportunities that could be considered but will be considered in final design stage include items such as light pollution minimization, low impact development for storm water management, earthwork balance, and recycling of materials. Additionally, an ADOT agency goal in future projects would be to introduce sustainability earlier into the design concept and NEPA stage, with an emphasis on education to the public on ADOT's sustainability efforts and considerations.

VIII. Use of INVEST Scoring for ADOT Project on State Route 179

This transportation project is located along State Route 179 (SR 179) from approximately MP 299 to MP 305 in Yavapai County, Arizona. The project length is approximately six (6) miles on SR 179 from MP 302.5 near Dry Beaver Creek Bridge and north through the project area is part of the National Scenic Byway System – Red Rock Scenic Byway. The project scope of work includes a variety of preservation activities such as pavement preservation, striping, rumble strips, guardrails, access turnouts and more. The project construction is estimated to cost $5,520,000. The goal of this project INVEST memorandum is to document the use of the INVEST scoring application on the SR179, I- 17 – Red Rock Vista pavement preservation project using the Project Development (PD) using the Rural Basic Scorecard.

The Project Development – Rural Basic Scorecard was used for the INVEST scoring of this project. The Rural Basic scorecard is for small, rural reconstruction or rural bridge replacement projects that do not expand capacity of the roadway. As this project is a

pavement preservation project with no new right-of- way, temporary construction easements, or major construction work needed, ADOT evaluated this based off the twenty-three (23) criteria available for the scorecard the final design stage of the project with the project engineers and key environmental staff. As shown in Appendix B in the SR179 INVEST memorandum, the project scored forty-nine (49) points for a silver rating.

Several key outcomes and points were noted as part of the design stage of this project:

- **Context Sensitive Project Development**: The project is located within an identified National Scenic Corridor (Red Rock All American Road) on Coconino National Forest, context sensitive project development was needed to ensure compliance with the US Forest Service scenic objectives, and compliance with the 2005 Corridor Management Plan
- **Habitat Restoration / Ecological Connectivity**: The ADOT team designed the project to avoid impacts to sensitive water and biological resources as this project is located on a National Forest
- **Scenic, Natural, and Recreational Qualities**: As mentioned earlier, this project is located within a national Scenic Corridor (Red Rock All American Road) and required coordination with the Coconino National Forest to ensure efforts were made to preserve, protect, and enhance the features of the area during and after construction
- **Long Life Pavement**: This criterion was met since the project is primarily pavement preservation and is focused on preservation of the pavement by application of long-lasting PCCP and overlaid with a rubber asphalt friction course. ADOT standard specifications include a pay incentive for pavement smoothness for both PCCP and the friction course as well.
- **Site Vegetation, Maintenance, and Irrigation**: Consideration and implementation of re-seeding with non-invasive and non-noxious species is a standard Best Management Practice (BMP) for ADOT and is followed for every project where needed

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area due to the high level of recreation, biological, cultural, and environmental considerations in the project area. Some opportunities that could be considered that were not in this final design but could be identified for future projects include items such as earthwork balance, recycling of materials, and construction equipment emission reduction. Due to the location of this project within the Coconino National Forest and the limited scope of work, some of these criteria were difficult to implement because of the constraints of development, costs, mobilization, and construction. Additionally, an ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with emphasis on education to the public and stakeholders on ADOT's sustainability efforts and considerations.

IX. Use of INVEST Scoring for ADOT Project on US Highway 93

This transportation project is located along United States Highway 93 (US 93) near the town on Wickenburg, Yavapai County, Arizona. ADOT, in coordination with FHWA, previously completed a design concept report (DCR) and accompanying environmental assessment (EA) for safety and traffic improvements along US Highway 93 (US 93). The project is now in final design and includes the Preferred Alternative recommendations and additional safety improvements for signage, drainage, and pavement. The project cost is estimated at $49,000,000.

The goal of this project INVEST memorandum was to document the use of the INVEST scoring application on the US 93 project using the Project Development (PD) module using the Rural Extended Scorecard. The Rural Extended scorecard is for rural projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of US 93 and includes new right-of-way, temporary construction easements, or major construction work needed, ADOT evaluated this based off the twenty-eight (28) criteria available for the scorecard with the final design project team. To achieve a minimum bronze rating for the Project Development Rural Extended scorecard, a project needs to be awarded a minimum of 46 points. Based on the assessment completed for the INVEST scoring in Appendix B for US 93, the project received a score of sixty-one (61) points, which identifies the project as a silver rating.

Several key outcomes and points were noted as part of the design stage of this project:

- **Context Sensitive Project Development**: The design required consideration of color, texture, aesthetic considerations, and input from the Town of Wickenburg and other stakeholders. Landscaping for roundabout features, art, and implementation of features such a multi-use path were part of the project design to ensure context sensitive development
- **Highway and Traffic Safety**: One of the major purposes of this project was to improve traffic and safety operations through this stretch of US 93 to reduce the potential for crashes and allow for improved intersection movements. During the initial design concept and final design stages of this project, information related to safety was provided to the public by ADOT regarding the proposed improvements.
- **Habitat Restoration / Ecological Connectivity**: Biological analysis was a large focus for ADOT since this the project was in areas near critical habitat and sensitive resources within the Hassayampa River
- **ITS for System Operations**: ITS systems such as managed lanes, roundabouts, variable speed limits, and vehicle restrictions were implemented to facilitate proper speeds and safety through the project area
- **Site Vegetation, Maintenance, and Irrigation**: Consideration and implementation of re-seeding with non-invasive and non-noxious species is a standard Best Management Practice (BMP) for ADOT and is followed for every project where needed. This is a success area for ADOT for many years

Some opportunities that could be considered that were not in the initial design stages and final design stage include items such as light pollution minimization, low impact development for storm water management, earthwork balance, and recycling of materials. Due to the rural location of this project, some sustainability criteria such as scenic, natural, and recreational qualities were difficult to implement due to limited resources and population growth. However, the rural project area could benefit from considerations of reduced light pollution, and low impact development especially near the Hassayampa River and near the Town of Wickenburg. Additionally, an ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with an emphasis on education to the public and stakeholders on ADOT's sustainability goals and efforts.

X. Use of INVEST Scoring for Interstate 10 Broadway Curve EA

The project is located along Interstate 10 (I-10) is located within the cities of Phoenix, Tempe, Chandler, and Town of Guadalupe in Maricopa County, Arizona. ADOT, FHWA, and MAG has evaluated improvements to I-10 through this corridor for numerous years through various studies. The preferred design alternative concepts that were identified in the past studies and evaluated in the current EA include the construction of collector-distributor roads (C-D), with other improvements such as the addition of general purpose lanes, high-occupancy vehicle lanes (HOV), reconstruction of interchanges, and other improvements such as pedestrian facilities and improved infrastructure technology systems. The project EA process completed and will proceed under a design-build alternative construction delivery method in 2020. The project cost is estimated at approximately $534,000,000.

The goal of this project INVEST memorandum was to document the use of the INVEST scoring application on the I-10 Broadway Curve project using the Project Development (PD) using the Urban Extended Scorecard. The Urban Extended scorecard is for urban projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of I-10 through a major metropolitan area, includes new right-of-way, temporary construction easements, and major construction and traffic control work needed, ADOT evaluated this based off the thirty-four (34) criteria available for the scorecard with the project design team. Based on the assessment completed for the INVEST scoring as seen in Appendix B of this report in the Broadway Curve Memorandum, the project received a score of seventy-three (73) points, which identifies the project as a silver rating.

Several key outcomes and points were noted as part of the design stage of this project:

- **Context Sensitive Project Development**: The study area has an average daily count of over 200,000 vehicles a day and is an important regional corridor for the Maricopa County region, so context sensitive design through the implementation of new pedestrian features, bridges, sound walls, traffic control planning, and comprehensive planning for public engagement through construction. A robust

team of technical experts from environmental, local jurisdictions, design engineers, and public involvement specialists were involved in the planning of this project.

- **Pedestrian Facilities:** New pedestrian facilities were considered at two locations within the study area to accommodate existing pedestrian linkages and public park facilities. Additionally, upgrades to existing facilities were incorporated into the project as well. These facilities were included as a result of public and stakeholder feedback on the project, and design and aesthetics of new pedestrian structures will be coordinated with the public for their input as well.
- **Habitat Restoration / Ecological Connectivity:** Although the area is mostly developed, consideration of minimizing impacts to aquatic resources was required due to the area being within the Salt River and Tempe Drain. The project team assessed alternatives to avoid impacts to aquatic features such as wetlands within the study area. After further consideration from design team, an alternative was chosen that would avoid all impacts to high quality aquatic resources (HQAR).
- **ITS for System Operations**: Due to the fact that this project's purpose and need focused on maintaining the functionality of this major corridor, the study team sought to identify strategies that would improve the efficiency of movement through this area through the deployment of intelligent transportation systems (ITS) technology
- **Construction Noise Mitigation:** Due to the high amount of residential and businesses within the study area, the ADOT project team has implemented requirements in the technical provisions and Final EA for the developer of the design-build process to implement a construction noise assessment memorandum that will address noise sensitive areas and identify project specific mitigation measures to reduce noise complaints and conflicts during construction. In addition to this, the contractor will monitor noise throughout construction at noise sensitive locations and follow all local jurisdiction noise ordinances.
- **Construction Quality Control Plan**: Due to the design-build alternative construction delivery method on this project, the ADOT project team has identified requirements in the developer's technical provision contract for the creation and implementation of a construction quality control management plan.

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area. Some opportunities that could be considered that were not in this final design stage include items such as: low impact development for storm water management, earthwork balance, recycling of materials, lifecycle cost analysis, educational outreach, and long-life pavements. Due to the location of this project, some of these sustainability criteria mentioned were difficult to implement due to the limited amount of right-of-way (ROW) currently available within the project area and other local area constraints. Others not accounted for in this scoring effort such as lifecycle cost analysis and long-life pavement could be considered as beneficial for consideration in future ADOT projects within this study area due to the high traffic counts and overall use of the transportation system within this area. The alternative construction delivery method of this

project as a design-build was a unique design process that allowed ADOT to consider the social, environmental, and economic aspects of the project in more detail as opposed to the traditional design and construction advertisement process; for example, construction noise mitigation was a large consideration from an economic standpoint as it considered a benefit to the agency in reducing public noise complaints response time savings, mitigation costs, and overall support from the public and stakeholders. As previously mentioned, a continued goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with an emphasis on education to the public of the social, economic, and environmental benefits of considering sustainability in design.

XI. Use of INVEST Scoring for State Route 189 EA

The project is located in the City of Nogales in Santa Cruz County, Arizona. The project begins at the SR 189 southern terminus of the Mariposa Port-of-Entry (POE), and extends northeast to the existing SR 189/Interstate 19 (I-19) traffic interchange (TI), continuing past the TI to end at the intersection with Grand Avenue (MP 3.75). SR 189 provides direct access between the Mariposa POE and the numerous warehousing and light industrial centers in Nogales. The Mariposa Port of Entry saw about $24.1 billion in imports and exports in 2018, and up to 1,800 commercial trucks a day use SR 189 during winter months. The project purpose is to improve vehicle access, circulation, and freight mobility within the Mariposa POE. The project includes improvements such as construction of fly over ramps, roundabouts, pavement widening, and raised medians to improve the existing intersections and movement through the area. The project is in the final design stage, and is estimated to go to construction in 2020. The project cost is estimated at approximately $134,000,000.

The goal of this project INVEST memorandum was to document the use of the INVEST scoring application on the SR189 EA project using the Project Development (PD) criteria using the Urban Extended Scorecard. The Urban Extended scorecard is for urban projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of SR189 and I-19 through a major commercial area, includes new right-of-way, temporary construction easements, and major construction and traffic control work needed, ADOT evaluated this based off the thirty-four (34) criteria available for the scorecard with the project design team. Based on the assessment completed for the INVEST scoring as seen in Appendix B of this report in the SR189 International Border to Grand Avenue memorandum, the project received a score of 68 points, which identifies the project as a bronze rating.

Several key outcomes and points were noted as part of the design stage of this project:

- **Context Sensitive Project Development**: The study area has an average daily count of over 300,000 trucks a day and is an important regional corridor for the Arizona and southwest region for commercial and trade, so context sensitive design through the implementation of aesthetic consideration for new bridges was important for Mariposa International Commerce and Industry Park and Centro Commercial areas. A team of technical experts from environmental, local jurisdictions, design

engineers, and public involvement specialists were involved in the planning of this project and will continue to be as the design progresses to construction

- **Freight Mobility**: The projects proposed flyover ramps will provide commercial freight traffic the direct access needed between SR189 and Interstate 10 highway, and allow the local arterial roads to better service the transportation needs of the local community
- **ITS for System Operations**: Due to the fact that this project's purpose and need focused on maintaining the functionality of this major corridor, the study team sought to identify strategies that would improve the efficiency of movement through this area through the deployment of intelligent transportation systems (ITS) technology. Measures identified as a result of this effort include fiber optic/wireless system technology, CCTV (closed-circuit television cameras), speed detectors, and work zone management.
- **Highway and Traffic Safety**: Before this project, there have been several evaluations completed to evaluate the safety of the SR189 corridor. This included comprehensive studies like the 2008 Connector Route Study that evaluated the need for improved access and safety of the existing SR 189 area. For this current study and project, an additional quantitative evaluation was completed specifically for traffic operations in a 2016 traffic report for the project.
- **Stormwater Quality and Flow Control**: Due to the design-build alternative construction delivery method on this project, the ADOT project team has identified requirements in the developer's technical provision contract for the creation and implementation of treating runoff through the project area. As described in the contracting documents, the contractor will manage and treat approximately 80% percent of the runoff flow.
- **Construction Quality Control Plan:** Due to the design-build alternative construction delivery method on this project, the ADOT project team has identified requirements in the developer's technical provision contract for the implement a Construction Quality Management Plan for this project

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area. Some opportunities that could be considered going into the final design stage that were not in this preliminary design stage include items such as earthwork balance, recycling of materials, lifecycle cost analysis, educational outreach, and long-life pavements. Due to the location of this project, some of these sustainability criteria mentioned were difficult to implement due to the limited amount of right-of-way (ROW) currently available within the project area and other local area constraints. Additionally, some criteria identified for pedestrian facilities, bicycle facilities, and scenic, natural, and recreation qualities were specific to certain elements that were outside of the scope of the project and so therefore could not be considered for scoring of this project. Others not accounted for in this scoring effort such as lifecycle cost analysis and long-life pavement could be considered as beneficial for consideration in the final design of

this project within this study area due to the high traffic counts and overall use of the transportation system within this area.

The alternative construction delivery method of this project as a design-build allowed for opportunities to consider the social, environmental, and economic aspects of the project in more detail as opposed to the traditional design and construction advertisement process; for example, consideration of freight mobility, and construction quality control plan were incorporated into this project as a result of ADOT's primary focus on traffic congestion and freight considerations as part of the design process. In addition, although the project was in a highly developed industrial and business area, ADOT focused on implementing aesthetic features into the consideration of new bridge structures through context sensitive development and ITS system improvements. Although these items are seen as social considerations that ADOT considered, they also have an economic consideration benefit to the agency when considering the positive outcomes from traffic congestion and local economy costs related to delays in freight movement, local community improvements from reduction of traffic on arterial roads, and overall support from important stakeholders on the project. An ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with an emphasis on education to the public of the social, economic, and environmental benefits of considering sustainability in design.

XII. ADOT INVEST Version 1.3 Scoring Outcomes and Key Recommendations

The various INVEST case studies and scoring efforts completed by ADOT through this period showcased the realities of a complex transportation system that spans 114,000 square miles, operates from sea level to 8,000 feet and withstands temperatures that range from below 0°F to over 120°F as previously mentioned. This scoring effort also showed the varying degrees of design, planning, environmental resource analysis considerations, and social engagement are undertaken through each specific project and the relative considerations that ADOT consistently monitors and evaluates in the civil engineer and construction frameworks of the agency.

A number of key outcomes were noted through this comprehensive and evaluation process that ADOT undertook with companies and various stakeholders:

- A strong connection to high level planning, NEPA, transportation, and the INVEST sustainability considerations can be found through a mix of different modules and criteria within the INVEST framework. Through the work of our case studies such as I-11, Sonoran Corridor, and the State Route 30 project, there were opportunities provided even at a high level NEPA planning stage to identify relevant sustainability considerations and tasks that could be incorporated into a full civil engineering design and construction efforts. Although a majority of these case studies were high level and did not provide a quantitative scoring analysis like the INVEST scoring modules usually do, the benefits of the tool were still clearly seen through the identification of relative

sustainability criteria to bring forward and discuss with stakeholders and engineering groups in collaboration through the existing NEPA process. As an agency, ADOT sees the benefit in the INVEST tool incorporation into these early planning studies as way to leverage the sustainability considerations early in the planning and engineering process, and the connection to this through the NEPA studies can be easily made.

- Alternative project delivery methods can allow for sustainability and innovation through design and collaboration. As an example, the Broadway Curve INVEST assessment and the SR189 International Border to Grand Avenue assessment were both alternative delivery construction method projects that were preliminary in design and had sustainability INVEST criteria that were considered early in the process and as a benefit to ADOT for quality assurance and expediency for the contractor. While these projects are usually fast paced and are subject to refinement through the developer design process, considerations for sustainability early on in the evaluation process can be incorporated by ADOT as shown through these case studies, and sometimes more easily than a traditional design, bid, build project. This new information is helpful to ADOT to consider as the agency grows in our ability to deliver and program these types of projects, and encourages contractors and developers to seek out innovate and sustainable considerations as well.
- Sustainable transportation education is a key growth area for ADOT. As mentioned in our evaluations of these case studies and scorings, ADOT will seek in future projects to incorporate sustainability education into our process more with the public and external stakeholders. To date, this has been a long term goal that has worked its way to the forefront of the next set of goals for the ADOT Sustainable Transportation Program.
- Considerations for life cycle cost analysis and life cycle assessment continues to be an area that ADOT seeks growth in. As explained in other sections of this report, ADOT is creatively exploring these topics through channels of case studies using university and external stakeholder input, and ADOT will continue to work to identify ways that this can be more easily incorporated into the full design of projects and the agency considerations.

In addition to these overarching outcomes noted through these evaluations that were completed, ADOT has identified a number of recommendations for the INVEST Version 1.3 scoring tool that could be implemented in future applications for the tool:

- The tool could be maximized to allow more linking with traditional project development criteria and system planning (high-level) criteria. Through our experience with the case studies for the large EIS and EA projects like I-11 and Sonoran Corridor, it was evident that there was no specific criteria to score these projects at a high level planning stage within the version 1.3 tool, but it was clear that opportunities existed if stronger connections to NEPA studies were made in other modules such as system planning. If the INVEST tool could allow a clearer link or more flexibility in the project development module or system planning in regards to high level NEPA studies, it would have a benefit to other state DOT's working on similar efforts and seeking to incorporate sustainability into the process sooner than final design stages.

- The tool could be maximized to allow for more considerations of alternative delivery methods and other design criteria considerations that are not included in the modules. Though the tool allows for consideration of different types of projects and programs, the tool is limited to the exploration of different delivery methods and the benefits and considerations of them through the context of sustainable development. Some consideration of incorporation of high level criteria that could be identified for alternative delivery method projects in the context of sustainability within the INVEST criteria would be helpful for state DOT's like ADOT to identify the relevant considerations that should be taken into account. These criteria could range from high level to detailed contractor requirements within the alternative delivery method process, and could serve as a helpful communication tool for agencies.
- The INVEST modules provide a whole host of criteria that allow for agencies to explore which best fits their needs, but it is evident that even some project development criteria are not always relevant to a project in the context of the project setting or purpose and need. Allowing some flexibility for agencies to disclose this in the scoring effort or create their own custom scorecard could be a benefit for some agencies and allow the transparency of the true tradeoffs of the engineering and design process to be shown.

PART II: ADOT Black & Green Sustainable Pavement Systems Program

I. Program Basis

Overall, ADOT views their Pavement Management System as contributing to sustainability by optimizing pavement life cycles to reduce costs, the environmental impacts of construction, and material usage. ADOT's pavement team always considers sustainable pavements for its projects. The sustainable pavements are used when they are the best option available. Pavement design life is a term that engineers use when they're planning to build a new road or maintain an existing roadway. They'll also use a number of years to go along with it, for example: 10-year pavement design life, 20-year pavement design life, etc. The phrase should not be taken to imply that a road is only being built to survive for a set number of years. What it does represent is the road's age at which some preventative maintenance or reconstruction will be considered so the road can continue to be durable and useful for the traffic it's serving. A lot is taken into consideration, soil condition, location, expected traffic levels, and the area's climate. All those conditions play a role in how the pavement is designed.

In ADOT's 2016 sustainability report an operations and maintenance pavement case study was developed. That has been re-introduced in this report and can be found in Appendix E. In that case study was an INVEST scoring effort using the following INVEST O&M criteria:

OM-07: Pavement Management System

Leverage a pavement management system to balance activities that extend the life and function of pavements with impacts to the human and natural environment.

Sustainability Linkage

Maintaining and using a pavement management system supports the environmental and economic principles by optimizing the management of pavements, including preservation, restoration, and replacement, to maximize their lifetime. This reduces costs, the environmental impacts of construction, and raw material usage.

This criterion includes the following elements:

- Develop a Pavement Management System and Collect Data
- Track Pavement Network Performance
- Set Goals and Monitor Progress
- Leverage Data to Demonstrate Sustainable Outcomes
- Sustainable Specifications

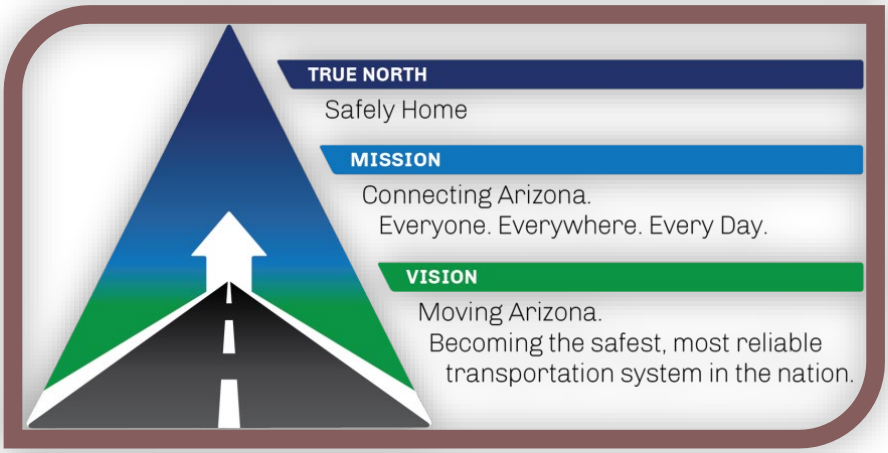


Figure 3 - ADOT "True North" Logo

Overall, ADOT views the INVEST OM Pavement Management System as contributing to sustainability by optimizing pavement life cycles to reduce costs, the environmental impacts of construction, and raw material usage. This case study formed the basis to explore developing a new dedicated sustainable pavement program due to the magnitude of annual expenditure ($200m) used on pavement preservation and full reclamation at ADOT. It was also an opportunity to begin to connect project level work, pavement and materials program goals, and the Agency and State of Arizona priorities (as shown above).

II. 2017-2019 ADOT Program Efforts and Goals

Leveraging the initial case study referenced above, it became clear that there was enough interest in developing an entire separate program. In 2017 and 2018 the sustainability team set out to format and launch a formal program titled Arizona DOT Black & Green Sustainable Pavement Systems Program. In order to take the first step in developing an entire separate program ADOT had to define sustainable pavement. The basis surrounded these concepts:

- FHWA *TechBrief* on Pavement Sustainability (2014)
- FHWA's *Toward Sustainable Pavement Systems* (2015)
- FHWA defines a sustainable pavement as one which "achieves its specific engineering goal" (i.e., meeting accepted performance standards) while meeting "basic human needs," using "resources effectively," and preserving/restoring ecosystems
- Pavement sustainability is meant to involve every phase of the pavement life cycle, including **1)** materials production, **2)** pavement design, **3)** construction, **4)** use, **5)** preservation, maintenance, and rehabilitation (the main emphasis of INVEST OM-07), and **6)** end-of life management

In 2018 and 2019 the program goal was to begin mapping the entire pavement program through the lens of sustainability including materials. The sustainable pavement and materials effort took three forms during this period – Existing Practice, Mapping pavement and materials to the sustainability program, introducing the idea of 40-50 pavement life cycle (perpetual pavement design).

i. Existing Practice Example toward Greater Sustainability

Increased Density (Increased Compaction):

a) Currently, ADOT specifies 3.5% to 9.0% in-place air voids with a target of 7.0% for all asphaltic concrete (AC) mixtures
b) Increased Density (by ADOT specs) requires 3.5% (or 3.0%) to 8.0% in-place air voids with a target of 6.0%. It is well established that increased density (increased compaction) improves pavement performance.
c) Achieving increased density may increase initial construction/materials costs:
    - Additional compactive effort
    - Increased Asphalt Content
    - Use of a compaction aid (warm mix additive)

Increased density trade off analysis is continuing.

ii. Practices Used Historically but not Consistently

- Full Depth Reclamation
- Cold-In-Place Recycling
- Hot in-Place Recycling
- Increased RAP (Reclaimed Asphalt Pavement) use (>25%) in HMA (Hot Mix Asphalt)

iii. Mapping Pavement and Materials to the Sustainability Program

ADOT's definition of Sustainable Pavement: Maximize performance and extend the life of our pavements to the furthest extent economically feasible while minimizing adverse impacts to both society and the environment. During the year long mapping exercise, led by

a major university engineering school, the following five overarching themes were developed:

- The methods and techniques developed by ADOT can be classified in three categories: Pavement Design, Construction and Rehabilitation; Maintenance, Preservation, Rehabilitation; End-of-Life
- Most of the sustainability methods in ADOT's toolbox fall within the first category: Pavement Design and Construction.
- Elements available to ADOT engineers within the sustainable pavement program are centered around elements of pavement design
- It is unclear if ADOT's Sustainable Pavement Program pursues potential benefits from the from material production and sourcing areas
- It is also unclear if ADOT considers the benefits associated with pavement use
    - Smoothness and Stiffness are related to increased fuel economy
    - Reduce lifetime maintenance reduces emissions associated with work zone delay; these are areas that ADOT could potentially add to their sustainability calculus

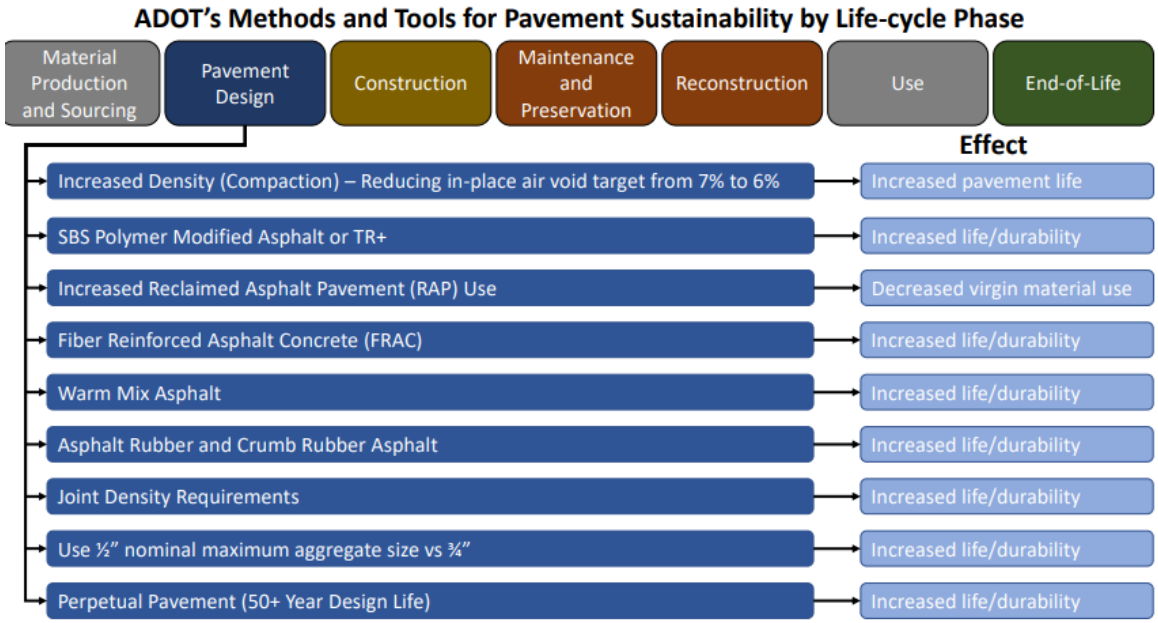


Figure 4 - Sustainable Mapping Example for one Phase of the Life Cycle - Final Mapping - Fall 2020

iv. Introducing the Idea of the 40-50 Pavement Life Cycle (Perpetual Pavement Design)

- FHWA INVEST
- Project Development Criteria 22 (PD-22) - Long-Life Pavement
- ADOT internal pavement and materials goals
- Minimize life-cycle costs by designing long-lasting pavement structures

- Sustainability Linkages

Including long-life pavement supports the environmental and economic principles by reducing the life-cycle costs of the road and the need for raw materials over time.

The definition of long-life pavement for this criterion is:

- Service life of 40+ years for new construction and major reconstruction projects that add travel lanes to an existing roadway or bridge. Service life of 20+ years for small reconstruction and bridge replacement projects that do not expand capacity of the roadway, preservation projects, and restoration projects.
- Pavement will have reduced potential for rutting, cracking, faulting, and spalling
- Pavement will maintain desirable ride and surface texture characteristics with minimal intervention activities, if warranted, for ride and texture, joint resealing, and minor repairs

This criterion is not applicable to roads that are not surfaced with hot mix asphalt (HMA) or Portland cement concrete (PCC), such as gravel roads, dirt roads, and roads sealed with bituminous surface treatments. Existing pavements that are to partially remain in place (in any condition) can also qualify for this criterion. In these cases, evaluation shall be based on the final pavement structure, which may include (1) existing pavement remaining in place, and (2) any new pavement structure added. In this manner, a diamond grind of an existing PCC pavement or an overlay of an existing HMA pavement can qualify for this criterion if the resultant pavement structure meets the requirements stated above.

At ADOT, we have begun the discussion to maximize performance and extend the life of our pavements to the furthest extent economically feasible while minimizing adverse impacts to both society and the environment. Thereby, developing the baseline discussion for a future rotation to a long life pavement model driven by:

- Project Selection
- Project & Pavement Design
- Materials Production & Engineering
- Construction
- Pavement Management (Preservation & Maintenance)
- Materials Management
- Quality

ADOT introduced all of the above goals in a presentation at the 2018 Arizona Pavement and Materials Conference with a particular focus on 40-50 year design life and a model for that approach.

III. 2020-2021 Program Goals

In partnership with a major university and FHWA's Sustainable Pavement Program, ADOT has scoped an effort to conduct LCA, LCCA, and EPD development work in light of ADOT's emphasis on sustainability considerations in pavement design and construction. The advantages and benefits of pavement recycling strategies are increasingly sought after by agencies.

Proposal research goals: In Arizona, HIPR and CIPR techniques have been used by ADOT since the early 2000s successfully. There are number of applications of HIPR and Repave with a life-time of more than 10-years. The goal of this study is to develop required tools and datasets and document sustainability benefits and trade-offs of those selected HIPR or Repave cases using LCA, LCCA, and EPD considerations. A multi-point sustainability assessment framework will be developed to make quantitative and comparative evaluation of preservation and rehabilitation alternatives.

PART III: Other ADOT Sustainability Efforts

I. ADOT Excellence in Advancing Sustainable Project Development Award Program

ADOT began the ADOT Excellence in Advancing Sustainable Project Development Award Program in the fall of 2014 and has continued to be a noteworthy program at the agency that drives the atmosphere of innovation and collaboration in project design efforts between ADOT District, project development groups, and other stakeholders. Below are some recent highlights from the program:

- **Excellence in Advancing Sustainable Operations & Maintenance (OM) Award:** This award focused on ADOT's effort to conduct workshops with INVEST scoring efforts focused on operations and maintenance criteria with subject matter experts in these departments. The outcome of this scoring effort reflected a Platinum status, and helped identify opportunities for further improvement for the agency as well.
- **White Mountain Apache Tribe (WMAT) SR79 Partnering**: This award focused on WMAT's sustainable partnering efforts on three separate transportation projects and INVEST scoring with areas of high achievement in context sensitive design, linking planning and the National Environmental Policy Act (NEPA), and other integrated planning steps.

II. ADOT Sustainable Project Development Checklist

ADOT recognizes that achieving sustainable project design is a process that can be challenging in a fast paced and large transportation agency. The window of opportunity to fulfill all that is desired from a sustainability perspective before a project's completion requires a high level of coordination, not only within a core group of individuals delivering the project but also those who are considered stakeholders during the project development process. With multiple driving forces influencing any given transportation project, including

fiscal responsibility, ensuring all essential aspects within the context of the project are addressed is ultimately the desired outcome.

To assist with this goal, ADOT has developed a checklist for use by the ADOT Project Management Group to facilitate the project development process and engage relevant design areas to identify sustainable and resilience strategies for integration into the planning, scoping, and design stages of transportation projects, as seen in Appendix D. The checklist incorporates project development criteria from the FHWA INVEST tool sustainable project design evaluation process, along with elements for consideration from ADOT's Complete Transportation Guidebook. Each item identified in the checklist focuses on criteria that incorporate social and community aspects, innovative project design and construction criteria, as well as natural and built environment project design criteria. With this checklist, the ADOT Project Management group has the ability to identify relevant criteria that can apply to any given transportation project, generate education within ADOT on sustainable project design, and identify areas for improvement within project design that were not previously considered or discussed.

ADOT's overall goal is to implement this checklist into a tool that can be incorporated into the early stages of design at the project assessment or design concept level. Incorporation of this checklist at an early stage in design will allow early considerations of sustainability with time for ADOT to evaluate any sustainable considerations as they progress into final design and other analysis for the project. Additionally, training and overall guidance on this topic will follow to assist the ADOT Project Management Group with discussions on this topic with other important design and ADOT groups such as regional districts, traffic, bridge, drainage, and roadside development.

III. ADOT Sustainable Transportation Program 2020/2021 Operational Focus Areas

As seen in Appendix C of this report, the ADOT Sustainable Transportation Program has continued to progress on the Operational Focus Areas, which builds upon the previous ADOT Sustainable Transportation Program Milestones Framework and have identified new and revised areas of intended progress within the 2020-2021 year.

These goals, which are aligned with the ADOT mission and values of the agency, are focused on the following justifications: (1) addresses a true operational need, (2) aligns with continuous improvement and performance-based practical design goals, (3) furthers environmental, economic, social, and environmental stewardship and improves environmental risk management overall. These thirty-two (32) specific action items identified within the 2020/2021 OFA's will still focus on the relevant areas that were identified in the original effort, but now includes the Sustainable Systems Pavement Program.

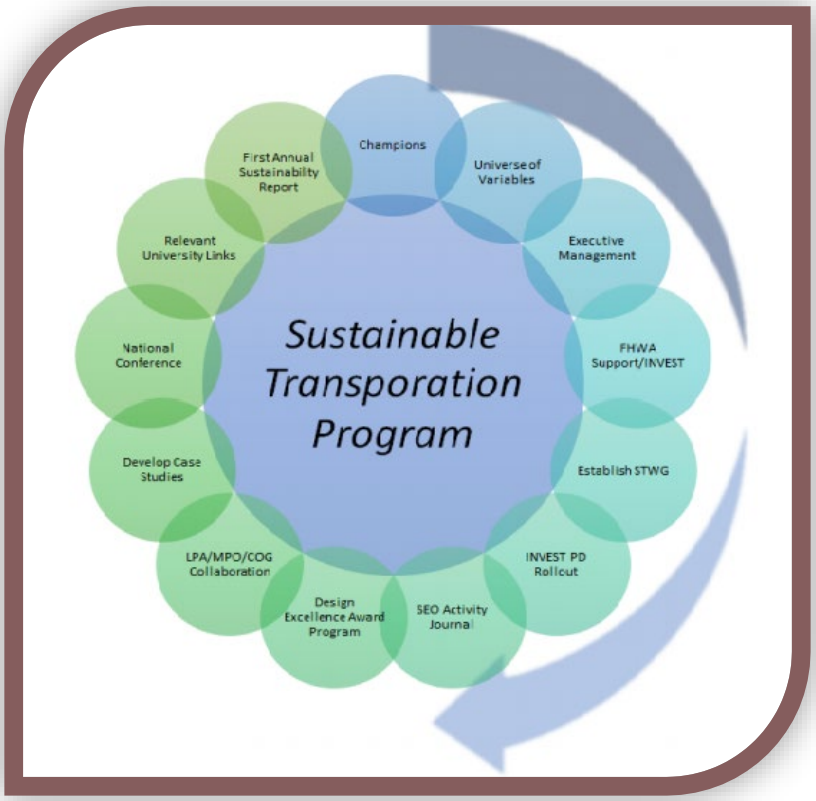


Figure 5 - ADOT Sustainable Transportation Program Framework

IV. ADOT Participation in FTA Section 5310 Enhanced Mobility Program & Regional Coordination Plans

The Federal Transit Administration (FTA) provides ADOT FTA and Surface Transportation Program (STP) funds for small urban and rural areas annually. These program funds are used for capital assistance, the purchase of vehicles, related equipment and operating funds statewide. In addition, mobility management awards are available to assist agencies and communities with their coordination efforts. Eligible recipients include private nonprofit and public agencies that provide transportation to the elderly and disabled. Examples include senior centers and programs for the physically, mentally, and developmentally disabled populations. The utilization of special transportation includes medical appointments, nutrition appointments, adult day care facilities, education and training, employment, and other categories.

The 5310 Program is made up of private nonprofit agencies or groups, public agencies, and Tribal communities. All projects funded under this program must be included in a locally developed, coordinated public transit-human services transportation planning process. Recipients of the funding are included in the Regional Coordination Plan for their area and participate in related coordination activities, such as coordination meetings. The regional coordination plans are managed individually by the state's council of governments (COGs) and metropolitan planning organizations (MPOs) with oversight by ADOT. The COGs and MPOs coordinate with ADOT to certify that the projects selected for the funding are derived from a locally developed, coordinated public transit-human services transportation plan that was developed through a process that includes representatives of public, private and nonprofit transportation and human service transportation providers; participation by the public; and representatives addressing the needs of older adults and individuals with disabilities. In addition, ADOT must certify to the FTA that the regional coordination plan was developed through a process that included representatives of public, private and nonprofit transportation and human services providers, and members of the public. This collaborative process between ADOT, FTA, COG's, and MPO's allows for this program to provide a socially sustainable, reliable, and essential service to Arizona citizens that are in need of transportation alternatives and assistance.

V. ADOT Participation in Arizona Stormwater Awareness Week

ADOT has many stormwater, culverts, and pump houses within the state that require compliance with the Arizona Department of Environmental Quality (ADEQ) permit Municipal Separate Storm Sewer System (MS4 Permit). This ADOT permit was certified in 2015 through collaboration efforts with ADOT, ADEQ, and the Environmental Protection Agency (EPA). As part of this MS4 permit, ADOT is required to monitor compliance, procedures, and activities of all projects and report annually.

In January 2020, ADOT Environmental Planning and the ADOT "Adopt a Highway" Program collaborated on a public outreach campaign with the StormWater Outreach for Regional Municipalities (STORM) group to educate the public on water quality issues associated with trash and stormwater runoff. The goal of this public information campaign was to encourage Arizona drivers to dispose of trash appropriately and to avoid putting trash contaminants into our water system, which creates water quality issues and operational concerns for ADOT with clogged culverts and flooding events. The collaborative effort between the ADOT groups and STORM resulted in a public outreach campaign that was promoted on the ADOT website, an informational video, a social media outreach, and local news media outreach. This partnership by the ADOT groups and STORM organization further promotes the agencies overall goal not only with environmental compliance, but with social and community involvement on sustainable practices that benefit our transportation system and water quality throughout the state.

VI. ADOT I-10 "Broadway Curve" Public Art Open House

ADOT, in partnership with the Maricopa Association of Governments (MAG) and robust coordination with local agencies such as the City of Tempe, City of Chandler, and Town of

Guadalupe are designing improvements to the I-10 “Broadway Curve” area between the I-17 and Loop 202 Santan Freeway. As part of the design concept and public input process for this project, consideration of pedestrian facilities to further local mobility and active transport in the community was incorporated into the project. Multiple recreational trails and facilities exist within the project area, such as the Western Canal mutli-use path, Mountain Vista Park, and Sun Circle trail and Maricopa trail.

In March 2020, ADOT held a public art open house for the pedestrian bridges that are proposed for the project to seek feedback on the theme of the bridges. The public art open house provided an opportunity for the public to provide input on what the design, imagery, and theme of the bridges should be and to meet the artists designing the bridges. The meeting was held in the project area in the City of Tempe at the public Tempe History Museum. This effort by the ADOT design team emphasizes the agency’s continued goal to deliver transportation solutions and improvements in a more sustainable manner that incorporates the social and community active transportation goals.

VII. ADOT Environmental Planning “NEPA Assignment” MOU

On March 22, 2017, Governor Doug Ducey signed into law Senate Bill 1211 which amended the Arizona Revised Statues Chapter 2, Article 2, Section 28-334 C. to allow ADOT to assume federal environmental review responsibility and to waive sovereign immunity under the Eleventh Amendment to the United States Constitution for the limited purposes of addressing legal matters in carrying out federal environmental review responsibilities pursuant to 23 USC 326 and 23 USC 327. As a result of this amendment, ADOT prepared an Application, which included a public review and comment period, and ADOT Environmental Planning also updated and developed a comprehensive collection of procedures and guidelines in place to assume federal environmental review responsibilities. ADOT also underwent various assessments to ensure that the agency was prepared for this larger role, and conducted various forms of outreach to inform interested stakeholders of this new role.

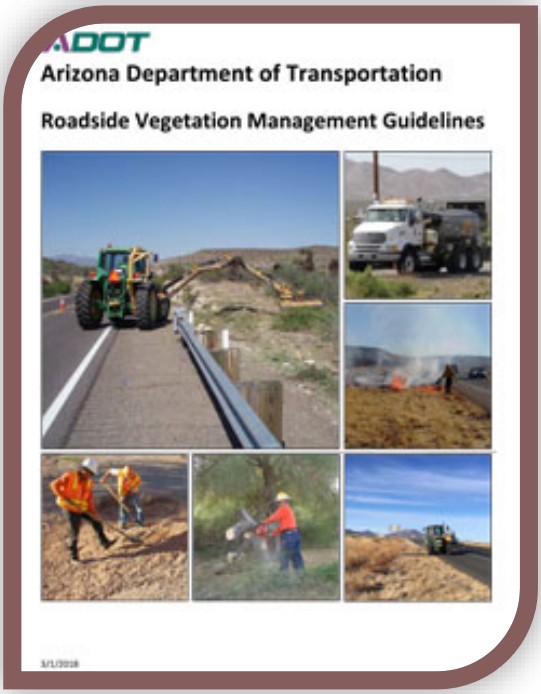
This effort undertaken by ADOT allows the agency to deliver safety and highway improvement projects faster to the public as the Lead Federal Agency while preserving environmental quality and compliance with NEPA. In addition, this effort is in line with Arizona Management System (AMS) in terms of increasing efficiency of service delivery, providing time and costs savings by eliminating additional layers of review, and enhancement of good working relationships with the public, agencies, Tribal governments, and other stakeholders. From a sustainability linkage aspect, this effort undertaken by ADOT contributes to positive economic and social benefits for the agency in a way that will improve processes and performance in the long term.

VIII. ADOT Roadside Vegetation Management Guidelines

ADOT manages vegetation along approximately 1,400 miles of highways across Arizona, totaling nearly 200,000 acres of land within ADOT rights-of-way. The primary goals of roadside vegetation management are maintaining traffic safety, preserving highway infrastructure, and maintaining a resilient native roadside plant community. In recent years, ADOT has updated our Roadside Vegetation Management Guidelines to incorporate the principles of Integrated Vegetation Management and is in the process of developing Vegetation Management Guides for each district.

Roadside design and management is integral to efficient highway planning, design, operation, and maintenance. These areas must be managed for multiple uses and benefits, including safety considerations, signage, utilities, water quality, aesthetics and habitat. Decisions on how to balance and manage these interests affects the appearance of the roadside and the user experience. Properly designed and managed vegetation complements the functions of the roadway, integrates the roadway into the surrounding landscape, and has a positive effect on the traveling public.

Figure 6 - Roadside Vegetation Management Guidelines Cover



In order to manage roadsides with these objectives in mind, ADOT's goal is to use a system of Integrated Roadside Vegetation Management (IRVM) to establish a plant community that is self-sustaining, resists weed infestations, requires only low maintenance effort, and provides necessary soil stabilization and erosion control. To this end, guidelines for vegetation management were developed based on input from the maintenance, construction, landscape architecture, design, and environmental groups. Districts are also developing vegetation management plans for each route with an overall goal of establishing self-sustaining, low growing, weed-free vegetation on the roadsides over as much of the state highway system as possible. This system is based on a process of removing undesirable species, such as noxious and invasive weeds and replacing them with desirable native species using targeted and seasonally-timed control measures.

Tailoring vegetation management to the functions of different roadside zones and seasonality of plants allows a reduction in effort and improved outcomes. For example, the zone closest to the pavement on the roadside is the recovery zone (sometimes called clear

zone). The general guidance is to maintain the recovery zone without any vegetation with a diameter over 4 inches at breast height, which can require removal or control of a large amount of brush and trees depending on the area within the state. The width of the recovery zone is defined based on the road design speed and average daily traffic. On less used roadways, the recovery zone may be narrower than the typical 30 foot distance on interstates. Incorporating the actual width of the recovery zone into brush removal plans rather than using a blanket width of 30 feet can reduce work effort significantly.

The guidelines also recommend mowing only one swath or pass with the mower along the roadside as a default unless there is a specific reason additional area needs mowing (to maintain sight lines at an intersection, for example) and to mow at certain times of the year based on the biotic community. This reduces the mowing effort and also allows the native plants in the ROW to bloom and produce seeds, providing resources for pollinators and reseeding the area for the following year. Scheduling mowing around this timing not only benefits long-term regeneration of the native plants and supports pollinators but typically reduces the number of times the roadside is mowed each year, resulting in additional labor and cost savings.

Cost Savings

While ADOT has not yet directly quantified the savings from implementing these guidelines, a cost-benefit analysis for another state DOT managing approximately 80,000 acres of ROW calculated that reduced costs from changing their routine vegetation management to a conservation mowing model resulted in an estimated total of $4.8M in savings annually (Cost-Benefit Analysis for the Monarch CCAA). A report prepared for Florida DOT estimated that implementing sustainable management practices would reduce vegetation management costs nearly 30 percent. ADOT has a pilot project for mowing utilization in the Southeast District that was initiated in mid-2019; a combination of improved training, maintenance and repair practices along with implementation of a master mowing schedule incorporating the updated Vegetation Guidelines resulted in a 111% increase in acres mowed, 21% decrease in mowing time per acre and 17.5% decrease in cost per acre for the October-November period in 2019 vs. 2018.

Monarch Candidate Conservation Agreement

ADOT's movement to integrated vegetation management techniques has additional benefits in that it prepares us for participation in the Nationwide Candidate Conservation Agreement with Assurances for Monarch Butterfly on Energy and Transportation Lands (Monarch CCAA). Participation in the Monarch CCAA is based on implementing conservation measures to create or enhance habitat for the monarch butterfly resulting in a net conservation benefit for the species. In exchange, the participants receive regulatory assurances that additional conservation actions beyond those initially approved will not be required if the species is listed under the Endangered Species Act. Because monarch butterflies may occur widely across Arizona and loss of habitat through mowing and use of herbicide are among the major threats to the species, the possibility of the species becoming listed creates

regulatory uncertainty for ADOT's construction and maintenance activities in the future. The main conservation measures ADOT will implement are to adjust mowing timing and frequency and adjust herbicide spraying practices to provide monarch resources at critical times of the year, as well as continuing to revegetate construction sites with diverse native seed mixes.

IX. ADOT Bicycle and Pedestrian Program

ADOT's Bicycle and Pedestrian Program, which is managed out of the Multimodal & Planning Division (MPD) of the agency, provides a number of helpful resources for the state of Arizona about walking and biking. These resources include education materials on how to incorporate biking and walking into a commuting plan, information on the best places to walk and bike in the state, and other ADOT maps, policies, and safety studies.

In 2018, MPD completed a Bicycle Safety Action Plan that focused on ADOT's planning goals related to reducing injuries and fatal motor-bicycle vehicles crashes on the State Highway System. This action plan focused on assessing the previous action steps identified in previous ADOT reporting standards, evaluating crash data, identifying high priority areas for safety improvements, and establishing countermeasures. In addition, the plan focused on where bicycle and pedestrian safety improvements could be incorporated into the agency's five year transportation program and funding sources available to advance these priorities. The general recommendations out of the Action Plan are aimed at improving existing policies for ADOT roadway design guidelines, improving education and outreach programs at ADOT and with MPO's, and other strategies that dealt with legislative actions, enforcement, data collection, and engineering considerations. This effort out of ADOT's MPD emphasizes the agency's goal of social responsibility from a safety and roadway efficiency standpoint, especially through the group's collaborative efforts with multiple MPO's and local jurisdictions.

X. Global Reporting Institute (GRI) Standards Exploration at ADOT

The Global Reporting Institute (GRI) is a non-profit organization that has taken efforts to help companies and governments complete sustainability reporting since 1997. The GRI Standards are the first and most widely used global standards for sustainability reporting, with over 200 corporations adopting the standards for use in their own annual reporting methods and goals. As described in their mission statement, GRI's mission is to empower decisions that create social, environmental, and economic benefits for everyone. GRI's core product is the "Sustainability Reporting Standards" which are made available to the public, and are developed with true multi-stakeholder contributions that is rooted in the public interest.

In Fall 2019, ADOT enrolled six employees from environmental planning, air quality, and materials design to complete training on these standards through a U.S. certified training center online to further ADOT's sustainability stewardship and reporting efforts. The course, which was offered as a web-based training, covered a variety of topics and case studies related to the GRI Sustainability Reporting Standards, GRI Sustainability Reporting Principles,

and how to create a sustainability report in accordance with the GRI Standards and with effective stakeholder engagement and coordination. This information and training will be a helpful skill for ADOT as we further our sustainability standards and reporting activities, and will be a benefit to the agency in a number of ways both internally and externally. In the future, ADOT will look to increase our benchmarking and sustainability assessment standards with the use of the GRI standards, and use these standards to help identify risks and opportunities within the agency. This effort will also benefit our agency from an external perspective by providing our stakeholders with a full perspective of the agency goals, values, and constraints when it comes to sustainable development and planning.

XI. ADOT Sustainable Infrastructure Award

In 2019, the Arizona State University Metis Center for Infrastructure and Sustainable Engineering awarded ADOT with a "Sustainable Infrastructure Award" for the Laguna Creek Bridge Scour Remediation project within the Navajo Nation Reservation. The Laguna Creek Bridge has a long history with multiple remediation efforts dating back to 1984 – 2012. The goal of the recent project was to provide protection of the existing bridge and roadway against the effects of local scour and severe channel meandering just upstream and downstream of the bridge crossing. The design of the project was implemented through a series of innovative GIS technology processes that involved 2-D modeling and collaboration with an interdisciplinary group of experts from the engineering and hydraulic groups at ADOT, along with the United Stages Geological Survey (USGS).

XII. ADOT COVID-19 Response Efforts

In April 2020, ADOT reallocated more than 2,600 N95 respirator masks to local assisted care facilities to help address the need for personal protective equipment during the current health crisis. ADOT also helped the local veteran community after a call was made for help by the Arizona Department of Emergency and Military Affairs and Governor Doug Ducey by delivering 2,500 masks to local veteran homes. ADOT had previously purchased the personal protective equipment during a previous viral outbreak and quickly evaluated the current inventory of supplies when the call was made for help. In addition to these efforts, ADOT followed guidance from the Arizona Department of Health Services by directing staff and construction contractors to implement social distancing guidelines in their work spaces, and wear cloth face coverings in public places.

ADOT has also implemented new processes for interacting with the public and social responsibility during this health crisis through a variety of different methods. For example, with many staying at home during this time period, ADOT has taken the opportunity to expand the construction and maintenance work hours to allow crews to advance projects in a safer environment during the day and weekdays, which has benefited not only the ADOT staff and construction workers, but also the traveling public too to speed up timelines. ADOT has also expanded the rest area capacitates and availability along the state highways by opening two previously closed rest areas for commercial travelers who's responsibility it is to deliver goods quickly to the state. ADOT also eased truck weight limits for commercial vehicles that provide direct assistance to the COVID-19 relief efforts by delivery of essential

supplies. This easing of restrictions allows the state to maintain its supply of goods and medical needs and keep the countries commerce moving. Lastly, ADOT has built upon the social responsibility during this time by moving venues of public interaction to online forums and meetings, virtual public meetings, and teleworking capabilities. These efforts all contribute to ADOT's overall true north mission of getting all Arizona citizens "safely home."

PART IV: Conclusion & Next Steps

As identified in our 2020/2021 OFA's, the ADOT Sustainable Transportation Program will continue to evolve and establish sustainability efforts in a variety of different departments within the agency in order to advance the overarching goal of continuous improvement and strategic investments for the agency. ADOT has continued to grow the sustainable transportation program over the last few years to meet various agency challenges using a particular focus on design engineering, project development, construction, and statewide maintenance and operations. This effort to advance this topic agency wide will occur through a number of different ways:

i. Sustainable Transportation Program

The 2020/2021 OFA's in Appendix C outline numerous project level and agency goals that include further adoption of LED lighting, exploring solar energy on ADOT right-of-way, and linking sustainability, National Environmental Policy Act (NEPA), public involvement, and planning. These goals will include coordination and collaboration with various departments within the agency including administration, planning departments, project engineers, construction districts, maintenance groups, and others. This expansive set of goals is ambitious but reflective of the opportunities that are available within the agency to advance innovative design and sustainability considerations into ADOT.

In addition, as the program further progresses, efforts will be given to increase sustainability reporting metrics and standards as outlined in the GRI reporting standards and TTI Partnership on a continual monitoring basis with additional focus on the environmental, social, and economic inputs of the agency. This effort will help increase the viability of the program and identification of goals, which will in turn provide a return on investment that aligns with the importance of delivering transportation solutions in a sustainable manner to achieve the State's economic, social, and environmental goals.

ii. Sustainable Pavement Systems Program

At the agency program level, a large focus has been placed on continuing the adoption and education of LCA and LCCA into the project design and engineering process. As identified in our 2020/2021 OFA's, further exploration of the use, applicability, performance of LCA and LCCA process in the project pavement design stage will be considered from a number of different application frameworks and mixtures:

- Full Depth Reclamation

- Cold-In-Place Recycling
- Hot in-Place Recycling
- Increased RAP (Reclaimed Asphalt Pavement) use (>25%) in HMA (Hot Mix Asphalt)
- Fiber Reinforced AC (FRAC)
- Warm Mix Asphalt (reduced production temperature, compaction aid, anti-stripping additive)
- Asphalt Rubber (ARAC & AR-ACFC), Crumb Rubber Asphalt (CRA)
- Use of ½" nominal maximum aggregate size vs ¾" nominal maximum aggregate size AC mixtures

In addition to these considerations, there is an additional set of evaluation criteria that will be considered to help facilitate the case studies and best practices framework for the agency:

- Joint Density Requirements
- Mixture performance testing: Balanced or Performance Engineered Mix Designs
- Roadside maintenance (drainage)
- Other construction best practices

iii. National Recommendations

- Develop a set of expectations for roadway infrastructure to begin to conduct sustainable return on investment (SROI)
- Incentivize State DOTs use of the Federal Aid Program by adding sustainability to the allowable State match waiver as is available for innovation in engineering
- Partner with the Transportation Research Board to promote a research project that identifies sustainable design and construction attributes that can be integrated and procured in the use of Alternative Delivery
- Fund a follow up effort with the Texas Transportation Institute to reinvigorate the 2013 *Guidebook for Sustainability Performance Measurement for Transportation Agencies*
- Fund use cases that begin to populate every INVEST Criteria across all Modules
- Launch the next INVEST version and support comprehensive regional webinars
- Develop a specific new area within INVEST to begin housing established performance measures, metrics, and indicators to begin moving INVEST use from anecdotal and qualitative to quantitative and specific use case outcomes for sustainability
- Begin the discussion of ways FHWA can support the use of green bonds and sustainable finance to drive sustainability initiatives, including investment in renewable energy, energy efficiency, and waste reduction projects
- Adoption of an end to end process and new INVEST Criteria to affect and improve the outcomes of EA and EIS documents, advance public involvement, and better link Planning-Sustainability-NEPA-Public Involvement as it relates to all facets of

transportation corridor planning, regional transportation programming, stewardship through the adoption of sustainable transportation goals, and project development brings these into the 21st cent. ADOT has submitted this idea to the EDC-6 Call for Ideas.

- Extend FHWA's Sustainable Pavement Program promotion of Life Cycle Assessment (LCA) further into all parts of FHWA.
- Fund an INVEST Round 4 effort – currently there are just no other ways to further, and fund, serious sustainable transportation adoption
- Conduct a full TRB Annual Meeting sustainable transportation / INVEST session. The January 2015 session garnered over 400 attendees
- Add in future INVEST versions a new dedicated "Corridor Planning" and/or "Environmental Study" module

The set of appendices that follow this summary provide a detailed look into the program efforts and outcomes through the various reports, case studies, and relevant information that are referred to in this report.

PART V: Appendices

Appendix A - ADOT Queen Creek Tunnel LCA and LCCA Report and Information

Appendix B – FHWA INVEST Scoring

Appendix C – 2020 – 2021 Operational Focus Areas

Appendix D – ADOT Sustainable Project Development Checklist

Appendix E – 2016 Final Report; Pavement Case Study

Appendix F - Roles & Responsibilities

Appendix A - ADOT Queen Creek Tunnel LCA and LCCA Report and Information

Life-Cycle Costing Analysis and Life-Cycle Assessment of the Roadway Lighting Conversion in Queen Creek Tunnel

Action Plan

April 30, 2019

The following describes the data requirements and workflow for completing an assessment of the Queen Creek Tunnel roadway lighting system. The assessment will rely on the generalized Life-Cycle Costing Analysis (LCCA) and Life-Cycle Assessment (LCA) model developed for assessing roadway lighting systems but use project specific data. The data requirements and workflow described below is applicable for all other roadway lighting analyses.

I. DATA REQUIREMENTS FOR PREVIOUS AND UPDATED ROADWAY LIGHITNG SYSTEMS

- ❑ Luminaires
  - Total Number of Fixtures
  - Make and Model
  - Input/Rated Wattage
  - Direct Costs
- ❑ Operation Conditions
  - Daily Operating Hours
  - Annual Average Operating Hours
  - Description of Dynamic Lighting Control Systems (if any)
- ❑ Maintenance Requirements
  - Expected Luminary Lifetime
  - Expected Lifetime of Ancillary Components (e.g. Ballasts)
  - Planned Maintenance Cycles
  - Direct Costs for Replacement Parts
- ❑ Utility Information
  - Utility Provider for Segment
  - Past Utility Bills
  - Utility Rate Plan (Metered vs. Unmetered)
- ❑ Additional System Details
  - Additional Upgrade Requirements
    - Wiring
    - Control Systems
    - Support Structures
  - Arizona Department of Transportation Discount Rate
- ❑ Labor
  - Rate(s) and Hours Required to Complete Upgrade
  - Rate(s) and Hours Required for Maintenance Activities
  - Travel Distance from Facility to Site

II. ASSESSMENT WORKFLOW

- ❑ LCCA and LCA – Time Required: 1.5 Weeks
  1. Validate Data
  2. Identify Generic Data Required to Fill Data Gaps
  3. Modify Generic Assessment Model for Explicit Assessment
  4. Model Run
  5. Validate Model Results
  6. Rerun Model if Required
- ❑ Reporting – Time Required: 0.5 Weeks

Case Study: Arizona Department of Transportation – Sustainable Transportation Program

January 2020

LED Life-cycle Costing Analysis and Life-cycle Assessment

Converting to light emitting diode (LED) technologies for roadway lighting can produce economic and environmental savings through the use phase of the system. However, there are also impacts associated with other phases of the lighting systems light-cycle that create non-trivial costs and environmental impacts. Life-cycle Costing Analysis (LCCA) and Life-cycle Assessment (LCA) are approaches used to examine the net effects of policies, services, and products. The holistic approach provided by these two methodologies can better describe the efficacy of LED roadway lighting in producing economic and environmental savings. Life-cycle costing focuses on upfront, future and avoided monetary costs while considering the time value of money. Life-cycle assessment focuses on the environmental impacts including impacts associated with material extraction, processing and production, use phase and end-of-life. The usefulness of these methodologies is that they provide a holistic accounting of potential impacts and can identify costs/impacts and potential tradeoffs that are not obvious. LCCA and LCA can help practitioners identify and select strategies that offer long-term economic and environmental benefits. LCCA and LCA are distinct in their approaches but can be complimentary. There is clear overlap between the methodologies and required inputs, especially for systems that require significant and near-continuous energy use. Using established LCCA and LCA guidelines and best practices a framework was developed to provide quantitative results to measure life-cycle costs and emissions of roadway lighting systems and evaluate the efficacy of technology transitions in producing long-term savings and environmental benefits.

When developing an LCCA or LCA it is necessary to define a system boundary. System boundaries are partially subjective and are specified across number of dimensions. To be clear, it is possible that quantitative conclusions reached using one system boundary are different than those using second, larger or smaller, system boundary. The system boundary defined here reflects elements within a roadway lighting system that an agency likely has some element of direct control or responsibility. The LCCA system boundary includes capital, maintenance, and electricity costs. The LCA boundary includes manufacturing, use, and maintenance of luminaries and some system components. The manufacturing phase includes raw material extraction, transportation, and production of interim and final products. The use phase covers impacts associated with energy consumption. The maintenance phase covers maintenance processes. While it is expected that upstream costs outside the system boundary are carried through to later phases and accounted for in an LCCA, environmental impacts and energy use beyond the boundary are not accounted for. In addition, civil infrastructure systems carry long term usage and maintenance commitments. As such, the time horizon of analysis, which is also subjective, can impact final quantitative results. Comparative assessments of two or more system alternatives are further complicated if the operational environment is different. In the case of roadway lighting systems, performance differences between technologies could result in different number of fixtures. This may be

particularly true when updating older lighting systems. Fewer total fixtures may be needed to meet nighttime visibility standards in systems using newer and better performing technologies.

Estimating the Energy, Greenhouse Gas, and Cost Savings of LED Roadway Lighting Conversion.

The Arizona Department of Transportation (ADOT) is engaged in the early stages of converting existing it's High Pressure Sodium (HPS) roadway lighting system to Light Emitting Diode (LED). The existing roadway lighting system operated and maintained by ADOT features more than 28,000 luminaries with an operating cost of approximately 4 million dollars (2015). The conversion is expected to produce energy, greenhouse gas emission, and cost savings over the lifespan of the LED system due to reductions in electricity demand and maintenance. Project Development 17 (PD-17) of FHWA's INVEST tool is specifically designed to promote economic and environmental gains through lighting conversion or on-site renewable power sources. While INVEST promotes sustainability qualitatively it does not provide enough information to develop quantitative economic and environmental assessment. This case study presents a combined LCCA and environmental LCA framework to quantify the potential benefits of lighting conversion. In addition to the benefits already mentioned, LEDs may provide other benefits relative to HPS, including light color and improved visibility, but are not easily captured by quantitative methods like LCCA and LCA. This study first examines an ADOT LED pilot project. Insights from the examination of the existing LED system are used in the development of an LED LCCA and LCA framework.

Recker 202 Pilot Conversion

In September 2016, ADOT installed 36 LED lighting fixtures in place of 36 HPS fixtures along one mile of the State Route 202 freeway. In preparation for this conversion, ADOT conducted a preliminary analysis of this conversion to estimate energy usage and cost savings. As specified by PD-17, the input wattage for HPS (438 Watts) and LED (170 Watts) were used to estimate potential savings. The conversion was expected to result in an energy savings of 61% and near equivalent dollar savings. Billing records show that the HPS system used approximately 48 MWh annually. Using INVEST table PD-17.2.A this specific conversion would have been awarded 3 points towards the PD-17 criteria. Ultimately, an analysis conducted after the system was installed and operational found energy and cost savings of 50% and 48% respectively. To better understand the discrepancy between realized savings and predicted savings an additional assessment was developed from raw energy use data.

While INVEST recommends the use of "input wattage" when estimating reductions in energy use, differences between rated and measured power ratings can be significant in roadway lighting luminaries. The sign and magnitude of these differences can vary by type, model and manufacturer. Where possible, measured wattage should be used rather than ratings specified by equipment manufactures. Among the smart features offered with new LED lighting systems are wireless monitoring systems. The General Electric LED system installed in the pilot project included such a system. One of the variables tracked was instantaneous power demand. We found that the pilot LED luminaries performed closely with specification with an average power demand of 171.4 watts across the 36 luminaries.

A key factor in predicting future energy use of a roadway lighting system is an estimate of total operating hours. INVEST PD-17.2 calls for using a baseline condition of 4,380 hours. Annual sunshine duration varies across the United States and it should be expected that operating hours for roadway

lighting hours to differ as well. Quantitative assessments of street lighting performance should use known operating standards for individual lighting systems. Based on the average power demand of individual luminaries and the annual power consumption of the LED array (≈ 21,000 kWh from September 2016 to September 2017), we estimate the average annual operating hours of this system to be approximately 3,400 hours (9.3 hours/day) (Equation 1) This is significantly lower than the baseline condition recommended by INVEST. There are two critical assumptions that may account for this discrepancy. First, by using the total energy consumption over the year we are assuming all 36 luminaries were 100% operational. If any fixtures were out for an extended period it would have a significant impact on annual energy use (>1.6 kWh per fixture per day). Second, one of the features and advantages of advanced LED streetlighting systems is the ability to dim lights during dawn and dusk periods or reduce overall brightness thus reducing power demand. We were unable to ascertain the extent to which dimming was used over the course of the year. If adaptive dimming was used it could explain why the estimated annual hours is low. INVEST states that "power savings associated with daylight sensors and activity level sensors" should not be included when estimating power savings. However, these technologies can produce non-negligible energy and costs savings and should be considered in quantitative assessments.

Equation 1

$$Total\ Operating\ Hours\ Per\ Luminarie = 21{,}000\ kwh * 1000\frac{w}{kw} * \frac{1}{171.4\frac{w}{luminare}} * \frac{1}{36\ luminare}$$

In the four years prior to conversion, the previous HPS system used considerably more energy with an annual average of 41,000 kWh. Using a variant of Equation 1 we attempted to derive some information about the operating conditions of the HPS system. We estimated the expected annual operating hours for the HPS system in four previous years based on the rated power of each luminaire and found significant discrepancies between the HPS and LED systems. From the annual metered consumption, we estimate that the average annual operating hours of each luminaire to be 2,590 and as low as 2,360 hours annually. These values are outside the bounds of what is reasonable. We hypothesize two reasons for the discrepancy. First, HPS power demand is significantly lower than their "input wattage" specification. If the new LED system adopted the same operating hours as the previous system (3,400 hrs/year), we estimate that the average power demand of an HPS luminaire to be 333 Watts, a 24% decrease from the input wattage rating. However, all HPS luminaries tested by Jiang et al. (2015) found that HPS power demand tends to be higher rather than lower when compared to rated performance. It then follows that the measured electricity demand of the previous system does not reflect a fully operational system. Given the 30 month expected lifespan of HPS lamps and time required to service them, it's possible that a number of the HPS lights were not operational during part or all of each year. The operational status of luminaries in the previous system can have a significant impact on realized energy and emission savings.

From the examination of the 202 Recker conversion we find that the assumptions made by INVEST PD-17 are unlikely to accurately estimate annual energy and costs savings of lighting technology conversion. Accurate estimates of energy and cost savings will be sensitive to differences in rated and measured power demand, annual operating hours, advanced adaptive and dimming light controls, and pre-conversion and post-conversion operating conditions. However, the inclusion of PD-17 is lauded for its potential to move transportation agencies towards more sustainable outcomes. The Recker 202 light

conversion reduced ADOT's annual electricity costs for that stretch of road by $2000 dollars and reduced CO_2e emissions by 9,400 kg. The reduction in CO_2e is roughly equivalent to taking two vehicles (12,000 miles per year) off the road. Cost savings were directly determined from billing data and the reduction in CO_2e was determined using billing energy use data and U.S. EPA's eGRID2016 emission rate for Arizona.

Key Findings and Recommendations

- Rated and measured power usage for luminaries can vary significantly. It is recommended that measured power be used when estimating the potential benefits of light technology conversions.
- Relative and absolute energy and emission savings will be impacted if technology is used that allows for adaptive controls and relative light dimming. The extent to which these technologies will be used and their impact on energy consumption should be considered.
- Absolute energy and emission savings will be impacted by total operating hours. When developing estimates of annual energy and emission reductions from the improved energy efficiency of lighting technologies, agencies should rely on known operating hours rather than assuming the 4,380 hours recommended by INVEST.
- Assumptions of systems in fully operational states may not be representative of actual conditions. Prolonged luminaire outages in pre-conversion systems could cause actual cost and emission savings to be significantly lower than expected.

Generalizable Model Framework

Though the specifics of roadway lighting systems are likely to vary from one system to another there are principal components that are expected to have significant impact on the results of LCCA and LCA assessments. These components are listed below and are loosely ordered based on their expected relative impact on the results. The general framework and the relationship between these inputs and final outputs is illustrated in Figure 1.

Luminary Input Wattage: The use phase associated with roadway lighting is generally expected to drive most costs and environmental impacts. As described in the assessment of the LED pilot project in Arizona, rated input wattage may not accurately reflect actual power use. When and where possible, input wattage used in these assessments should be measured with multimeters. Additionally, the effect of adaptive lighting controls that temporarily decrease power demand should be considered on general power demand

Number of Luminaries: The total number of luminaries in the system based on type and wattage.

Current and Future Operating Hours: The operational duration of lights will vary due to seasonality as well as the potential effects of weather. Experience should be used to estimate annual operating hours rather than estimates based on sunrise and sunset times.

Carbon Intensity of Current and Future Electricity Mix: The emissions associated with electricity consumption are dependent on the technology (coal, natural gas, nuclear, etc.) which supplies electricity to the grid. Carbon intensity of energy varies regionally in the United States. To effectively assess future emissions, the evolution of grid energy mixes should be considered. Many states and regions have adopted renewable portfolio standards which can be used to help define future energy mix scenarios.

Electricity Pricing: The costs associated with electricity use are both fixed and variable. Fixed charges often include taxes, account and meter fees while variable charges depend on total usage as well as tiered and seasonal pricing structures. Reviewing past utility bills associated with roadway lighting systems that detail electricity use and total costs can provide a possible range of effective electricity rates. As with the carbon intensity of energy mixes, potential changes in the price of electricity should be considered to estimate future costs.

Luminary and Labor Costs: Theses costs should reflect both the cost of the fixtures, other necessary physical components and installation labor costs. Costs associated with replacement parts and maintenance labor are also required.

Luminary Operational Life: The service life of luminary lamps (total operating hours) and other luminary components. Expected service life drives maintenance cycles and associated replacement and labor costs and environmental impacts.

Luminary and System Material Components and Emission Factors: To determine the upstream environmental impacts of roadway lighting systems a material breakdown of system components is required including luminaries and support structures. The bill of materials can be associated with emission factors found in LCA databases or published literature. In some cases, data points that reflect the entire luminary may exist. In others, the cumulative environmental impact can be estimated through the breakdown of its constituent parts.

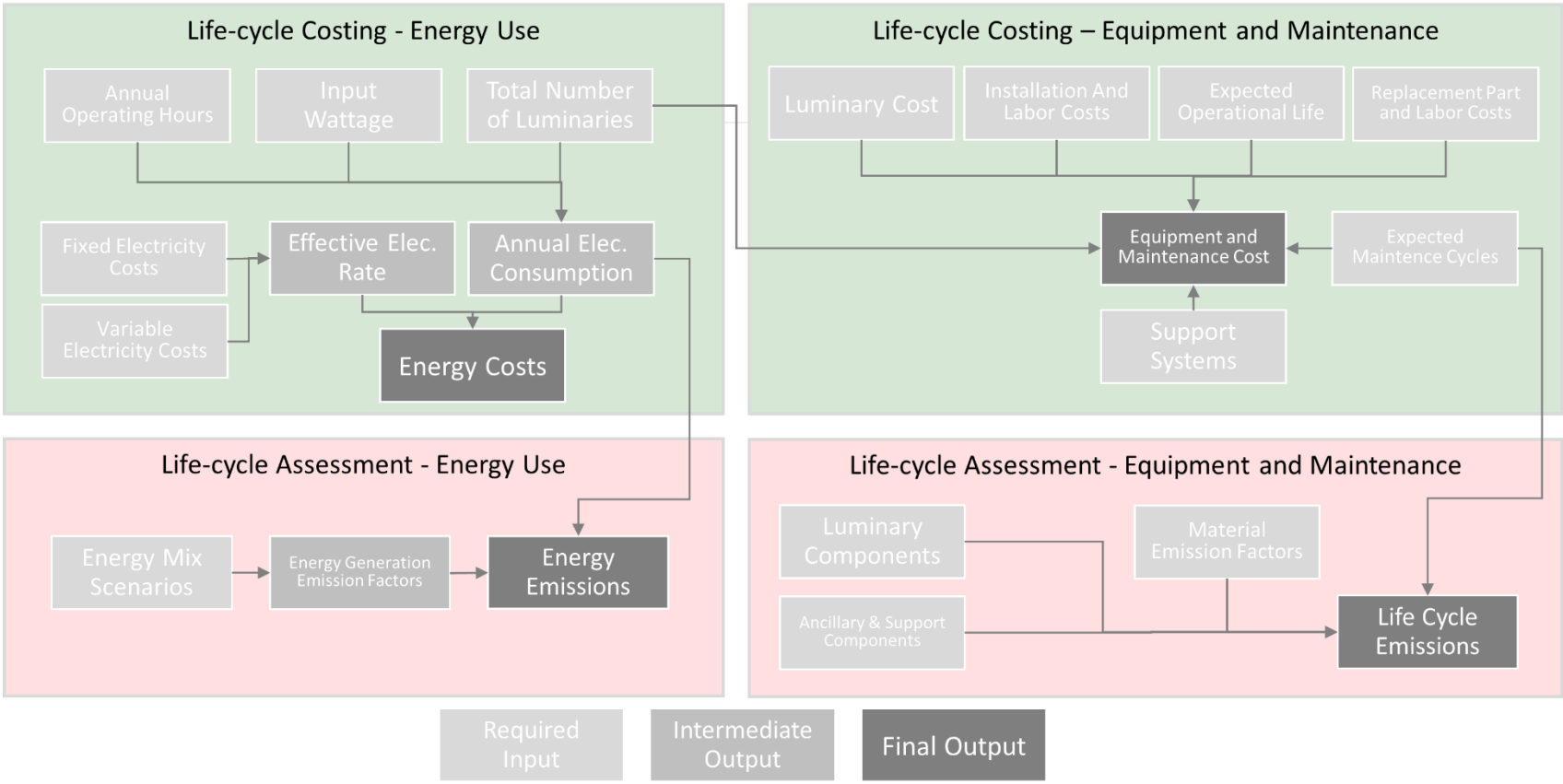


Figure 1 LED Life-cycle Costing Analysis and Life-cycle Assessment Generalized Framework.

Queen Creek Roadway Lighting Case Study and LCCA and LCA Estimator

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Prepared June 30, 2019

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Introduction

In 2016, Arizona Department of Transportation (ADOT) installed a Light-emitting Diode (LED) lighting system in the Queen Creak Tunnel along the US 60 east of Superior, AZ. It was the first tunnel in Arizona to feature LED technologies which provide energy and cost savings. While LED are known to provide energy and cost savings relative to other technologies, the system is also supported by control systems that adjusts lighting levels and electricity demand based upon ambient light and weather conditions. The new system has significantly improved visibility in the tunnel and lowered operational electricity use and costs relative to the previous system that featured high-pressure sodium (HPS) luminaries. The project cost $4.3 million dollars and was partially supported by $1 million-dollar federal grant.

Completed in 1952, Queen Creek Tunnel had undergone several lighting improvements over its lifetime. The last upgrade occurred in 1974 when 144 400 watt HPS sodium lights were installed with 72 lining each side. Near the end of its life-cycle, the system was faced with increasing maintenance and repair requirements and the system no longer met modern tunnel lighting requirements. Additionally, the configuration of the luminaries along the sides of the tunnel was no longer conducive to large truck traffic. In 2007, ADOT began exploring alternatives to replace the existing system. LED was not yet a viable or cost-effective technology and configurations of HPS fixtures were considered. Due to a lack of funding, the upgrade was shelved for 6 years. In 2013, ADOT revisited the tunnel lighting project and considered LED technology for the first time. LED offered a number of benefits relative to HPS or other lighting technologies including increase lamp efficacy (lumen/watt), rated service life, and increased correlated color temperature (CCT) resulting in a whiter light improving driver visibility. The design process produced several options based on LED and HPS technologies. Ultimately, an LED design was selected, and construction began in January 2016 and finished in December.

Life-cycle Costing and Life-Cycle Assessment

The benefits provided by LED road lighting systems produce long-term cost savings through reduced electricity demand and maintenance commitments. A reduction in electricity use and maintenance activities also produces environmental co-benefits reducing emissions associated with these elements. However, there are also impacts associated with other phases of the lighting systems light-cycle that create non-trivial costs and environmental impacts. Life-cycle Costing Analysis (LCCA) and Life-cycle Assessment (LCA) are approaches used to examine the net effects of policies, services, and products. The holistic approach provided by these two methodologies can better describe the efficacy of LED roadway lighting in producing economic and environmental savings. Life-cycle costing focuses on upfront, future and avoided monetary costs while considering the time value of money. Life-cycle assessment focuses on the environmental impacts including impacts associated with material extraction, processing and production, use phase and end-of-life. The usefulness of these methodologies is that they provide a holistic accounting of potential impacts

and can identify costs/impacts and potential tradeoffs that are not obvious. LCCA and LCA can help practitioners identify and select strategies that offer long-term economic and environmental benefits. LCCA and LCA are distinct in their approaches but can be complimentary. There is clear overlap between the methodologies and required inputs, especially for systems that require significant and near-continuous energy use. Using established LCCA and LCA guidelines and methods a tool was developed to provide quantitative results to measure life-cycle costs and emissions of roadway lighting systems and evaluate the efficacy of technology transitions in producing long-term savings and environmental benefits.

Queen Creek Tunnel Case Study and LCCA and LCA Tool

The objective of this case study is twofold: 1) Assess the long-term costs and emissions (CO_2e) benefits of the transition to LED lights in the Queen Creek Tunnel and 2) Develop a simple tool that can be used to estimate costs and emissions associated with other roadway lighting systems. While the specifics of roadway lighting systems are likely to vary from one system to another there are principal components that are expected to have significant impact on the results of LCCA and LCA assessments. The use phase is generally considered to be the most impactful phase both in terms of cost and environmental impacts across lighting technologies. The principle components are listed below and are loosely ordered based on their expected relative impact on the results.

- *Luminary Input Wattage*: While rated input wattage may not accurately reflect actual electricity demand it is a known and published value and can be used to directly compare different luminaries.
- *Number of Luminaries*: The total number of luminaries in the system based on type and wattage.
- *Current and Future Operating Hours*: The operational duration of lights will vary due to seasonality as well as the potential effects of weather. Experience should be used to estimate annual operating hours rather than estimates based on sunrise and sunset times. Federal Highway Administration's INVEST tool recommends using a baseline of 4380 hours (12 hours/day) when estimating impacts associated with roadway lighting.
- *Carbon Intensity of Current and Future Electricity Mix*: The emissions associated with electricity consumption are dependent on the technology (coal, natural gas, nuclear, etc.) which supplies electricity to the grid. Carbon intensity of energy varies regionally in the United States. To effectively assess future emissions, the evolution of grid energy mixes should be considered. Many states and regions have adopted renewable portfolio standards or carbon intensity standards which can be used to help define future energy mix scenarios.
- *Electricity Pricing*: The costs associated with electricity use are both fixed and variable. Fixed charges often include taxes, account and meter fees while variable charges depend on total

usage as well as tiered and seasonal pricing structures. Reviewing past utility bills associated with roadway lighting systems that detail electricity use and total costs can provide a possible range of effective electricity rates. As with the carbon intensity of energy mixes, potential changes in the price of electricity should be considered to estimate future costs.

- *Luminary and Labor Costs*: Theses costs should reflect both the cost of the fixtures, other necessary physical components and installation labor costs. Costs associated with replacement parts and maintenance labor are also required.
- *Luminary Operational Life*: The service life of luminary lamps (total operating hours) and other luminary components. Expected service life drives maintenance cycles and associated replacement and labor costs and environmental impacts.
- *Luminary and System Material Components and Emission Factors*: To determine the upstream environmental impacts of roadway lighting systems a material breakdown of system components is required including luminaries and support structures. The bill of materials can be associated with emission factors found in LCA databases or published literature. In some cases, data points that reflect the entire luminary may exist. In others, the cumulative environmental impact can be estimated through the breakdown of its constituent parts.
- *Construction and Maintenance Fuel Use:* Emissions directly related to construction and maintenance activities are determined from estimates of fuel use by vehicles.

The relationship of these components to an LCCA and LCA of a roadway lighting system is illustrated in Figure 1. Impacts associated with ancillary and support systems are not covered by the tool due to a lack of data but are included in the system diagram.

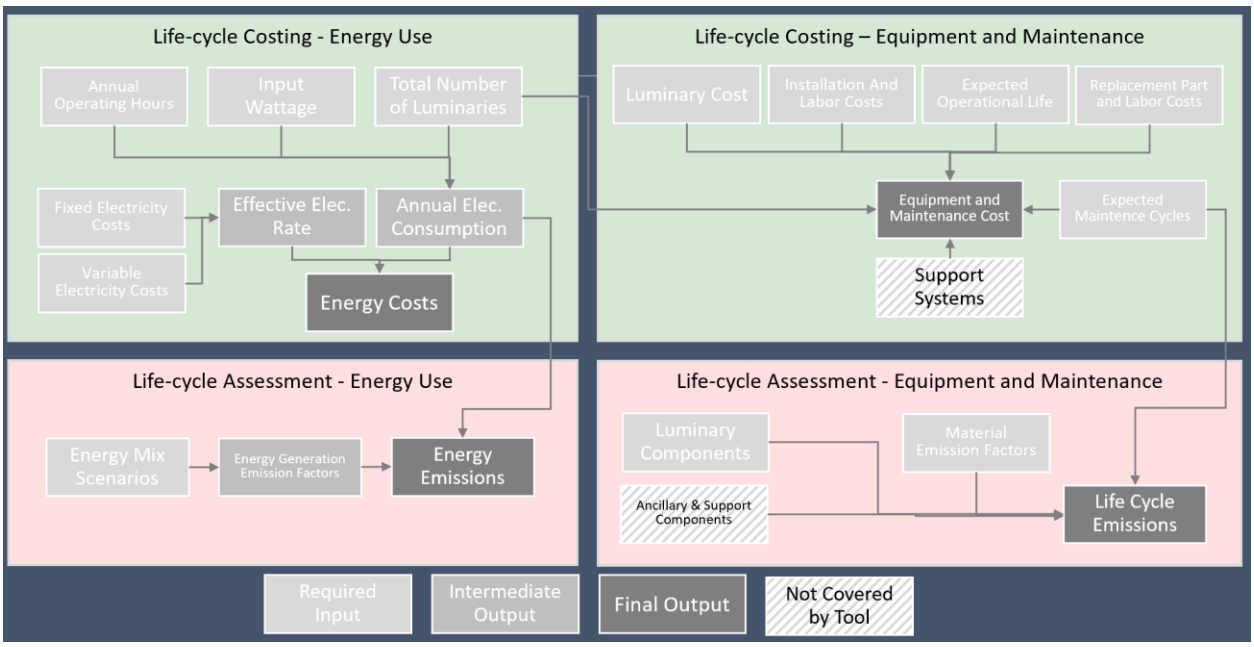


Figure 1 LCCA and LCA Roadway Lighting Tool System Diagram

Queen Creek Tunnel Data

To develop estimates for the Queen Creek Tunnel data was collected from various sources.

Luminaries

Three different lighting configurations were modeled. They include the HPS system present prior to the LED upgrade, the LED System, and a functionally equivalent new HPS system that was considered in the design process. The details of these systems are described in Table 1

Table 1 Luminary Details for System Alternatives (Source: Queen Creek Tunnel Lighting History – Presentation, Karim Rashid)

	Number of Fixtures	Input Wattage	Lumens
Original HPS	144	400	45000
LED	69	123	15000
	262	349	34000
New HPS	46	150	15000
	472	400	45000

Annual Operating Hours

For visibility, tunnels require both daytime and nighttime lighting. It is assumed that the original HPS System referenced above operated 24 hours a day (8,760 hours annually). Engineering plans for the new LED system identify nighttime exclusive, always on, and emergency lighting within the tunnel. It is assumed that nighttime exclusive lighting operates 4,380 hours annually (12 hours/day) and emergency lights operate zero hours annually. While engineering documents are not available for the new HPS alternative, it is assumed that the relative percentage of nighttime exclusive, always on, and emergency lighting is consistent with the LED system (Table 2).

Table 2 Annual Operating Hours by System and Light Type

	Number of Fixtures	Nighttime Exclusive	Always on	Emergency
Original HPS	144	0	144	0
LED	69	9	29	31
	262	262	0	0
New HPS	46	6	19	21
	472	472	0	0

Carbon Intensity of Current and Future Electricity Mix

With sustainability in mind, states and agencies that provide electricity have made commitments to reducing emissions created by electricity generation through improvements in

efficiency of existing technologies and transitions towards renewable technologies. While Arizona's current commitments only extend through 2025 with a goal of 15% renewables, both Arizona Power Supply (APS) and Salt River Project (SRP) have made long term commitments to reducing their carbon footprint. SRP's ambitious goals of reducing carbon CO_2 emissions by 62% from 2005 levels by 2035 and 90% in 2050 were used to approximate an annual electricity emission factor within Arizona (Figure 2).

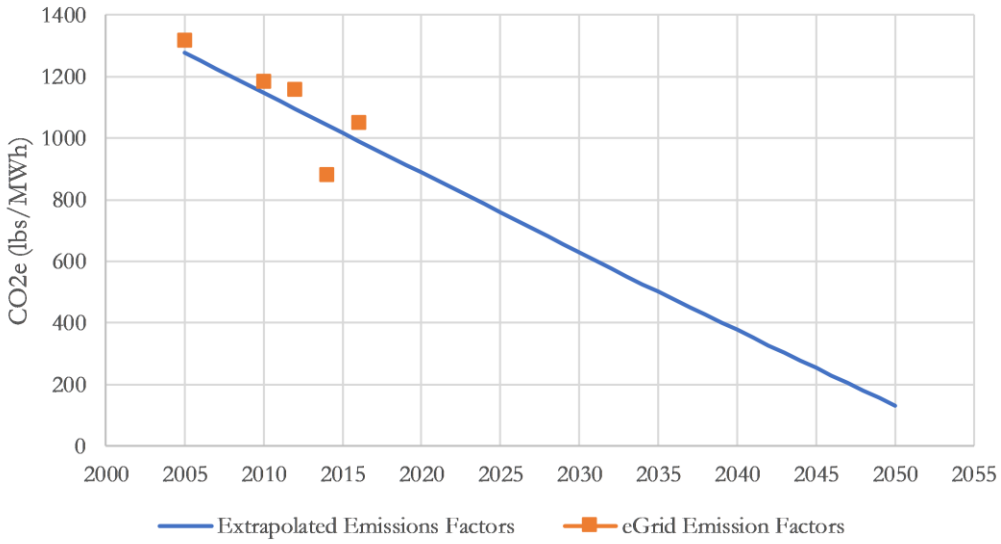


Figure 2 Arizona Electricity Emission Factors (Source: eGrid and SRP 2035 Sustainability Goals)

Electricity Pricing

The price of electricity can vary depending on several factors. Costs include both fixed costs such as service fees as well as variable costs including usage and taxes. To determine an average rate to use in this assessment past ADOT accounts for roadway lights in both APS and SRP service areas were examined (Figure 3). An average effective rate of $0.11/kWh was selected for this analysis.

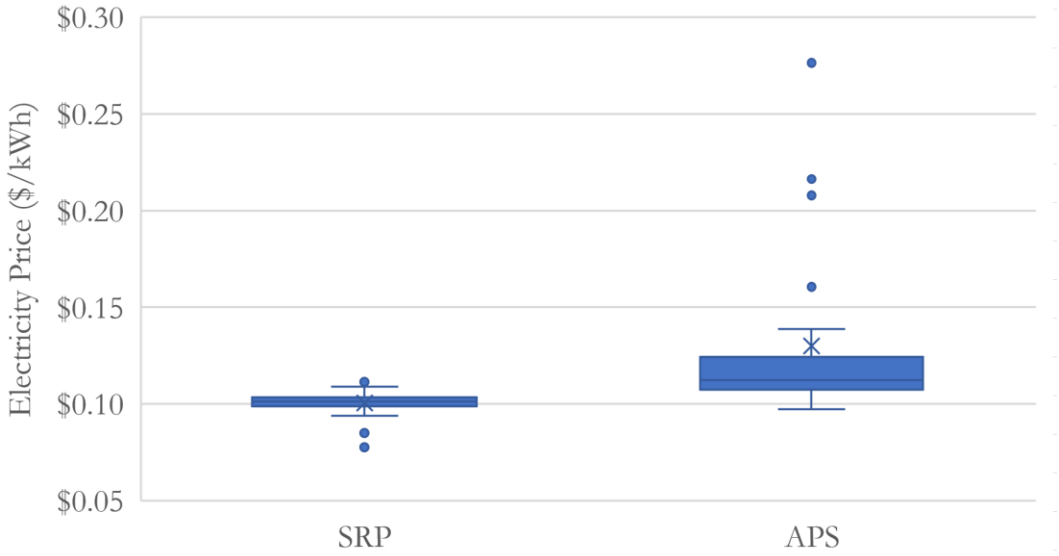


Figure 3 Effective Electricity Rates of Existing ADOT Roadway Lighting Systems Within SRP and APS Service Areas

Luminary and Labor Cost

To determine costs associated with the two new systems, bid estimates were examined. Average maintenance costs which include materials, labor, traffic control and other elements were determined from recent ADOT roadway lighting maintenance contracts. The existing maintenance contracts are for HPS systems exclusively. Due to a lack of information on LED maintenance, it is assumed that maintenance costs for LED and HPS systems are equivalent. Average maintenance costs are assumed to be $305/fixture.

Table 3 Year 0 System Costs. (Year 0 Costs for the old HPS System are assumed to be one entire maintenance cycle)*

	Price
Old HPS*	$45,000
LED	$4.3 Million
New HPS	$5.5 Million

Luminary Operational Life

ADOT's standard maintenance cycles for HPS lights include lamp replacement after 30 months and ballast and lamp replacement after 60 months. Maintenance cycles for LED lights are based on an estimated lifetime of 100,000 hours (approximately 136 months).

Luminary and System Material Components and Emission Factors

There is limited publicly available information on the luminaries used and other system components. In order to approximate the life-cycle impacts associated with HPS and LED luminaries manufacturing processes and materials a 2015 LCA study comparing the two lighting

technologies was used (Table 4). The study represents the most comprehensive LCA study of the two technologies to date. There are likely opportunities to update these factors as environmental product declarations (EPDs) become more common for consumer products. A limitation of this case study and tool is the inability to capture the life-cycle impacts associated with other system aspects such as adaptive diming controllers and sensors.

Table 4 Life-cycle Impacts of LED and HPS Roadway Lighting Technologies (Source: Tähkämö, Leena, and Liisa Halonen. "Life cycle assessment of road lighting luminaires–comparison of light-emitting diode and high-pressure sodium technologies.")

	LED	**HPS**
kg $CO2_e$/Gigalumen Hour	822	175

Construction and Maintenance Fuel Use

Data associated with fuel use during construction and maintenance of roadway lighting systems are not readily available. This analysis assumes that fuel costs represent 1% of the total construction or maintenance costs for the respective projects. All fuel used in construction and maintenance is assumed to be diesel and an average per gallon price of $2.30 (Source: Energy Information Administration – 2016 Average Price).

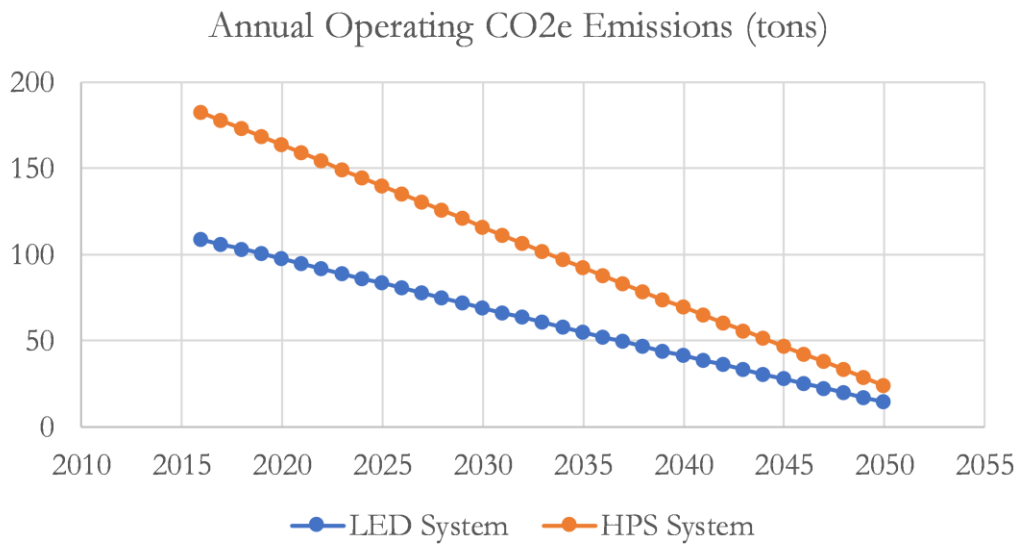
Results

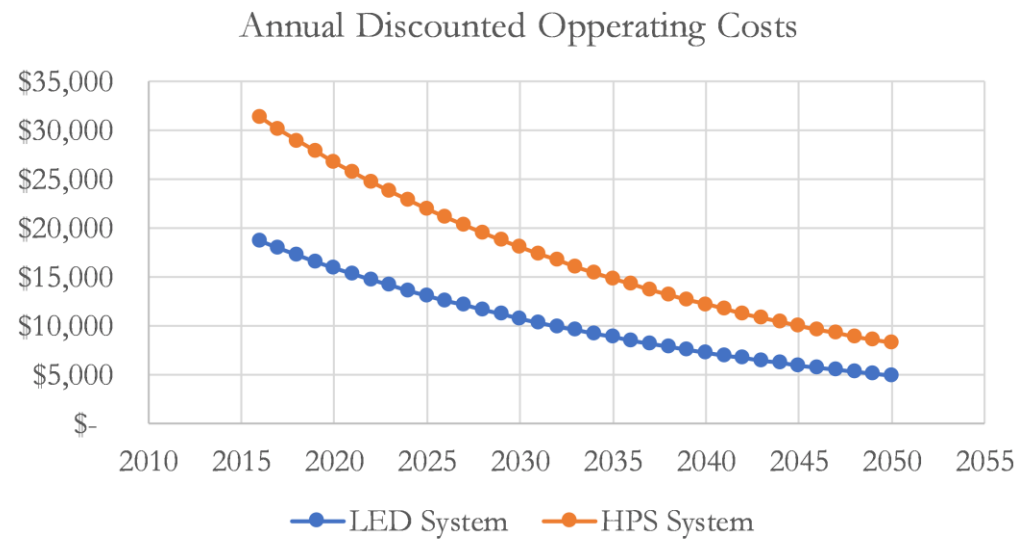
Among the potential options available to ADOT with the Queen Creek Tunnel was the rehabilitation of the existing system. While it did not meet modern lighting requirements for tunnels, rehabilitation of the existing system would have been significantly cheaper. It is estimated that a system rehabilitation would have cost approximately $45,000 compared to the $4.3 million spent installing the current LED system. In addition to meeting modern tunnel lighting requirements and improving safety within the tunnel it is estimated that the new LED system will save approximately $450,000 in operational and maintenance costs through 2050. In terms of emissions, the LED system is estimated to produce $CO2_e$ savings of 1154 tons through 2050. As expected, based on previous lighting studies, the vast majority of the savings result from significant reductions in operational $CO2_e$ that result from the improved efficiency of LED lights (Table 5). However, as electricity becomes less carbon intense in the future the savings provided by LED lights relative to the old HPS system significantly diminish (Figure 4 – Annual Operating $CO2_e$ Emissions). If a primary goal of upgrading to LED roadway lighting systems is environmental savings, the results show that transitioning to LED technologies as soon as possible is critical to achieve maximum environmental savings.

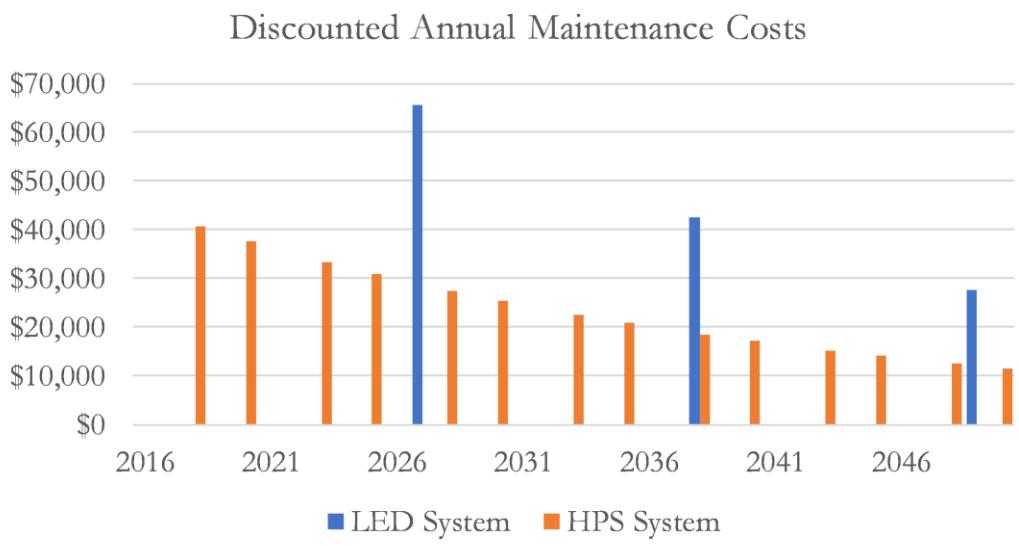
Table 5: Life-cycle Cost and Life-cycle Assessment Key Metrics Comparing Old High-Pressure Sodium System with the new Light-emitting Diode System. (Note: an annual discount rate of 4% was assumed)

Life-cycle Cost Metrics		
	LED System	HPS System
Year 0 Costs (Initial Construction or Refurbishment)	**$4,345,949**	**$45,000**
Total Discounted Maintenance Cost to 2050	**$135,848**	**$327,648**
Total Discounted Operating Cost to 2050	**$362,254**	**$607,744**
Net Impact of LED compared to HPS System	**-$3,863,659**	

Life-cycle Assessment Metrics		
	LED System	HPS System
Life-cycle Operational MWh	**7684**	**12892**
Life-cycle Operational CO2e Emissions (tons)	**2137**	**3585**
Life-cycle Luminary CO2e Emissions (tons)	**138**	**38**
Construction CO2e Emissions (tons)	**212**	**2**
Life-cycle Maintenance CO2e Emissions (tons)	**15**	**30**
Net CO2 Savings (tons)	**1154**	


Annual Operating CO2e Emissions (tons)
200
150
100
50
0
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
LED System
HPS System


Annual Discounted Opperating Costs
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$-
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
LED System
HPS System


Discounted Annual Maintenance Costs
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$0
2016
2021
2026
2031
2036
2041
2046
LED System
HPS System

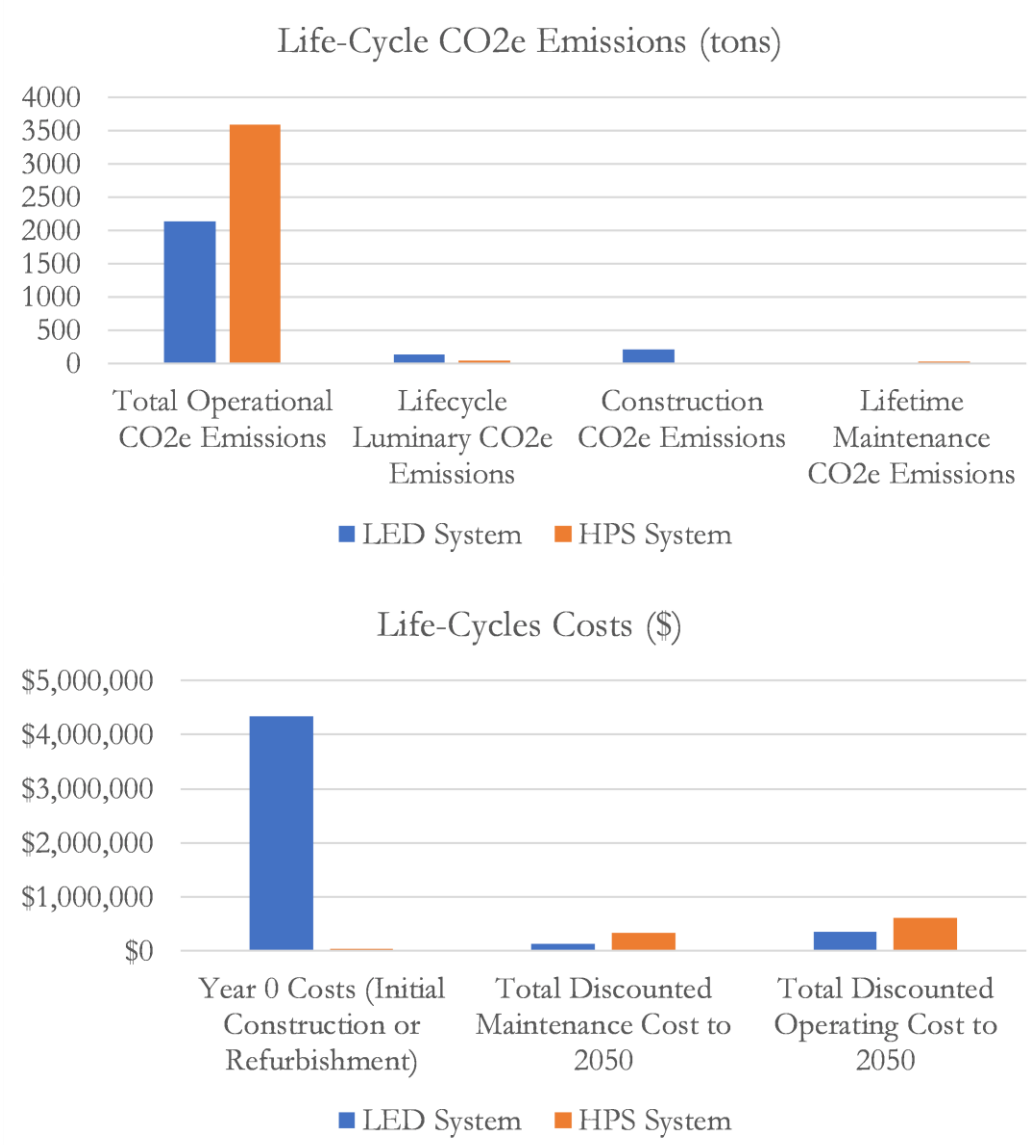


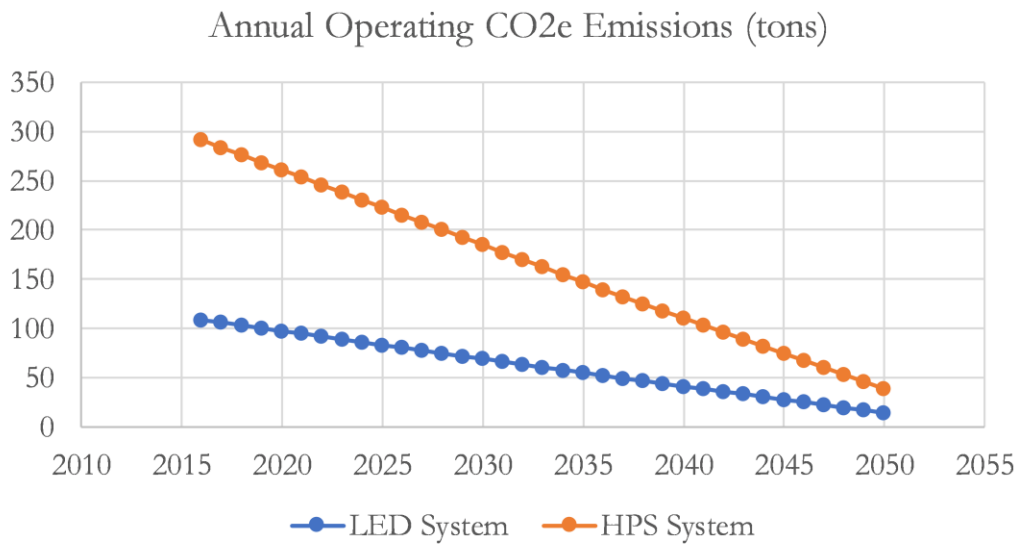
Figure 4 Annual Operation and Life-Cycle Figures Comparing Old High-Pressure Sodium System with the new Light-emitting Diode System

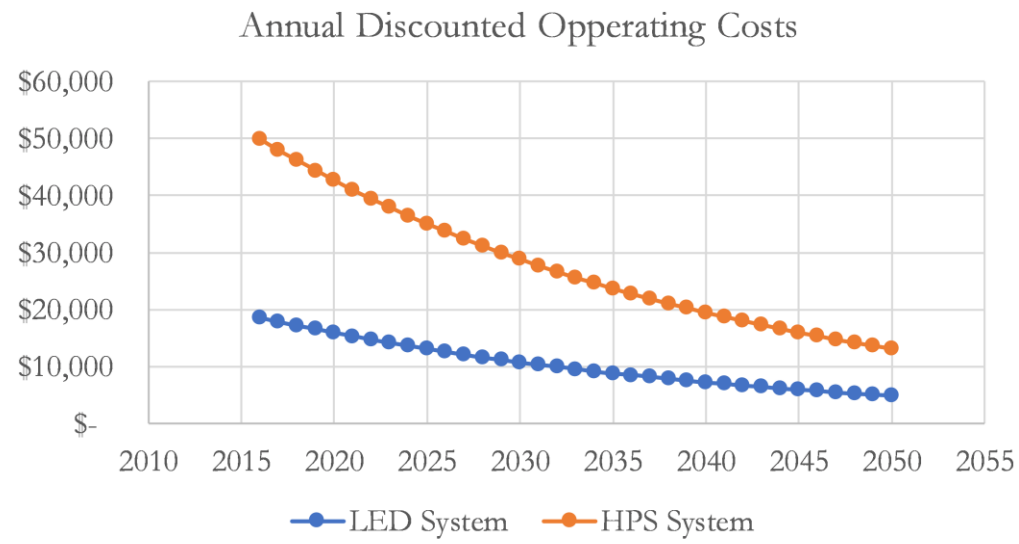
ADOT considered several options to upgrade the Queen Creek Tunnel lighting system. The options included both HPS and LED technologies and a variety of luminary placement options. The installed LED system was compared with the lowest cost HPS system. In addition to significant upfront cost savings (approximately $1.2 million) it is estimated that the LED system will yield long-term cost and environmental benefits. The life-cycle cost savings (out to 2050) of the LED system when compared with the HPS alternative is $2.8 million and saves 3654 tons of $CO2_e$ emissions. While life-cycle $CO2_e$ savings are dominated by savings in operational electricity usage (97%), cost savings are more evenly distributed across upfront (41%), maintenance (37%), and operational (22%) savings (Table 6).

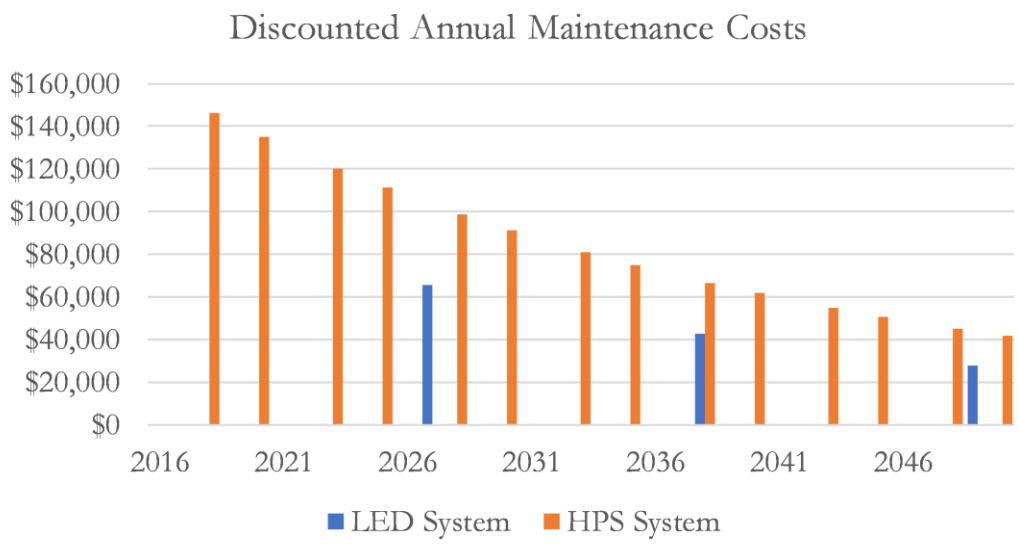
Table 6: Life-cycle Cost and Life-cycle Assessment Key Metrics Comparing new Light-emitting Diode System and High-pressure Sodium Upgrade Option (Note: an annual discount rate of 4% was assumed)

Life-cycle Cost Metrics		
	LED System	HPS System
Year 0 Costs (Initial Construction or Refurbishment)	**$4,345,949**	**$5,500,000**
Total Discounted Maintenance Cost to 2050	**$135,848**	**$1,178,622**
Total Discounted Operating Cost to 2050	**$362,254**	**$969,098**
Net Impact of LED compared to HPS System	**$2,803,669**	

Life-cycle Assessment Metrics		
	LED System	HPS System
Life-cycle Operational MWh	**7684**	**20557**
Life-cycle Operational CO2e Emissions (tons)	**2137**	**5716**
Life-cycle Roadway Luminary CO2e Emissions (tons)	**138**	**63**
Construction CO2e Emissions (tons)	**212**	**268**
Life-cycle Maintenance CO2e Emissions (tons)	**15**	**108**
Net CO2 Savings (tons)	**3654**	


Annual Operating CO2e Emissions (tons)
350
300
250
200
150
100
50
0
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
LED System
HPS System


Annual Discounted Opperating Costs
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$-
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
LED System
HPS System


Discounted Annual Maintenance Costs
$160,000
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
2016
2021
2026
2031
2036
2041
2046
LED System
HPS System

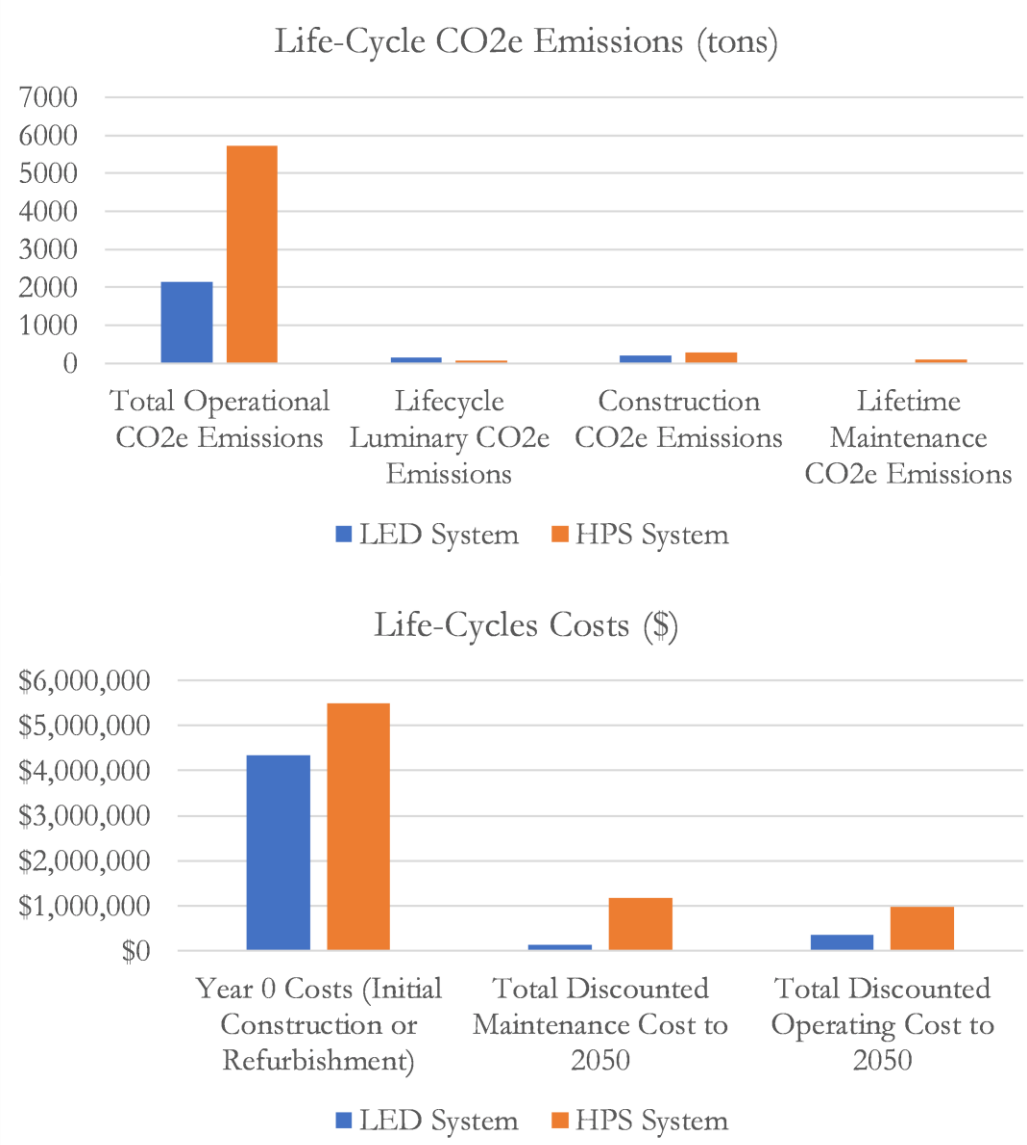


Figure 5 Annual Operation and Life-Cycle Figures Comparing new Light-emitting Diode System and High-pressure Sodium Upgrade Option

Conclusions

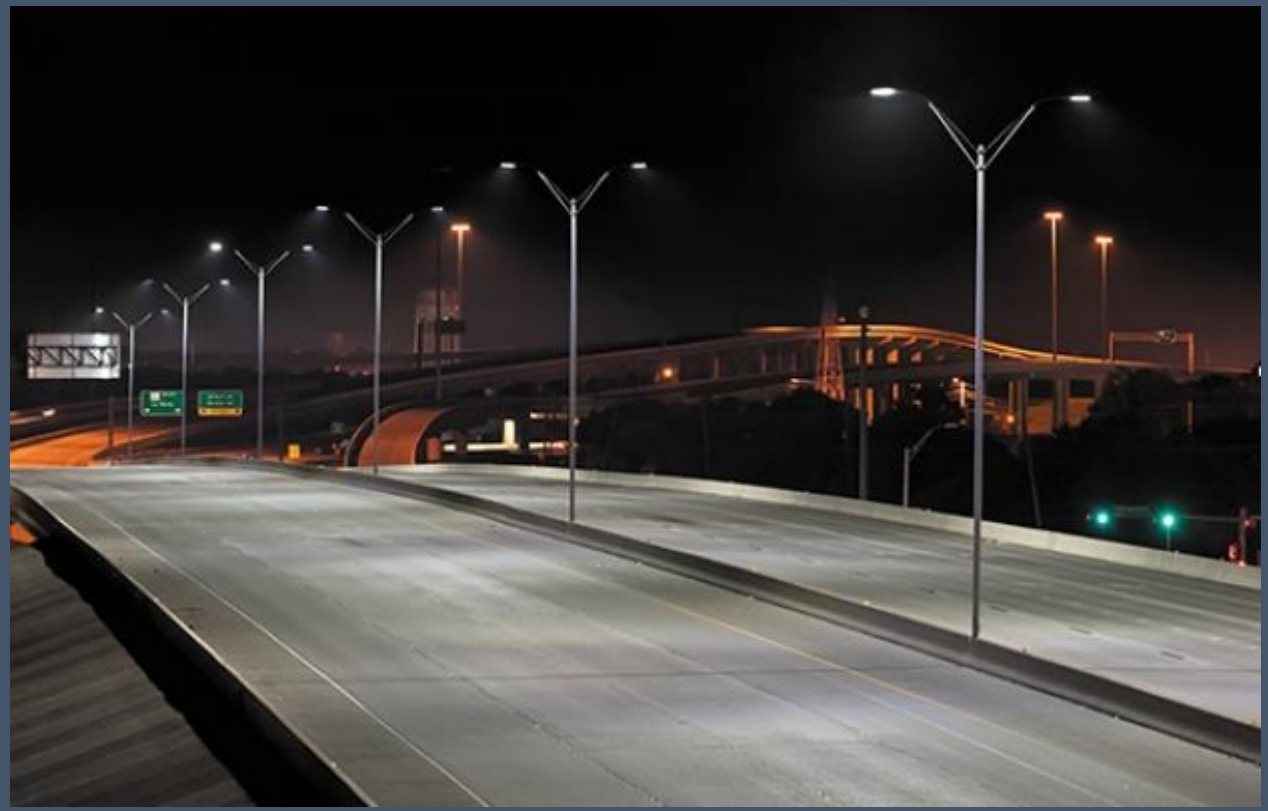
- Light-emitting Diode roadway technologies can offer substantial cost and environmental benefits relative to High-pressure Sodium.
- The operational electricity savings are responsible for the majority environmental benefits while cost savings are spread more evenly across the systems life-cycle in functionally equivalent systems.
- Reductions in the carbon intensity of electricity in the future will significantly reduce the environmental benefits of LEDs relative to HPS technologies.

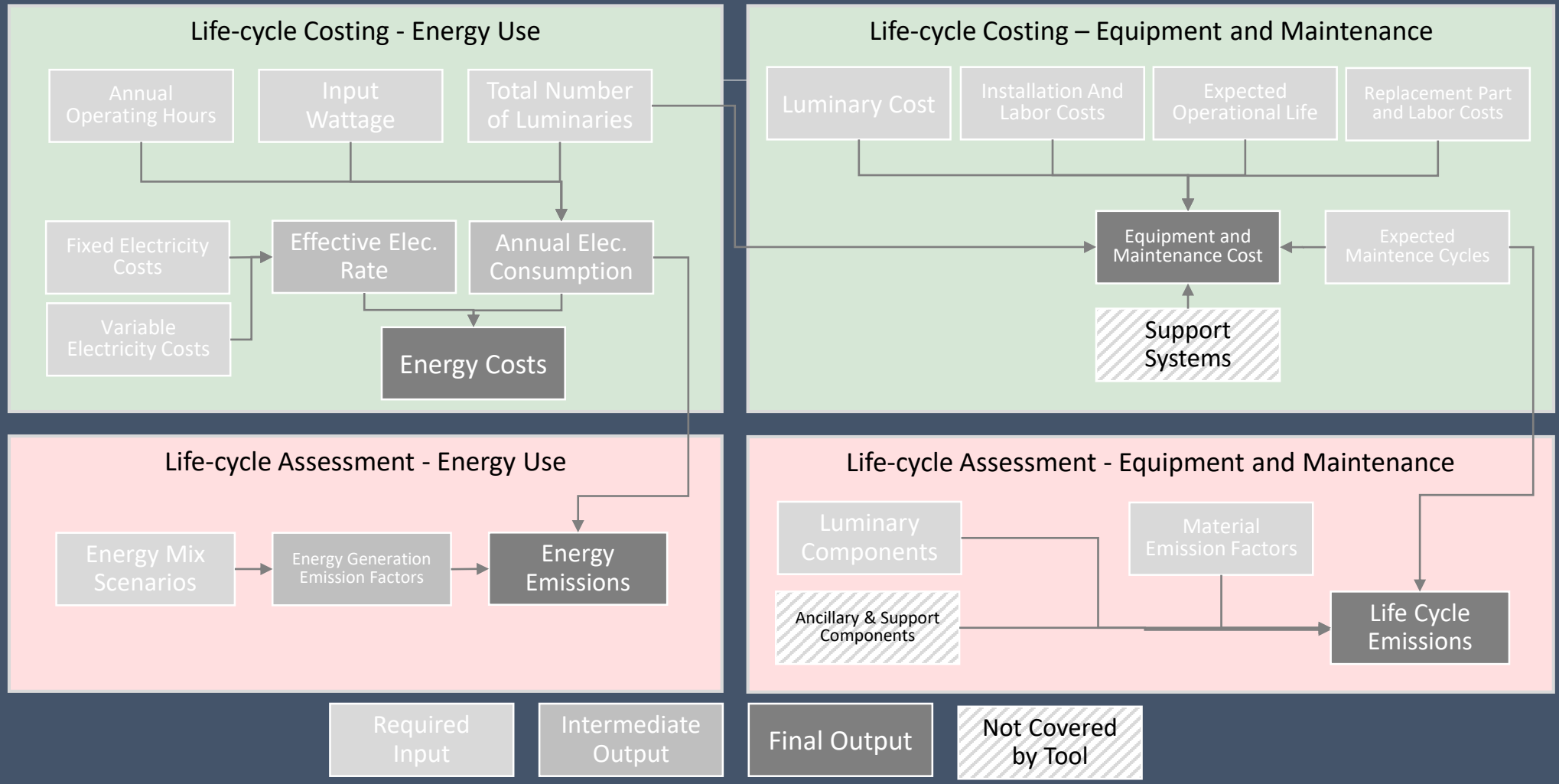
Roadway Lighting LCA & LCCA Estimator

Andrew Fraser, Ph.D.
Assistant Research Professor
School of Sustainable Engineering and the Built Environment
Arizona State University

Roadway Lighting LCA & LCCA Estimator

- The tool uses basic inputs describing roadway lighting systems to estimate Life-cycle Emissions and Life-cycle Costs.
- It is designed to directly compare Light Emitting Diode (LED) and High Pressure Sodium (HPS) lighting technologies or analyze each separately.




Life-cycle Costing - Energy Use
Annual Operating Hours
Input Wattage
Total Number of Luminaries
Fixed Electricity Costs
Variable Electricity Costs
Effective Elec. Rate
Annual Elec. Consumption
Energy Costs
Life-cycle Costing – Equipment and Maintenance
Luminary Cost
Installation And Labor Costs
Expected Operational Life
Replacement Part and Labor Costs
Equipment and Maintenance Cost
Expected Maintence Cycles
Support Systems
Life-cycle Assessment - Energy Use
Energy Mix Scenarios
Energy Generation Emission Factors
Energy Emissions
Life-cycle Assessment - Equipment and Maintenance
Luminary Components
Material Emission Factors
Ancillary & Support Components
Life Cycle Emissions
Required Input
Intermediate Output
Final Output
Not Covered by Tool

Spreadsheet Tool Interface

Roadway Lighting System Details

		Quantity	Rated Wattage	Annual Operating Hours	Lumens	Electricity Use Reduction Factor*
LED System	Luminary Type 1	9	123	4380	15000	51%
	Luminary Type 2	29	123	8760	15000	51%
	Luminary Type 3	31	123	0	15000	51%
	Luminary Type 4	262	359	4380	34000	51%
HPS System	Luminary Type 1	144	400	8760	45000	27%
	Luminary Type 2					0%
	Luminary Type 3					0%
	Luminary Type 4					0%

		LED System	HPS System
Year 0 Cost		$4,345,949	$ 45,300
Construction Fuel Use (Gallons)		1000	1000
Maintenance Costs per Fixture	Traffic Control	$ -	$ -
	Labor	$ -	$ -
	Ballast	$ -	$ -
	Lamp	$ -	$ -
	Materials (etc.) #	$ 314.58	$ 314.58
Maintenance Frequency	Expected Lamp Life (Months)	136	30
	Expected Ballast Life (Months)	0	60
Maintenace Fuel Use (Gallons per Fixture)		5	5

Electricity Price ($/kwh) ×	$ 0.09
Nominal Electricty Cost Escalation Rate (%)	1.0%
Nominal Maintenance Cost Escalation Rate	1.0%
Nominal Discount Rate (%)	4.0%
Analysis First Year	2005

* Energy Reduction factor is used to account for the effects of addaptive dimming, light outages, or other system aspects that reduce electricity demand.
# If costs for individual categories listed above are unknown, an average maintenance cost per fixture should be entered here.
× Electricity costs should also include average fixed costs if available.

Spreadsheet Tool Interface

		Quantity	Rated Wattage	Annual Operating Hours	Lumens	Electricity Use Reduction Factor*
LED System	Luminary Type 1	9	123	4380	15000	51%
	Luminary Type 2	29	123	8760	15000	51%
	Luminary Type 3	31	123	0	15000	51%
	Luminary Type 4	262	359	4380	34000	51%
HPS System	Luminary Type 1	144	400	8760	45000	27%
	Luminary Type 2					0%
	Luminary Type 3					0%
	Luminary Type 4					0%

- The first table requires basic inputs describing the lights and operating conditions.
- The Electricity Use Reduction Factor is used to capture the effects associated with adaptive dimming controls, prolonged light outages within the system, or other elements that reduce annual electricity use.

Spreadsheet Tool Interface

		LED System	HPS System
Year 0 Cost		$4,345,949	$ 45,300
Construction Fuel Use (Gallons)		1000	1000
Maintenance Costs per Fixture	Traffic Control	$ -	$ -
	Labor	$ -	$ -
	Ballast	$ -	$ -
	Lamp	$ -	$ -
	Materials (etc.) #	$ 314.58	$ 314.58
Maintenance Frequency	Expected Lamp Life (Months)	136	30
	Expected Ballast Life (Months)	0	60
Maintenace Fuel Use (Gallons per Fixture)		5	5

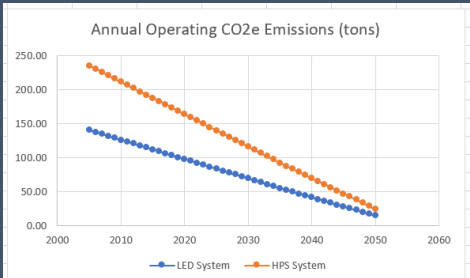
- The second table asks for specifics about construction and maintenance costs, fuel use and maintenance frequency.
- Fuel use is used to estimate the environmental impact of construction and maintenance activities
- Maintenance costs have been broken out into several key components. If unknown, general costs can be entered in the Materials category
- Maintenance frequencies are used determine in which future years maintenance occurs.

Spreadsheet Tool Interface

Electricity Price ($/kwh) *	$ 0.09
Nominal Electricty Cost Escalation Rate (%)	1.0%
Nominal Maintenance Cost Escalation Rate	1.0%
Nominal Discount Rate (%)	4.0%
Analysis First Year	2005

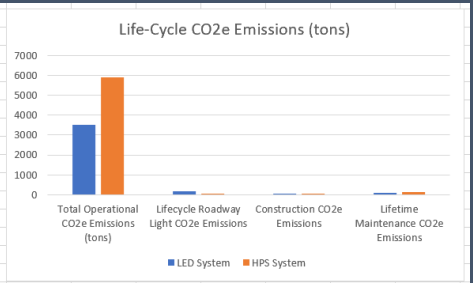
- The final table references other key parameters.
- Electricity costs should include both unit-based as well as fixed costs.
- Escalation factors can be used to account for projected increases in the cost of electricity and maintenance. Increasing maintenance costs would include both labor and materials.
- All future costs are discounted based on the nominal discount rate provided.
- The tool is capable of running analyses back to 2005. All analyses regardless of “First Year” are run until 2050.

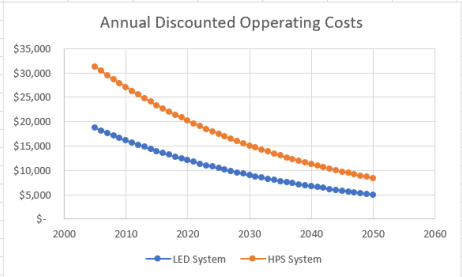
Spreadsheet Tool Results

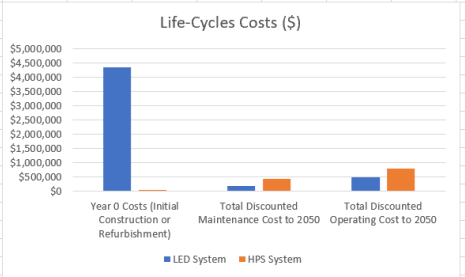


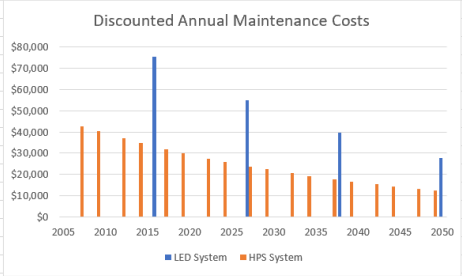
Life Cycle Cost Metrics		
	LED System	HPS System
Year 0 Costs (Initial Construction or Refurbishment)	$4,345,949	$45,300
Total Discounted Maintenance Cost to 2050	$197,680	$446,422
Total Discounted Operating Cost to 2050	$478,638	$802,999
Net Impact of LED compared to HPS System	-$3,727,547	

Life Cycle Assessment Metrics		
	LED System	HPS System
Lifetime Operational MWh	10099	16944
Total Operational CO2e Emissions (tons)	3521	5908
Lifecycle Roadway Light CO2e Emissions	181	50
Construction CO2e Emissions	11	11
Lifetime Maintenance CO2e Emissions	74	145
Net CO2 Savings (tons)	2327	









Spreadsheet Tool Results

- The results tab displays five figures and a table describing the results.
- The figures include:
  - Annual Operating $CO2_e$ Emissions
  - Annual Discounted Operating Costs
  - Annual Discounted Maintenance Costs
  - Life-cycle $CO2_e$ Emissions
  - Life-cycle Costs
- The table directly compares key Life-cycle Assessment and Life-cycle Cost Metrics between the two systems.

Life Cycle Cost Metrics		
	LED System	HPS System
Year 0 Costs (Initial Construction or Refurbishment)	$4,345,949	$45,300
Total Discounted Maintenance Cost to 2050	$197,680	$446,422
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Life Cycle Assessment Metrics		
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Lifetime Operational MWh	10099	16944
Total Operational CO2e Emissions (tons)	3521	5908
Lifecycle Roadway Light CO2e Emissions	181	50
Construction CO2e Emissions	11	11
Lifetime Maintenance CO2e Emissions	74	145
Net CO2 Savings (tons)	2327	

Appendix B – FHWA INVEST Scoring

INVEST Memorandum - Interstate 11

Use of INVEST Sustainable Project Development and System Planning for States Modules to Explore Sustainability in the Tier 1 I-11 Build Corridor Alternatives

September 2019

ADOT

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

U.S. Department of Transportation
Federal Highway Administration

Federal Aid No. 999-M(161)S
ADOT Project No. 999 SW 0 M5180 01P

Acronyms and Abbreviations

ADOT	Arizona Department of Transportation
ASR	Alternatives Selection Report
BCA	Benefit-Cost Analysis
BMP	Best Management Practice
CSS	Context-Sensitive Solutions
CWMP	Construction and Demolition Waste Management Plan EIA
	Economic Impact Analysis
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
GIS	Geographic Information Systems
HOAR	High Quality Aquatic Resources I
	Interstate
ITS	Intelligent Transportation Systems
INVEST	Infrastructure Voluntary Evaluation Sustainability Tool
LCCA	Lifecycle Cost Analysis
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NMP	Noise Mitigation Plan
NRHP	National Register of Historic Places NRMCA
	National Ready Mixed Concrete Association OM
	Operations and Maintenance
PD	Project Development
RAP	Reclaimed Asphalt Pavement
RCA	Recycled Concrete Aggregate
SPS/SPR	System Planning for States/System Planning for Regions

INTRODUCTION AND OVERVIEW

Overview of INVEST

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by the Federal Highway Administration (FHWA) as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects. The INVEST web-based tool allows users to self-evaluate programs or projects using these criteria to obtain a snapshot of the sustainability of the program or project in time. The tool also allows the user to include notes on scoring and implementation actions that can assist the user in integrating criteria and making progress over time. Although many agency efforts could already be considered sustainable, INVEST is focused on "above and beyond" efforts. Efforts that are typically required, such as National Environmental Policy Act (NEPA) resource analysis areas, are not included within the INVEST criteria.

INVEST considers the full lifecycle of projects and has four modules to self-evaluate the entire lifecycle of transportation services, including System Planning for States or Regions (SPS or SPR), Project Development (PD), and Operations and Maintenance (OM). Each of these modules is based on a separate collection of criteria and can be evaluated separately.

Purpose of Memorandum

The Arizona Department of Transportation (ADOT), in partnership with the FHWA has utilized the latest version of INVEST (1.3) on numerous agency projects and programs in varying stages of development to document, explore, and identify sustainability elements of projects for incorporation, as well as provide feedback on the current INVEST 1.3 version of the tool. The goal of this I-11 INVEST memorandum is to document the use of INVEST on the three Build Corridor Alternatives currently under study as part of the FHWA and the ADOT Interstate 11 (I-11) Tier 1 Environmental Impact Statement (EIS), and to complete this case study that will explore and identify potential ways the INVEST tool can link sustainability and the NEPA process, inform future Tier 2 design efforts, and influence overall ADOT sustainable transportation program implementation processes.

I-11 Tier 1 EIS

The ADOT and FHWA are conducting the environmental review process for the I-11 Corridor from Nogales to Wickenburg, Arizona. An Alternatives Selection Report (ASR) and Tier 1 Environmental Impact Statement (EIS) have been prepared as part of this process in accordance with NEPA and other regulatory requirements.

The study is atypical in that it is a tiered EIS process assessing a corridor of approximately 280-miles. Initially, the ASR assessed a comprehensive range of corridor alternatives through a robust high level evaluation process that used extensive public and agency input, innovative public outreach methods, previous studies, and various topographical, environmental, and other planning information to help identify opportunities and constraints. The study also used Quantm, a specialized program used to

design roadway and railway alignments. The software uses topographic information, engineering design criteria, and environmental constrains to generate a list of optimized alignments. These were reduced to a reasonable range and carried forward into the Draft Tier 1 EIS for more detailed environmental review – see Figure 1.

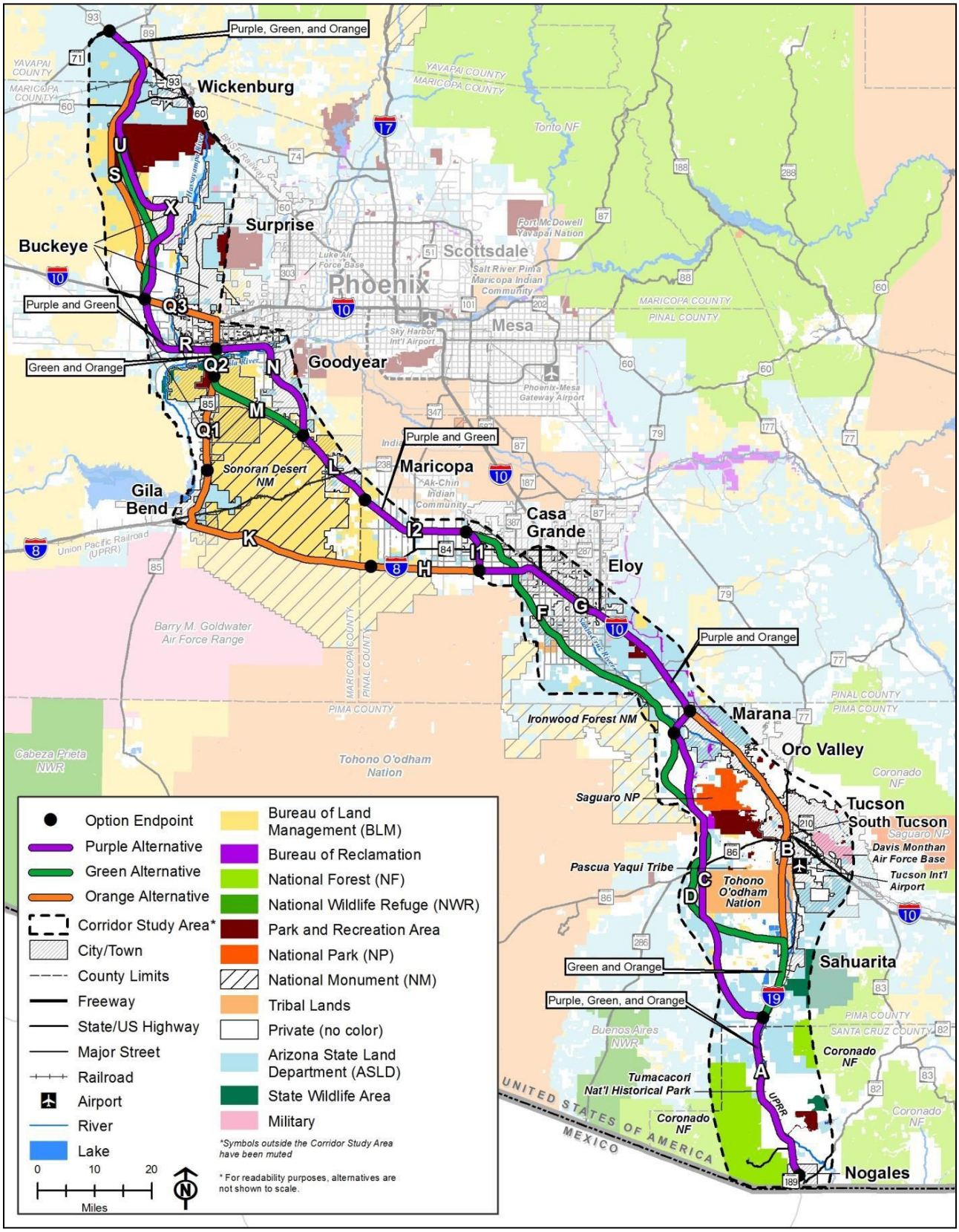


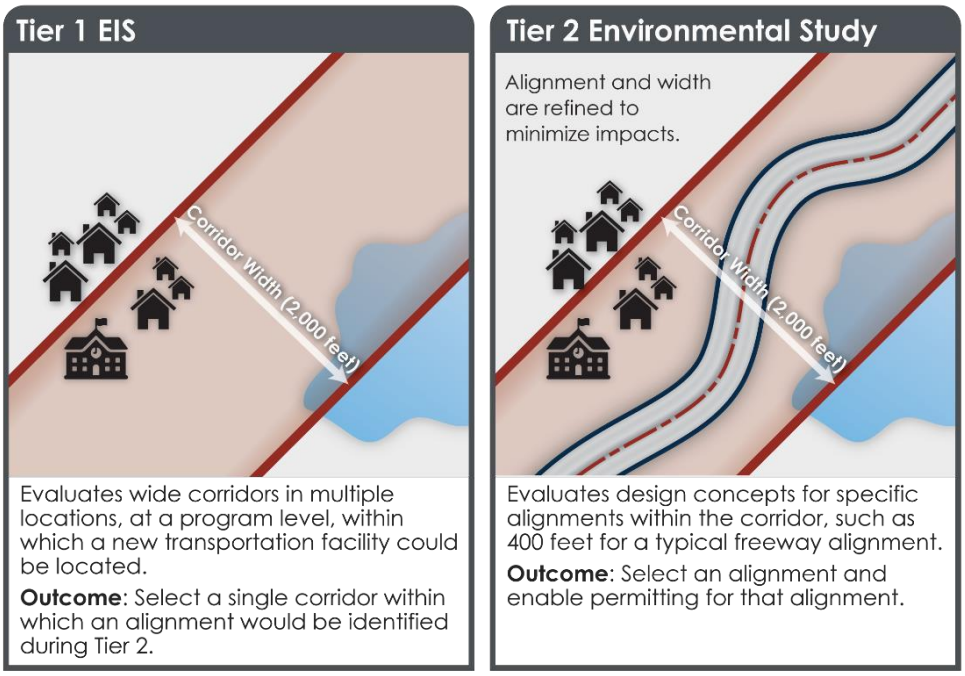
Figure 1. I-11 Build Corridor Alternatives

The Tier 1 EIS continues to assess the potential social, economic, and natural environmental impacts of the No Build Alternative and remaining corridor alternatives (i.e., Build Alternatives). In addition to the Tier 1 EIS, a project specific Tier 1 Section 106 Programmatic Agreement has been created to identify a Tier 2 Section 106 process and ensure coordination and compliance for all stages of the EIS. The I-11 Draft Tier 1 Environmental Impact Statement and Preliminary Section 4(f) Evaluation (Draft Tier 1 EIS) was completed and made available for public review and comment on April 5, 2019. Based on the comments received and any additional technical analysis, the study team will prepare a Final Tier 1 EIS, outlining a Preferred Alternative for I-11. A Preferred Corridor Alternative will be identified in the Final Tier 1 EIS in late 2020, that will provide an initial concept for proposed incremental projects within the I-11 Corridor that could be pursued in the future, following completion of the Tier 1 EIS. A Tier 1 document will not include design details.

Scope of a Tier 1 EIS

A Tier 1 EIS encompasses a programmatic approach for identifying existing and future conditions and evaluating the comprehensive effects of the project on the region. The decision at the end of the Tier 1 EIS process would select a 2,000-foot-wide Build Corridor Alternative that would advance to further design and Tier 2 NEPA analysis or select the No Build Alternative. Tier 2 environmental studies would be required to determine the specific alignment of I-11, including design details, and would evaluate more specific project-level issues, such as individual property impacts and specific mitigation. Tier 2 environmental studies could occur in phases, breaking up the 280-mile long Nogales to Wickenburg corridor into interim projects or shorter segments, as funding becomes available. Figure 2 provides context to the level of detail in a Tier 1 environmental study.

Figure 2. Tier 1 Environmental Study Level of Detail



INVEST MODULE AND SCORING

INVEST Module

The I-11 Tier 1 EIS corridor alternatives represent the range of viewpoints voiced during the study, from supporting the development of a mostly new corridor (Green) to using the existing corridors as much as possible (Orange), and a mix of the two (Purple). INVEST was used for this project as a case study to qualitatively assess the three Build Corridor Alternatives and present their scorings in this INVEST memorandum using the Project Development (PD) Module and the System Planning for States (SPS) module for purposes of linking NEPA and planning studies to incorporate sustainability into the long range project development process. The SPS is traditionally the first step in the lifecycle of a transportation project, and the module includes criteria to self-evaluate an agency's system-level planning and programming policies, processes, procedures and practices. The SPS module in the current INVEST tool includes a total of seventeen (17) criteria that are generally organized from system analysis to corridor wide metropolitan planning programs. PD is traditionally the second step in the lifecycle of a transportation project, where specific projects are planned, designed, and constructed. The PD module in the current INVEST tool includes a total of thirty-three (33) criteria that are generally organized from planning to design to construction. The PD criteria are further organized into seven (7) scorecards for the evaluation of projects. The scorecards are designed to identify applicable criteria based on the project type (paving, small/spot improvements, new facility/corridor project) and location (urban/rural). Six (6) of these scorecards pre-identify criteria that are most likely to be applicable for the project type and location.

Because the study is 280-mile in length, the corridor alternatives were assessed using the PD – Urban Extended scorecard, comprised of thirty-three (33)criteria, defined as a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. Additionally, this evaluation also included SPS that considers regional evaluations for economics, social, multimodal planning, and other regional planning considerations. Combining the criteria of these two modules for this case study will help further understand the linkages that can be made to NEPA planning, project development, and sustainability.

In addition to the PD – SPS criteria, the I-11 Tier 1 EIS also completed innovative and “above and beyond” practices that could be identified as Innovative Criteria. As described by the FHWA INVEST tool, the Innovative Criteria allows sustainable innovations and emerging technologies to be addressed in their projects or programs evaluation that are not represented in INVEST in order to earn points for these innovations. For the purposes of this case study evaluation, the following Innovative Criteria are identified:

SPR-IN-01 – Use of Emerging Technology for Alternatives Analysis (Quantm): Because of the high level analysis needed at the Tier 1 level, an innovative GIS program was used to design roadway and railway alignments. The software uses topographic information, engineering design criteria, and environmental constrains to generate a list of optimized alignments. This helped refined a range of reasonable alternatives at this Tier 1 high level with consideration from all public, agency, and tribal stakeholders.

SPR-IN-02 – Above and Beyond Public Input with Udall Foundation Efforts: The ADOT and FHWA engaged with the public in Southern Arizona in an additional effort to seek input on the Tier 1 effort. This coordination effort was undertaken with the study team and the US Institute for Environmental Conflict Resolution (Udall Foundation). A series of workshops and meetings were had to discuss the Tier 1 study and valuable input was provided to the study team for incorporation into the EIS.

SPR-IN-03 – Above and Beyond Section 106 Programmatic Agreement & NEPA Innovative Process for Tier 1 Studies: Because the future of Tier 2 studies is unknown and not programmed or funded, the ADOT and FHWA sought out an innovative way to ensure compliance with Section 106 and the National Historic Preservation Act through the use of a project specific Tier 1 Programmatic Agreement (PA). This PA allowed decisions for the process, implementation, and coordination to be discussed and formally documented in the Tier 1 document for any future Tier 2 projects.

The current version of INVEST is Version 1.3, which is the result of extensive user input and collaboration that began in 2017. FHWA launched INVEST Version 1.0 in October 2012 with a national webcast. Upon the release of INVEST Version 1.0, FHWA solicited partnerships with transportation departments, metropolitan planning organizations, federal land managers, and local governments that chose to use INVEST Version 1.0 to assess and enhance the sustainability of their projects and programs. INVEST Versions 1.1 (released in January 2015) and 1.2 (released in September 2015) included revisions to INVEST based on extensive feedback received from these partnerships. Version 1.3 was launched in April 2018.

The basis for INVEST's sustainability scoring is its criteria. An INVEST criterion is a collection of results-based sustainable solutions or best practices, combined based on similarity in discipline or timing and including a goal, description, and requirements.

ADOT Sustainability Program and INVEST

Arizona's transportation infrastructure is spread over 114,000 square miles, operates from sea level to 8,000 feet, and withstands temperatures that range from below 0°F to over 120°F. Maintaining optimum health and performance of this infrastructure is critical to Arizona's economic vitality, quality of life, and natural and built environments. The ADOT recognizes the critical need to plan and prioritize resources more efficiently in order to maintain and operate a robust, economically beneficial transportation network. The ADOT also recognizes the importance of delivering transportation solutions in a more sustainable manner to achieve economic, social, and environmental goals. The ADOT has moved from the early stages of identifying sustainable strategies in 2010 to implementing a sustainable transportation program that encompasses core administrative, planning, design, construction, operation, and maintenance activities.

The three primary principles of sustainability focus on achieving an efficient, well-balanced use of economic, social, and environmental resources—commonly known as the triple bottom line (Figure 3). In theory, this will allow for proper use of funding while attaining all potential project needs and objectives. A sustainable highway, for example, will not only incorporate mobility and transportation alternatives but also consider safety, accessibility, livability, asset management, and environmental stewardship. As stated in the *Guidebook for Sustainability Performance Measurement for Transportation Agencies*;

> Often, a goal will support more than one principle. Yet no one goal in itself is sufficient to achieve sustainability - it takes multiple goals, pursued in concert, to promote sustainability. When a final set of goals is defined, it's important to crosscheck the package of goals to ensure that all of the principles are well addressed. In doing so, take care not to force-fit the goals to make them map to the principles. A balanced goal set, however, achieves comprehensive coverage of the basic principles of sustainability… (NCHRP Report 708, 2011, p. 20, p. 47).

Figure 3. Sustainable development across all disciplines

To support its sustainability program, the ADOT has made optimal use of the INVEST program. The ADOT initially became interested in using INVEST in 2010, then in beta testing, while in the midst of updating two of its long-term planning documents, *Building a Quality Arizona (bqAZ)* and *What Moves You Arizona?* Arizona was—and is continuing to—go through a period of rapid demographic change and population growth. Simultaneously, many members of the public have become more informed about the transportation planning process and demand that transportation projects address more than just mobility and accessibility needs to also include environmental, social, and economic components. The ADOT began discussing sustainability principles as the FHWA first sent out a call to state transportation departments to pilot the tool. INVEST provided the opportunity to connect the sustainability principles already under discussion at the ADOT with actual activities. Key outcomes of ADOT's initial work with INVEST included:

- Scoring over 50 individual transportation projects using the PD module and developing recommendations for improvements to agency sustainability practices based on the evaluation;
- Integrating recommendations and sustainability concepts into ADOT manuals and guidance, including the ADOT *Complete Transportation Guidebook* completed in February 2016;
- Conducting sustainability training with internal ADOT departments and external stakeholders and partners; and
- Developing a sustainability award program to recognize ADOT projects and projects managers that go above and beyond, as measured by the INVEST score, best management practices, and collaboration.

The ADOT continues to use, expand, and improve INVEST as one of the cornerstones of its Sustainable Transportation Program.

INVEST APPLICATION ON I-11 BUILD CORRIDOR ALTERNATIVES

Scoring Summary

The PD Urban Extended and SPS scorecards were use for this effort. All three I-11 Build Corridor Alternatives received the same scoring for the Project Development Module each criterion because the INVEST scorecard is structured based on the process followed, not a comparative evaluation of the results of the process. Therefore, since all three were compared using the same process as part of the I-11 Tier 1 EIS, this tool does not provide enough detailed differentiation measures to contribute to a decision on a Preferred Alternative, but rather reflects sustainable outcomes and useful considerations for integrating sustainability into Tier 2 NEPA processes. What this alternatives analysis effort did present was how valuable it is to identify where certain criteria would be better addressed and overall act as a sustainable corridor baseline for future phases – EIS Tier 2, design, construction, operating, and maintenance.

In considering opportunities to link sustainability and NEPA through the INVEST tool, the evaluation also used selected System Planning for States criteria, and three additional innovative criteria identified as part of the Tier 1 EIS study. Based on the assessment at this Tier 1 level, each of the three Build Corridor Alternatives scored the same. The three innovative criteria also provided additional potential points for the scoring assessment. This cross-utilization of criteria from different modules allowed for the Tier 1 EIS study to identify the relevant sustainability considerations at this Tier 1 level, and allowed for more flexibility in scoring than was provided in the Project Development module only. **What this portion of the effort presented is the need in future INVEST versions to include a new dedicated Corridor Planning and Environmental Study module.**

Table 1 presents a summary of each criteria, the total scoring achieved, and notes on the application of that criteria to the I-11 study effort. **Table 2** presents the detailed PD scoring matrix, including columns denoting which is the most applicable project development phase to consider each criterion. This is critical for tracking future progress, to be proactive and incorporate sustainability considerations as early in the process as feasible in Tier 2 studies. The hybrid criteria have a total of 299 available points. The scoring effort garnered a total of 111 points. **On a percentage basis, this corridor already starts with 37% of the sustainability attributes being considered in the study are deemed a sustainable approach according to INVEST. This forms the sustainable baseline to work from in future phases.**

Lessons Learned and Opportunities for Future NEPA Studies

At an early stage in the project development process, it was anticipated that this INVEST case study for I-11 Build Corridor Alternatives would not attain a high level rating based on one chosen module alone. Overall, criteria in Project Development related to design or construction received fewer points, as those project development activities are beyond the scope of this Tier 1 study. Considering this information, the ADOT identified relevant NEPA planning scoring criteria in other modules such as SPS and Innovative Criteria that allowed for a more broad and conceptual INVEST scoring with NEPA and sustainability elements. This flexible approach of multiple criteria and modules allowed for a multi-level evaluation that considered NEPA and sustainability not only in the project development design stage, but also combined the higher level

planning and programming considerations that is considered in NEPA as well. Combining the elements of planning, programming, and project development design with NEPA in this INVEST tool and evaluation

created an evaluation that considered the NEPA and sustainability linkage process from the first step to a second step lifecycle process of a project.

Utilization of INVEST on a series of planning-level alternatives and NEPA studies would be most beneficial with a flexible criteria approach such as the one used in this case study, since the ADOT has many different studies and evaluations at different levels. Additionally, this high level evaluation could be documented as a way to identify and track the relevant sustainability considerations at each level of evaluation, such as a Tier 1 study and Tier 2 study.

Regardless of the type of planning/environmental review process, revisiting the INVEST criteria at the start of each project phase is ideal to continue to integrate sustainability elements into a project and maintain sight on the goals and potential sustainability solutions.

Table 1. I-11 Build Corridor Alternatives INVEST Scoring Summary

ID	Criteria	Available Points	INVEST Scoring			Criteria Application Notes
			Purple	Green	Orange	
TOTAL		**299**	**111**	**111**	**111**	
PD-01	Economic Analyses	5	3	3	3	Economic analyses were a key part of the alternatives evaluation process, but at the Tier 1 level, and an initial economic analysis was completed but will be refined in Tier 2
PD-02	Lifecycle Cost Analyses	3	0	0	0	*More applicable in later project phases.*
PD-03	Context Sensitive Project Development	10	6	6	6	The alternatives scored well on planning-related criteria; three sub-criteria are specifically related to construction activities and should be considered in later project phases.
PD-04	Highway and Traffic Safety	10	4	4	4	Safety analyses were conducted, but not using road safety audit procedures that include human factor analyses. This added level of detail can be explored further in later phases (Tier 2).
PD-05	Educational Outreach	2	2	2	2	Outreach is a critical component of every project and should continue to be an active component of all project phases.
PD-06	Tracking Environmental Commitments	5	0	0	0	*More applicable in later project phases.*
PD-07	Habitat Restoration	7	3	3	3	At this Tier 1 level high quality environmental resources were identified and avoided to the extent possible within the corridor. Further evaluation will confirm in Tier 2 analysis.
PD-08	Stormwater Quality and Flow Control	6	0	0	0	*More applicable in later project phases.*
PD-09	Ecological Connectivity	4	3	3	3	Ecological connectivity was considered and measures have been taken to avoid impacts, and would be further analyzed in Tier 2 studies.

Table 1. I-11 Build Corridor Alternatives INVEST Scoring Summary (continued)

ID	Criteria	Available Points	INVEST Scoring			Criteria Application Notes
			Purple	Green	Orange	
PD-10	Pedestrian Facilities	3	0	0	0	*More applicable in later project phases.*
PD-11	Bicycle Facilities	3	0	0	0	*More applicable in later project phases.*
PD-12	Transit and HOV Facilities	3	0	0	0	Transit considered in EIS but not at the facility level.
PD-13	Freight Mobility	7 (max)	0	0	0	*More applicable in later project phases.*
PD-14	ITS for System Operations	5	0	0	0	*More applicable in later project phases.*
PD-15	Historic, Archaeological, and Cultural Preservation	3 (max)	2	2	2	Actions have been taken to minimize impact to historic, archeological, and cultural resources, however specific mitigation measures will not be defined until a final alignment is selected.
PD-16	Scenic, Natural, or Recreational Qualities	3 (max)	1	1	1	Although at a Tier 1 level, historic and scenic recreational facilities were identified within the study area that ADOT has committed to minimize impacts in a Tier 2 study
PD-17	Energy Efficiency	8	0	0	0	*More applicable in later project phases.*
PD-18	Site Vegetation, Maintenance and Irrigation	6	6	6	6	Although at a Tier 1 level, the EIS includes strategies for vegetation planning and prevention through the study area. This will be further refined in Tier 2 with an ADOT project. Standards are already in place for noxious and invasive species control.
PD-19	Reduce, Reuse and Repurpose Materials	12 (max)	0	0	0	*More applicable in later project phases.*
PD-20	Recycle Materials	10 (max)	0	0	0	*More applicable in later project phases.*
PD-21	Earthwork Balance	5	0	0	0	*More applicable in later project phases.*
PD-22	Long-Life Pavement	7 (max)	0	0	0	*More applicable in later project phases.*
PD-23	Reduced Energy and Emissions in PM	3 (max)	0	0	0	*More applicable in later project phases.*

Table 1. I-11 Build Corridor Alternatives INVEST Scoring Summary (continued)

ID	Criteria	Available Points	INVEST Scoring			Criteria Application Notes
			Purple	Green	Orange	
PD-24	Permeable Pavement	2	0	0	0	*More applicable in later project phases.*
PD-25	Construction Environmental Training	1	0	0	0	*More applicable in later project phases.*
PD-26	Construction Equipment Emission Reduction	2 (max)	0	0	0	*More applicable in later project phases.*
PD-27	Construction Noise Mitigation	2	0	0	0	*More applicable in later project phases.*
PD-28	Construction Quality Control Plan	5	0	0	0	*More applicable in later project phases.*
PD-29	Construction Waste Management	4	0	0	0	*More applicable in later project phases.*
PD-30	Low Impact Development	3	0	0	0	*More applicable in later project phases.*
PD-31	Infrastructure Resiliency Plan and Design	12	0	0	0	*More applicable in later project phases.*
PD-32	Light Pollution	3	0	0	0	*More applicable in later project phases.*
PD-33	Noise Abatement	5 (max)	0	0	0	*More applicable in later project phases.*
System Planning for States Criteria except for SPS 4, 6, 7, 9, 10, 11, 12, 15, 16 did not align with this effort						
SRS-01	Integrated Planning	15	8	8	8	Commitment to participate in local land use planning (i.e., White Tanks Conservancy), metropolitan planning organizations, and other regulatory agencies. This commitments will be kept in future Tier 2 efforts.
SPS-02	Integrated Planning – Natural Env.	15	10	10	10	Invited AGFD as the only non-federal Cooperating Agency. Commitment for wildlife studies to inform Tier 2 – i.e. setting up corridor at landscape-scale level for multiple future projects.
SPS – 03	Integrated Planning-Social	15	4	4	4	Public engagement is inherently part of NEPA. Investment in wildlife studies and participation in local land planning.

Table 1. I-11 Build Corridor Alternatives INVEST Scoring Summary (continued)

ID	Criteria	Available Points	INVEST Scoring			Criteria Application Notes
			Purple	Green	Orange	
SPS-05	Access and Affordability	**15**	11	11	11	The study considered and analyzed many traffic and transportation related effects for access, equity, and populations in our EIS and in our public outreach efforts. A fundamental part of the EIS analysis and consideration at Tier 1 level
SPS-08	Freights and Goods Access	**15**	2	2	2	Freight and mobility were considered for incorporation at the Tier 1 level.
SPS-13	Analysis Methods	**15**	11	11	11	The travel demand model used for EIS and other analysis within the EIS were all peer reviewed and approved by regional, state, and federal agencies and included a high level of data that would be further refined at Tier 2
SPS-14	TSMO	15	6	6	6	The EIS considered ITS and TSMO strategies in it's documentation, and included efforts to connect the ADOT agency goals with a future I-11 roadway. Further refinements to include update TSMO strategies will be needed in a possible Tier 2 study
SPS - 17	Planning and Env Linkages	15	14	14	14	Because this is a Tier 1 EIS, NEPA planning and environmental linkages were the focal point of consideration in regards to alternatives analysis and decision making process. Further linkages and NEPA considerations will be evaluated in Tier 2 studies.
SPS-IN-01	Innovative Criteria – Quantm	5	5	5	5	An innovative GIS program was used for analysis
SPS-IN-02	Innovative Criteria - Udall	5	5	5	5	Above and beyond public and stakeholder outreach was conducted
SPS-IN-03	Innovative Criteria – Section 106 PA	5	5	5	5	Above and beyond Section 106 regulatory requirements were met for NEPA/Section 106

Appendix: I-11 PD and SPR Module Scorecards

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

Project Scorecard

I-11 Pilot PD - Jun 14, 2019

Module: Project Development
Scorecard: Rural Extended
Points: 32
Achievement Level: Not Rated

Rural Extended Scorecard

Criteria Points

PD-01 **Economic Analyses** 3/5

Using the principles of benefit-cost analysis (BCA) or economic impact analysis (EIA), provide evidence that the benefits, including environmental, economic, and social benefits, justify the full life-cycle costs.

PD-01.1a Was a benefit-cost analysis (BCA) for the project completed using minimum acceptable industry practices?
No (0 points)

PD-01.1b Was an Economic Impact Analysis (EIA) completed that meets all the listed requirements?
Yes (3 points)

Scoring Notes
A high level analysis was completed for the study

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-02 **Lifecycle Cost Analyses** 0/3

Reduce life-cycle costs and resource consumption through the informed use of life-cycle cost analyses of key project features during the decision-making process for the project.

PD-02.1a Was an LCCA performed for all pavement structure alternatives in accordance with the method described in the FHWA's Technical Bulletin for Life-Cycle Cost Analysis?
No (0 points)

PD-02.1b Was an LCCA performed for all stormwater infrastructure alternatives considered?
No (0 points)

PD-02.1c Was an LCCA performed for the project's major feature (bridges, tunnels, retaining walls, or other items not listed in the preceding options) for each of the alternatives considered?
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-03 **Context Sensitive Project Development** 6/10

Deliver projects that harmonize transportation requirements and community values through effective decision-making and thoughtful design.

PD-03.1 Did the project development process generally follow the six-step CSS framework described in NCHRP report 480 and NCHRP report 642, or an equivalent process?
Yes (2 points)

PD-03.2 Did the project development process feature a "cradle-to-grave" project team that included planners, traffic engineers, public involvement specialists, design engineers, environmental experts, safety specialists, landscape architects, right-of-way staff, freight experts, construction engineers, and others to work on projects who worked together to achieve the desired CSS-based vision for the project?
Yes (1 point)

PD-03.3 As a result of CSS-influenced project development process, were external "champions" for the project created in the affected community who were engaged and proactive in supporting it?
Yes (1 point)

PD-03.4 Was acceptance achieved among project stakeholders on the problems, opportunities, and needs that the project should address and the resulting vision or goals for addressing them?
Yes (1 point)

PD-03.5 Do project features consider the appropriate scale of the project?
Yes (1 point)

PD-03.6 Did the project remove objectionable or distracting views?
No (0 points)

PD-03.7 Did the project integrate context sensitive aesthetic treatments?
No (0 points)

PD-03.8 Were aethetics for structural items incorporated into the design of the project?
No (0 points)

Scoring Notes
Context sensitive development was considered for various locations within the Study Area at Tier 1

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-04 **Highway and Traffic Safety** 4/10

Safeguard human health by incorporating science-based quantitative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.

PD-04.1 Were human factors considerations incorporated?
The project relied solely on published design and operational performance standards during the project development process. (0 points)

PD-04.2 Was awareness built among the public regarding contributing factors to crashes?
No (0 points)

PD-04.3 Does the agency conduct explicit consideration of safety using quantitative, scientifically proven methods?
Yes (0 points)

> **PD-04.3a Was the project type established during scoping of project alternatives through a quantitative and statistically reliable process?**
> Yes (1 point)
>
> **PD-04.3b Were project design and/or operational alternatives developed and evaluated using explicit consideration of substantive safety through quantitative, statistically reliable methods?**
> Yes (2 points)
>
> **PD-04.3c Were quantitative and statistically reliable methods and knowledge used to assess substantive safety performance in the development of preliminary and final design details?**
> No (0 points)

PD-04.4 Was a statistically reliable, science-based method used to evaluate the safety effectiveness of the implemented project?
Yes (1 point)

Scoring Notes
Considerations were made that would be further refined in Tier 2 studies.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-05 **Educational Outreach** 2/2

Increase public, agency, and stakeholder awareness of the integration of the principles of sustainability into roadway planning, design, and construction.

PD-05.1 Did this project incorporate public educational outreach that promotes and educates the public about sustainability by installing or performing a minimum of two different elements from Table PD-05.1.A?
Yes (2 points)

Scoring Notes
Information during public hearings was identified with these requirements.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-06 **Tracking Environmental Commitments** 0/5

Ensure that environmental commitments made by the project are completed and documented in accordance with all applicable laws, regulations, and issued permits.

PD-06.1a Was a comprehensive environmental compliance tracking system used for the project and related facilities?
No (0 points)

PD-06.2 Has the principal project constructor assigned an independent environmental compliance monitor who will provide quality assurance services and report directly to and make recommendations to the regulatory and Lead Agencies?
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-07 **Habitat Restoration** 3/7

Avoid, minimize, rectify, reduce, and compensate the loss and alteration of natural (stream and terrestrial) habitat caused by project construction and/or restore, preserve, and protect natural habitat beyond regulatory requirements.

PD-07.1 Was project-specific mitigation or mitigation banking used on this project? Use Table PD-07.1.A to determine the points earned.
1 Point (1 point)

PD-07.2 Were high quality aquatic resources (HQAR) avoided or were the impacts minimized on this project? Use Table PD-07.2.A to determine the points earned.
1 Point (1 point)

PD-07.3 Were high quality environmental resources avoided or were the impacts minimized on this project? Use Table PD-07.3.A to determine the points earned.
1 Point (1 point)

Scoring Notes
At this Tier 1 level high quality environmental resources were identified and avoided to the extent possible within the corridor. Further evaluation will confirm in Tier 2 analysis.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-08 **Stormwater Quality and Flow Control** 0/6

Improve stormwater quality from the impacts of the project and control flow to minimize their erosive effects on receiving water bodies and related water resources, using management methods and practices that reduce the impacts associated with development and redevelopment.

PD-08.1 Did the project treat at least 80% of the total runoff volume? Use Tables PD-08.1.A and PD-08.1.B to determine points.
No (0 points)

PD-08.2 Did the project manage the flow from at least 80 percent of the total runoff volume, and is flow control based on controlling peak flows or durations from the project site? Use Tables PD-08.2.A and PD-08.1.B to determine points.
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-09 **Ecological Connectivity** 3/4

Avoid, minimize, or enhance wildlife, amphibian, and aquatic species passage access, and mobility, and reduce vehicle-wildlife collisions and related accidents.

PD-09.1P Was a site-specific ecological assessment of the roadway project using GIS data or regional expertise conducted?
Yes (0 points)

PD-09.1 Were methods used to minimize impacts to ecological connectivity? Use Table PD-09.1.A to determine points.
2 (2 points)

PD-09.2 Did the project team engage natural resource and regulatory agencies throughout the planning process and ensure consistency with broader planning goals and objectives?
Yes (1 point)

Scoring Notes
Considerable effort was made for the Tier 1 EIS for ecological connectivity, and further analysis and coordination with natural resource agencies will occur with Tier 2 studies. ADOT has continued with a comprehensive strategy on this topic due to the wide scale of the project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-13 **Freight Mobility** 0/7

Enhance mobility of freight movements, decrease fuel consumption and emissions impacts, and reduce freight-related noise.

PD-13.1 Were freight facilities installed on this project consistent with the need, purpose, and appropriateness for freight mobility within the project footprint? Use Table PD-13.1.A to determine points.
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-14 **ITS for System Operations** 0/5

Improve the efficiency of transportation systems through deployment of technology and without adding infrastructure capacity in order to reduce emissions and energy use, and improve economic and social needs.

PD-14.1 Were one or more allowable ITS applications installed? Use Table PD-14.1.A to determine points.
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-15 **Historic, Archaeological, and Cultural Preservation** 2/3

Preserve, protect, or enhance cultural and historic assets, and/or feature National Scenic Byways Program (NSBP) historic, archaeological, or cultural intrinsic qualities in a roadway.

PD-15.1P Is any part of the project or resource listed in the NRHP or been determined eligible for the NHRP by a State, Local, or Tribal Historic Preservation Officer?
Yes (0 points)

PD-15.1 Has an effort been made to minimize impacts, avoid impacts, or enhance features?
PD-15.1b Measures have been taken to specifically avoid impacts to the features from PD-15.1P. (2 points)

Scoring Notes
Measures have been taken to avoid impacts, and would be further analyzed in Tier 2 studies.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-16 **Scenic, Natural, or Recreational Qualities** 1/3

Preserve, protect, and/or enhance routes designated with significant scenic, natural, and/or recreational qualities in order to enhance the public enjoyment of facilities.

PD-16.1P Is any portion of the project along one of America's Byways®, a State Scenic Byway, an Indian Tribe Scenic Byway, or other route that was designated or officially recognized as such?
Yes (0 points)

PD-16.2P Was existing access to scenic, natural, or recreational qualities not removed (i.e., maintained) as a part of this project unless it was specifically removed to protect the scenic, natural, and/or recreational qualities themselves?
Yes (0 points)

PD-16.1 Were efforts made to avoid or minimize impacts,or enhance features, of the scenic, natural, and/or recreational qualities?
PD-16.1a An effort has been made to minimize “adverse effects” to the scenic, natural, or recreational qualities to the features from PD-16.1P. (1 point)

Scoring Notes
Although at a Tier 1 level, historic and scenic recreational facilities were identified within the study area that ADOT has committed to minimize impacts in a Tier 2 study

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-17 **Energy Efficiency** 0/8

Reduce energy consumption of lighting systems through the installation of efficient fixtures and the creation and use of renewable energy.

PD-17.1 Were energy needs evaluated for the project?
No (0 points)

PD-17.2 Was the energy consumption on the project reduced through the installation of energy efficient lighting and signal fixtures and through the installation of autonomous, on-site, renewable power sources?
No (0 points)

PD-17.3 Was a plan established for auditing energy use after project completion as part of operations and maintenance?
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-18 **Site Vegetation, Maintenance and Irrigation** 6/6

Promote sustainable site vegetation within the project footprint by selecting plants and maintenance methods that benefit the ecosystem.

PD-18.1P Does all site vegetation use non-invasive species only, use non-noxious species only, use seeding that does not require consistent mowing for a viable stand of grass, and minimize disturbance of native species?
Yes (0 points)

PD-18.1 Based on Table PD-18.1.A, how many points did the project earn? Points for features are additive, however this criterion shall not exceed a total of 3 points.
3 Points (3 points)

PD-18.2 Based on Table PD-18.2.A, how many points did the project earn for vegetative maintenance? Points for features are cumulative, however this scoring requirement shall not exceed a total of 3 points.
3 Points (3 points)

Scoring Notes
Although at a Tier 1 level, the EIS includes strategies for vegetation planning and prevention through the study area. This will be further refined in Tier 2 with an ADOT project. Standards are already in place for noxious and invasive species control.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-19 **Reduce, Reuse and Repurpose Materials** 0/12

Reduce lifecycle impacts from extraction and production of virgin materials by recycling materials.

PD-19 Points for different methods are cumulative; however, this criterion shall not exceed a total of twelve points. Points exceeding twelve will not contribute to overall score.
I understand. (0 points)

PD-19.1 Was remaining service life increased through pavement preservation activities? Points are awarded per Table PD-19.1.A.
No (0 points)

PD-19.2 Was the amount of new pavement materials needed reduced? Points are awarded per Table PD-19.2.A.
No (0 points)

PD-19.3 Was remaining service life increased through bridge preservation activities? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.4 Was remaining service life increased through retrofitting existing bridge structures? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.5 Were existing pavements, structures, or structural elements reused for a new use? Points are awarded per Table PD-19.5.A.
No (0 points)

PD-19.6a Were foundry sand or other industrial by-products used in pipe bedding and backfill?
No (0 points)

PD-19.7 Was a project-specific plan for the recycling and reuse plan developed as described?
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-20 **Recycle Materials** 0/10

Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by recycling materials.

PD-20 Points for different methods are cumulative; however, this criterion shall not exceed a total of ten points. Points exceeding ten will not contribute to overall score.
I understand. (0 points)

PD-20.1 Was RAP or RCA used in new pavement lifts, granular base course, or embankments? Points are awarded per Tables PD-20.1.A or PD-20.1.B.
No (0 points)

PD-20.2 Were pavement materials recycled in place using cold-in-place recycling, hot-in-place recycling, and full depth reclamation methods? Points are awarded per Table PD-20.2.A.

No (0 points)

PD-20.3 Did the project reuse subbase granular material as subgrade embankment or as part of the new subbase? Points are awarded per Table PD-20.3.A.
No (0 points)

PD-20.4 Did the project relocate and reuse at least 90 percent of the minor structural elements, including existing luminaires, signal poles, and sign structures that are required to be removed and/or relocated onsite?
No (0 points)

PD-20.5 Did the project salvage or relocate existing buildings?
No (0 points)

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

Scoring Notes
Not applicable at Tier 1 level

PD-21 **Earthwork Balance** 0/5

Reduce the need for transport of earthen materials by balancing cut and fill quantities.

PD-21.1a Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10%?
No (0 points)

PD-21.1b Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10% if construction banking is used?
No (0 points)

PD-21.2 Has an earthwork management plan been established, implemented and actively managed on this project?
No (0 points)

PD-21.3 Has topsoil been preserved or reused on this projet?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-22 **Long-Life Pavement** 0/7

Minimize life-cycle costs by designing long-lasting pavement structures.

PD-22 Points for different methods are cumulative; however, this criterion shall not exceed a total of seven points. Points exceeding seven will not contribute to overall score.
I understand. (0 points)

PD-22.1 Which of the following describes how long-life pavement was used on this project?
No long-life pavement was used or it was and did not meet the minimum requirements of the options below. (0 points)

PD-22.2 Was the asphalt density of 100 percent of the total new or reconstructed pavement increased to a minimum of 94 percent?
No (0 points)

PD-22.3 Was a performance-based pay incentive for pavement smoothness used on this project?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-23 **Reduced Energy and Emissions in Pavement Materials** 0/3

Reduce energy use in the production of pavement materials.

PD-23 Points for different methods are cumulative; however, this criterion shall not exceed a total of three points. Points exceeding three will not contribute to overall score.
I understand. (0 points)

PD-23.1 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from asphalt production?
No (0 points)

PD-23.2 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from cement production?
No, or it did not meet the minimum requirements in the options above. (0 points)

PD-23.3 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from concrete production?
No, or it did not meet the minimum requirements in the options above. (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-24 **Permeable Pavement** 0/2

Improve flow control and quality of stormwater runoff through use of permeable pavement technologies.

PD-24.1and2P Does the project include a maintenance plan for permeable pavements and are permeable pavements placed in areas where no sand will be used for snow and ice control or pavement sealing?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-25 **Construction Environmental Training** 0/1

Provide construction personnel with the knowledge to identify environmental issues and best practice methods to minimize impacts to the human and natural environment.

PD-25.1 Did the owner require the Contractor to plan and implement a formal environmental awareness training program during construction to ensure the project stay in compliance with environmental laws, regulations, and policies?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-26 **Construction Equipment Emission Reduction** 0/2

Reduce air emissions from non-road construction equipment.

PD-26.1 Were one or more methods implemented to reduce non-road emissions? Points are awarded per Table PD-26.1.A.
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-28 **Construction Quality Control Plan** 0/5

Improve quality by requiring the contractor to have a formal Quality Control Plan (QCP).

PD-28.1 Is the Contractor required to plan and implement quality control measures throughout construction with care and for materials above and beyond what is typically required by specifications and regulations?
No (0 points)

PD-28.2 Does the contract leverage the use of Quality Price Adjustment Clauses to link payment and performance of the constructed products?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-29 **Construction Waste Management** 0/4

Utilize a management plan for road construction waste materials to minimize the amount of construction-related waste destined for landfill.

PD-29.1 Is the contractor required to establish, implement, and maintain a formal Construction and Demolition Waste Management Plan (CWMP) during roadway construction, or its functional equivalent?
No (0 points)

PD-29.2 Can the owner demonstrate that a percentage of the construction waste has been diverted from landfills?
No, or diverted less than 50 percent of the construction waste from landfills (0 points)

PD-29.3 Were excess materials hauled directly to other project sites for recycling on those projects?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-30 **Low Impact Development** 0/3

Use low impact development stormwater management methods that reduce the impacts associated with development and redevelopment and that mimic natural hydrology.

PD-30.1 Did the project use effective BMPs or stormwater management techniques that mimic natural hydrology to treat pollutants? Use Tables PD-30.1.A and PD-30.1.B and PD-30.1.C to determine points.
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-31 **Infrastructure Resiliency Planning and Design** 2/12

Respond to vulnerabilities and risks associated with current and future hazards (including those associated with climate change) to ensure transportation system reliability and resiliency.

PD-31.1 Did the project incorporate consideration of climate change at a project-specific level in project development and environmental reviews?
Yes (2 points)

PD-31.2 Did the project incorporate future consideration of climate change effects in the design process?
No (0 points)

PD-31.3 Did the project mitigate the effects of GHG emissions through design efforts above and beyond requirements and regulations?
No (0 points)

Scoring Notes
Although at a Tier 1 level, the EIS does include information regarding greenhouse gases in the Draft EIS stage. More information will be included in any Tier 2 or future studies.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-32 **Light Pollution** 0/3

To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.

PD-32.1 Were the uplighting ratings met on this project per Table PD-32.1.A?
No (0 points)

PD-32.2 Were the backlighting ratings met on this project per Table PD-32.2.A?
No (0 points)

PD-32.3 Were the glare ratings met on this project per Table PD-32.3.A?
No (0 points)

Scoring Notes
Not applicable at Tier 1 level

Next Actions

Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

Project Scorecard

I-11 SPR - Jun 14, 2019

Module: System Planning Region
Points: 66
Achievement Level: Not Rated

Criteria	Points
SPR-01 **Integrated Planning: Economic Development and Land Use (for Regions)**	8/15

Integrate statewide and metropolitan Long Range Transportation Plans (LRTP) with regional and/or local land use plans and economic development forecasts and goals. Proactively encourage and facilitate sustainability through the coordination of transportation, land use, and economic development planning.

SPR-01.1a Has the agency developed goals and objectives for the integration of metropolitan and/or statewide transportation planning with economic development and land use planning above and beyond current requirements?
Yes (1 point)

> **SPR-01.1b Are the goals and objectives consistent with applicable economic development and land use plans above and beyond current requirements?**
> Yes (1 point)

SPR-01.2a Does the agency regularly engage land use and economic development agencies in its jurisdiction throughout the transportation planning process?
Yes (2 points)

> **SPR-01.2b Does the agency utilize institutional mechanisms to facilitate the engagement?**
> Yes (1 point)

SPR-01.3 Does the agency use best practice quantitative methods to analyze and evaluate the performance of alternative land use/ transportation scenarios?
No (0 points)

SPR-01.4 Does the agency provide institutional leadership in encouraging transportation planning that is consistent with land use and economic development plans and that supports sustainability principles?
Yes (2 points)

SPR-01.5 Can the agency demonstrate sustainable outcomes?
SPR-01.5a The LRTP is integrated with land use and economic development plans, and the agency is implementing transportation investments that support sustainability principles. (1 point)

Scoring Notes
Commitment to participate in local land use planning (i.e., White Tanks Conservancy), metropolitan planning organizations, and other regulatory agencies. This commitments will be kept in Tier 2 if any future studies occur.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

SPR-02 **Integrated Planning: Natural Environment (for Regions)** 10/15

Integrate ecological considerations into the transportation planning process, including the development of long range transportation plans (LRTP), corridor plans, and the TIP. Proactively support and enhance long-term ecological function through the coordination of transportation and natural resource planning.

SPR-02.1a Has the agency developed goals and objectives that meet the requirement for the integration of metropolitan and/or statewide transportation planning with applicable environmental plans, policies, and goals?
Yes (1 point)

SPR-02.1b Are the goals and objectives consistent with or surpass local, metropolitan, and/or statewide environmental plans, policies, and goals?
Yes (1 point)

SPR-02.2a Does the agency go above and beyond current consultation requirements by regularly engaging natural resource and regulatory agencies?
Yes (2 points)

SPR-02.2b Does the agency utilize institutional mechanisms to facilitate the engagement?
Yes (1 point)

SPR-02.3 Does the agency applY system or landscape-scale evaluation techniques using natural resource data?
The agency applies system or landscape-scale evaluation techniques using natural resource data during the transportation planning process and has completed all of the required items. (4 points)

SPR-02.4 Can the agency demonstrate sustainable outcomes?

SPR-02.4a The LRTP is integrated with applicable environmental plans, policies, and goals; the agency implements transportation investments that support and enhance long-term ecological function. (1 point)

Scoring Notes
Invited AGFD as the only non-federal Cooperating Agency. Commitment for wildlife studies to inform Tier 2. "Note that doing project-level NEPA analyses on transportation projects does not meet the intent of this requirement." However a Tiered NEPA analysis should? Setting up corridor at landscape-scale level for multiple future projects.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

SPR-03 **Integrated Planning: Social (for Regions)** 4/15

The agency's Long Range Transportation Plan (LRTP) is consistent with and supportive of the community's vision and goals. When considered in an integrated fashion, these plans, goals and visions support sustainability principles. The agency applies context-sensitive principles to the planning process to achieve solutions that balance multiple objectives to meet stakeholder needs.

SPR-03.1 Do the metropolitan and/or statewide transportation planning agencies share the community's vision for overall sustainability efforts; are transportation-related goals and objectives are consistent with that vision?
No (0 points)

SPR-03.2 Does the agency successfully identify a diverse range of stakeholders and public participants?
Yes (0 points)

SPR-03.2a Does the agency identify a diverse range of stakeholders and public participants, which include, at a minimum, all interested parties (as defined by current regulations), in addition to all other parties potentially affected by changes to the transportation system?
Yes (1 point)

SPR-03.2b Does the agency give special consideration and attention to the engagement of low-income, minority, disabled, and linguistically isolated populations, and use a diverse and innovative range of public involvement techniques to ensure the engagement process is inclusive?
Yes (2 points)

SPR-03.2c Does the agency include an education component so that stakeholders understand the transportation planning process and are able to better provide informed and meaningful input?
No (0 points)

SPR-03.3a Does the agency use a transparent process to inform stakeholders how their input will be used and then follow through accordingly?
No (0 points)

SPR-03.3b Does the agency demonstrate to stakeholders how their input was used to inform and affect transportation planning decisions?
No (0 points)

SPR-03.4 Can the agency demonstrate sustainable outcomes?

Yes (0 points)

SPR-03.4a Does the agency implement transportation investments that support the community's vision and goals and help achieve sustainability outcomes?
Yes (1 point)

SPR-03.4b Does the LRTP include performance measures to assess the effectiveness of its public involvement process?
No (0 points)

SPR-03.4c Does the agency monitor progress toward goals for at least one year and can the agency demonstrate measureable advancement toward goals?
No (0 points)

Scoring Notes
Public engagement is inherently part of the NEPA process. Investment in wildlife studies and participation in local land use planning

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

SPR-04 **Integrated Planning: Bonus (for Regions)** 0/10

The agency has a continuing, cooperative, and comprehensive (3-C) transportation planning process. Planners and professionals from multiple disciplines and agencies (e.g., land use, transportation, economic development, energy, natural resources, community development, equity, housing, and public health) work together to incorporate and apply all three sustainability principles when preparing and evaluating plans.

Prerequisite SPR-04.1P Has the agency achieved a score of 10 points or higher on each of the first three INVEST System planning criteria (SPR-01 through SPR-03)?

Scoring Notes

Next Actions

SPR-05 **Access and Affordability (for Regions)** 11/15

Enhance accessibility and affordability of the transportation system to all users and by multiple modes.

SPR-05.1a Do system planning documents analyze physical access and identify specific population groups or areas where this is an issue?
Yes (1 point)

SPR-05.1b Do system planning documents analyze access and equity and identify specific populations or areas where this is an issue?
Yes (1 point)

SPR-05.1c Do system planning documents analyze affordability and identify specific populations or areas where this is an issue?

Yes (2 points)

SPR-05.1d Do system planning documents include documentation of targeted, enhanced outreach or communication that has been used to engage these population groups or areas in the transportation planning process?
Yes (2 points)

SPR-05.2a Does the agency use travel model, census, geospatial, and other data to quantitatively evaluate the nature and distribution of accessibility and affordability concerns in its jurisdiction?
Yes (2 points)

SPR-05.2b Does the agency analyze how its transportation planning documents address or improves issues?
Yes (3 points)

SPR-05.3a Does the LRTP include sustainability-related performance measures that can be used to monitor the effects of plan implementation on transportation accessibility and affordability?
No (0 points)

Scoring Notes
The study considered and analyzed many traffic and transportation related effects for access, equity, and populations in our EIS and in our public outreach efforts. This is a fundamental part of the EIS analysis and consideration at Tier 1 level

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

SPR-06 **Safety Planning (for Regions)** 0/15

Agency integrates quantitative measures of safety into regional planning policies, ordinances, activities, projects, and programs, and across all modes and jurisdictions.

SPR-06.1 Does the agency collaborate and participate in the development and implementation of the State Strategic Highway Safety Plan?

SPR-06.2a Has the agency incorporated the Toward Zero Death (TZD) vision and implementing TZD as part of its transportation planning activities?

SPR-06.2b Has the agency developed strategies/plans to support TZD?

SPR-06.3 Does the agency develop a plan that incorporates safety into short- and long-range transportation planning?

SPR-06.4 Does the agency integrate quantitative safety performance measures into the transportation planning process?

SPR-06.5a Does the agency incorporate and integrate quantitative safety considerations into the selection and evaluation of strategies for different user groups?

SPR-06.5b Does the agency select strategies that include systemic treatments with proven effectiveness in reducing fatalities and serious injuries?

SPR-06.6 Does the agency integrate statistically sound approaches to determine projected safety performance into the long-range transportation planning process?

SPR-06.7a Does the agency system plan or program include safety-related performance measures?

Scoring Notes

Next Actions

SPR-07 **Multimodal Transportation and Public Health (for Regions)** 0/15

Expand travel choices and modal options by enhancing the extent and connectivity of multimodal infrastructure. Support and enhance public health by investing in active transportation modes.

SPR-07.1a Has the agency developed goals and objectives for enhancing the extent and connectivity of multimodal infrastructure within its jurisdiction?

SPR-07.1b Has the agency developed goals and objectives related to active transportation and the improvement of public health?

SPR-07.2 Does the agency regularly engage public health and active mode stakeholders?

SPR-07.3a Does the agency's planning process include and prioritize active, non-motorized transportation projects and programs as a component of the LRTP?

SPR-07.3c Has the agency evaluated the health impacts of the LRTP to determine whether the planned transportation investments will help the agency to meet its public health and active transportation goals?

SPR-07.4 Does the agency evaluate its progress toward meeting its multimodal and public health goals and makes adjustments as necessary?

Scoring Notes

Next Actions

SPR-08 **Freight and Goods Access & Mobility (for Regions)** 2/15

Implement a transportation plan that meets freight access and mobility needs while also supporting triple bottom line sustainability principles.

SPR-08.1a Does the agency include in system plans, specific provisions for maintaining and improving freight reliability and connectivity between modes and to freight generators for both inter- and intra-city freight, in ways that enhance sustainability?
Yes (1 point)

SPR-08.1b Does the agency consider multimodal freight mobility needs in the planning process?
Yes (1 point)

SPR-08.2a Does the agency regularly engage freight service providers, stakeholders, workers, and representative in developing transportation planning documents?
No (0 points)

SPR-08.3a Does the agency include and monitor freight access performance measures in planning documents?
No (0 points)

SPR-08.3b Does the agency include and monitor freight mobility performance measures in planning documents?
No (0 points)

SPR-08.4a Does the agency provide for planning, evaluating, maintaining and improving intermodal freight connectors and linkages to freight generators at all levels?
No (0 points)

SPR-08.4b Does the agency provide for planning, evaluating, maintaining, and enhancing freight mobility utilizing appropriate quantitative measures and monitoring for freight modes?
No (0 points)

SPR-08.4c Does the agency monitor progress toward goals for at least one year and show measurable advancement toward goals?
No (0 points)

Scoring Notes
Freight and mobility were considered for incorporation at the Tier 1 level.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

SPR-09 **Travel Demand Management (for Regions)** 0/15

Reduce vehicle travel demand throughout the system.

SPR-09.1a Has the agency developed quantifiable TDM goals and objectives for reducing travel demand for the transportation network within its jurisdiction?

SPR-09.2 Is the agency implementing a comprehensive TDM program that includes several of the various types of TDM strategies described?

SPR-09.3 Does the agency have quantifiable TDM performance measures and can the agency demonstrate ongoing monitoring of its TDM program?

SPR-09.4 Can the agency demonstrate sustainable outcomes?

Scoring Notes

Next Actions

SPR-10 **Air Quality & Emissions (for Regions)** 0/15

To plan, implement, and monitor multimodal strategies to reduce emissions and to establish a process to document emissions reductions.

SPR-10.1 Has the agency developed goals and objectives for the reduction of air emissions in transportation planning documents?

SPR-10.2 Does the agency regularly engage partner agencies throughout the transportation planning process?

SPR-10.3 Is the agency implementing multimodal strategies as part of a transportation plan to reduce emissions?

SPR-10.4 Was an emissions analysis performed?

Scoring Notes

Next Actions

SPR-11 **Energy and Fuels (for Regions)** 0/15

Reduce the energy and fossil fuel consumption from the transportation sector and document it in the transportation planning process.

SPR-11.1a Has the agency developed energy and/or fossil fuel reduction goals and objectives for the transportation system within its jurisdiction?

SPR-11.2a Has the agency developed and does the agency maintain a baseline inventory of current energy and/or fossil-fuel consumption from transportation?

SPR-11.3 Is the agency developing a plan and implementing strategies to reduce transportation-related energy and/or fossil fuel usage?

SPR-11.4 Does the agency develop performance measures, monitor progress and demonstrate sustainable outcomes?

Scoring Notes

Next Actions

SPR-12 **Financial Sustainability (for Regions)** 0/15

Evaluate and document that financial commitments made across transportation system plans are reasonable and affordable.

SPR-12.1 Is an inter-agency, cooperative approach for advanced revenue forecasting practices used?

SPR-12.2 Is an inter-agency, cooperative approach for advanced project estimating practices used?

Scoring Notes

Next Actions

SPR-13 **Analysis Methods (for Regions)** 11/15

Agencies adopt and incentivize best practices in land use, socioeconomic and transportation systems analysis methods.

SPR-13.1a Does the agency demonstrate that the analysis has a strong foundation in observed data suitable for developing tools which model the land use, socioeconomic, transport, and environmental systems?
Yes (1 point)

SPR-13.1b Does the agency demonstrate that the data used in planning analysis are evaluated and updated on a regular basis?
Yes (2 points)

SPR-13.2 Does the agency have a current strategic plan, analysis program, or equivalent?
No (0 points)

SPR-13.3a Does the agency's organizational structure include a technical committee to review data collection/ quality, planning assumptions, and forecasting methods?
Yes (2 points)

SPR-13.3b Has the agency convened a peer review of its analysis methods?
Yes (3 points)

SPR-13.3c Has the agency convened a peer review of its travel demand model?
Yes (3 points)

Scoring Notes
The travel demand model used for EIS and other analysis within the EIS were all peer reviewed and approved by regional, state, and federal agencies and included a high level of data that would be further refined at Tier 2

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

SPR-14 **Transportation Systems Management and Operations (for Regions)** 6/15

Optimize the efficiency of the existing transportation system.

SPR-14.1a Has the agency developed clearly defined goals and objectives for improving the efficiency of the transportation system within its jurisdiction?
Yes (1 point)

SPR-14.1b Are the goals and objectives also consistent with or do they surpass relevant local, state and/or metropolitan goals and objectives for improving transportation system efficiency?
Yes (1 point)

SPR-14.2a Are TSM&O strategies included in the LRTP, or other planning documents, as appropriate?
No (0 points)

SPR-14.2b Does the LRTP, or equivalent, include a discussion of the impacts of including TSM&O strategies?
No (0 points)

SPR-14.2c Are the TSM&O strategies considered and prioritized in the LRTP, or other planning documents?
No (0 points)

SPR-14.3 Has the agency implemented or is the agency funding TSM&O strategies?
Some, but not all, TSM&O strategies identified as priorities are being implemented by the agency or funded through inclusion in the transportation improvement program (TIP and/or STIP) for which the agency has responsibility. (2 points)

SPR-14.4 Does the agency include TSM&O performance measures in planning documents?
Yes (2 points)

SPR-14.5 Does the agency monitor progress toward goals for at least one year and can the agency show measurable advancement toward goals?
No (0 points)

Scoring Notes
The EIS considered ITS and TSMO strategies in it's documentation, and included efforts to connect the ADOT agency goals with a future I-11 roadway. Further refinements to include update TSMO strategies will be needed in a possible Tier 2 study

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

SPR-15 **Linking Asset Management and Planning (for Regions)** 0/15

Leverage transportation asset management data and methods within the transportation planning process to make informed, cost-effective program decisions and better use existing transportation assets.

SPR-15.1 Has the agency developed clearly defined goals and objectives for linking asset management and planning in their planning documents?

SPR-15.2 Does the agency cooperate with partner agencies to integrate their asset management data and economic analysis to prioritize investments?

SPR-15.3 Does the agency leverage performance-based planning and programming components of asset management to analyze and evaluate trade-offs in long-range transportation planning processes?

SPR-15.4a Does the agency prioritize transportation decisions that support maintenance and good repair of existing transportation assets?

SPR-15.4b Does the agency monitor progress toward goals for at least one year and can the agency show measurable advancement toward goals?

Scoring Notes

Next Actions

SPR-16 **Infrastructure Resiliency (for Regions)** 0/15

Anticipate, assess, and plan to respond to vulnerabilities and risks associated with current and future hazards (including those associated with climate change) to ensure multi-modal transportation system reliability and resiliency. Identify a range of vulnerability and risks to both existing and planned transportation infrastructure.

SPR-16.1a Has the agency developed goals and objectives consistent with partner agencies for infrastructure resiliency in transportation planning documents?

SPR-16.2 Does the agency regularly coordinate with partner agencies within its jurisdiction throughout the transportation planning process, to reduce barriers and further the prospects for implementation of strategies to address infrastructure resiliency?

SPR-16.3 Does the agency coordinate with partner agencies to collect infrastructure vulnerability and risk assessments into planning documents and identify and inventory necessary event-based transportation plans that need to be developed as a result?

SPR-16.4 Does the agency coordinate with partner agencies to develop appropriate strategies to address transportation events related to hazard events?

SPR-16.5 Does the agency have infrastructure resiliency performance measures incorporated into its transportation planning documents?

SPR-16.6 Does the agency monitor progress towards goals for at least one year and can the agency show measurable advancement towards goals?

Scoring Notes

Next Actions

SPR-17 **Planning and Environmental Linkages (for Regions)** 14/15

Integrate system planning process information, analysis, and decisions with the project-level environmental review process, and reference it in NEPA documentation.

SPR-17.1 Has the agency developed landscape-level goals and objectives for linking system and corridor planning with NEPA documentation and implementing PEL best practices?
Yes (2 points)

SPR-17.2 Does the agency have documented procedures that link system-level planning analyses to project-level NEPA analysis?
Documented procedures exist that cover all requirements in the criterion. (2 points)

SPR-17.3 Can the agency document communication from executive management to staff level regarding the agency's commitment to strengthening planning and environmental linkages?
Yes (2 points)

SPR-17.4 Are NEPA practitioners consulted during system-level planning?
NEPA practitioners are fully integrated in the planning process to help ensure materials are consistent with downstream needs. (3 points)

SPR-17.5a Do planning processes, including long-range, corridor, and sub-area studies, feature components that use NEPA principles and methods, including at least four of those listed?
Yes (2 points)

SPR-17.5b Does the agency systematically and successfully incorporate information from the system-level planning process into project-level documents?
Yes (2 points)

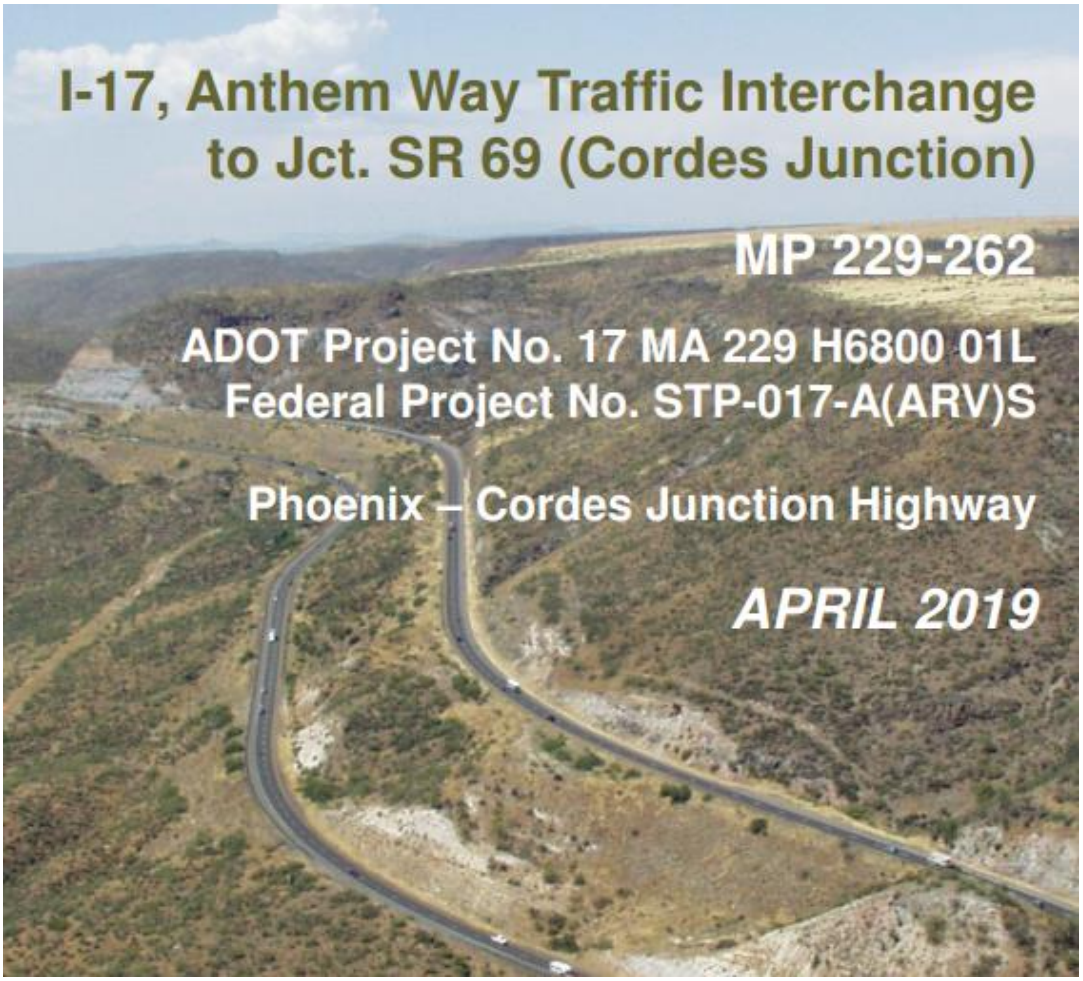
SPR-17.6a Do planning and policy documents include PEL implementation performance measures?
Yes (1 point)

SPR-17.6b Does the agency monitor progress towards goals for at least one year and can the agency show measurable advancement toward goals?
No (0 points)

Scoring Notes
Because this is a Tier 1 EIS, NEPA planning and environmental linkages were the focal point of consideration in regards to alternatives analysis and decision making process. Further linkages and NEPA considerations will be evaluated in Tier 2 studies.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

INVEST Memorandum
I-17, Anthem Way to Jct. SR 69
Arizona Department of Transportation



September 2019

INVEST Score: Gold (88 points)

Arizona DOT Sustainable Transportation Program

Background

The Arizona Department of Transportation (ADOT) has completed a study to prepare a design concept report and environmental documentation for improvements to the segment of Interstate 17 (I-17) between the Anthem Way Traffic Interchange (TI) (MP 229) and the State Route 69 TI near Cordes Junction (MP 262+). This section of I-17, designated the "Arizona Veteran's Highway" in 2004, currently consists of two lanes in each direction, traversing rolling terrain in the southern and northern segments and mountainous terrain in the middle segment. I-17 is part of the National Highway System and connects I-10 with I-40, two of the nation's principal east-west interstate highways. I-17 also provides the major connection between Phoenix and communities in northern Arizona. This project is exploring various means of adding capacity and improving operational safety to I-17. In recent years, the study has focused on long-term solutions between Black Canyon City (MP 245) and Cordes Junction (MP 262+). However, the current effort focuses on adding capacity in the near-term between Anthem Way (MP 229) and Sunset Point (MP 252). Construction estimate - $320,000,000.

Figure 1. Project Map

Recommended Build Alternative

Anthem Way TI to Black Canyon City TI: The Recommended Build Alternative includes adding a lane in both directions, widening the northbound roadway toward the median side and widening the southbound roadway toward the median in some segments and toward the outside in other segments.

Black Canyon City TI to Sunset Point TI: The Recommended Build Alternative includes constructing two flex lanes next to but separated from the southbound roadway by a concrete barrier. The flex lanes would be open to either northbound or southbound traffic depending on the peak traffic direction. Access to the flex lanes would be controlled by gates or a similar mechanism.

What is INVEST?

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by the Federal Highway Administration (FHWA) as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects.

INVEST considers the full lifecycle of projects and has four modules to self-evaluate the entire lifecycle of transportation services, including System Planning for States or Regions (SPS or SPR), Project Development (PD), and Operations and Maintenance (OM). Each of these modules is based on a separate collection of criteria and can be evaluated separately.

Purpose of the Memorandum

The ADOT, in partnership with the FHWA has utilized the latest version of INVEST (1.3) on numerous agency projects and programs in varying stages of development to document, explore, and identify sustainability elements of projects for incorporation, as well as provide feedback on the current INVEST 1.3 version of the tool. The goal of this INVEST memorandum is to document the use of INVEST scoring on the I-17, Anthem Way to Jct. SR 69 project using the Project Development (PD) and the Urban Extended Scorecard.

INVEST Scoring

INVEST may be used to score a project based on total points achieved. In the INVEST tool, FHWA does not recognize a project as having met the achievement level of sustainability based on scores; but rather recognizes that the user has self-evaluated their project and met the indicated achievement level.

The total points a project earns can be compared to several “achievement levels” that serve as relative benchmarks for sustainability accomplishments. Table 1 shows the minimum number of points necessary to meet each achievement level for the PD module.

According to the INVEST User Guide;

> The Project Development module spans the entire project development process. It includes early project planning, alternatives analysis, environmental documentation, preliminary and final design, and construction. Although the criteria span all phases of project development, including construction activities, the project owner typically has control over the decisions and actions necessary to meet all of the criteria. Scoring The Project Development Module of INVEST has seven (7) project scorecards available for the evaluation of projects. This approach allows for flexibility, since not all of the criteria will apply to every project. Six of the scorecards are based on both the type of project (paving, basic, extended, or scenic/recreational) and the location (rural or urban) and include a defined subset of the thirty-three (33) total criteria relevant to the type and location of the project. There is also a custom scorecard that includes eleven (11) core criteria plus user-selected criteria to make a custom self-evaluation for projects that don't t well into the five verified scorecards. The Project Development module contains the thirty-three (33) criteria listed below, used in various combinations to create the seven (7) different scorecards.

Table 1. INVEST User Guide P.4

Project Development by Criteria Scorecard	Paving	Urban Basic	Urban Extended	Rural Basic	Rural Extended	Scenic and Recreational	Custom Core Criteria [1]
PD-1 Economic Analyses			●		●		
PD-2 Life-Cycle Cost Analyses	●	●	●	●	●		●
PD-3 Context Sensitive Project Development		●	●	●	●	●	
PD-4 Highway and Traffic Safety	●	●	●	●	●	●	●
PD-5 Educational Outreach		●	●	●	●	●	
PD-6 Tracking Environmental Commitments	●	●	●	●	●	●	●
PD-7 Habitat Restoration		●	●	●	●	●	
PD-8 Stormwater Quality and Flow Control		●	●	●	●	●	
PD-9 Ecological Connectivity			●	●	●	●	
PD-10 Pedestrian Facilities		●	●			●	
PD-11 Bicycle Facilities		●	●			●	
PD-12 Transit & HOV Facilities		●	●			●	
PD-13 Freight Mobility			●		●		
PD-14 ITS for System Operations		●	●		●		
PD-15 Historical, Archaeological, and Cultural Preservation		●	●	●	●	●	
PD-16 Scenic, Natural, or Recreational Qualities			●	●	●	●	
PD-17 Energy Efficiency		●	●	●	●		
PD-18 Site Vegetation, Maintenance, and Irrigation		●	●	●	●	●	
PD-19 Reduce, Reuse, and Repurpose Materials	●	●	●	●	●	●	●
PD-20 Recycle Materials	●	●	●	●	●	●	●
PD-21 Earthwork Balance			●		●	●	
PD-22 Long-Life Pavement	●	●	●	●	●	●	●
PD-23 Reduced Energy and Emissions in Pavement Materials	●	●	●	●	●	●	●
PD-24 Permeable Pavement	●	●	●	●	●	●	●
PD-25 Construction Environmental Training		●	●	●	●	●	
PD-26 Construction Equipment Emission Reduction	●	●	●	●	●	●	●
PD-27 Construction Noise Mitigation		●	●			●	
PD-28 Construction Quality Control Plan	●	●	●	●	●	●	●
PD-29 Construction Waste Management	●	●	●	●	●	●	●
PD-30 Low Impact Development		●	●	●	●	●	
PD-31 Infrastructure Resiliency Planning and Design			●		●	●	
PD-32 Light Pollution		●	●	●	●		
PD-33 Noise Abatement		●	●				
Total Number of Criteria in Scorecard	11	27	34	23	29	27	11

([1]) Indicates the core criteria that must be included in the custom scorecard. The user may choose as many additional criteria as desired.

The Project Development – Urban Extended Scorecard was used for the INVEST scoring of this project. Project Development (PD) is traditionally the second step in the lifecycle of a transportation project, where specific projects are planned, designed, and constructed. The PD module in the current INVEST tool includes a total of thirty-three criteria that are generally organized from planning to design to construction. The PD criteria are further organized into seven (7) scorecards for the evaluation of projects. The scorecards are designed to identify applicable criteria based on the project type (paving, small/spot improvements, new facility/corridor project) and location (urban/rural). Six (6) of these scorecards pre-identify criteria that are most likely to be applicable for the project type and location.

The Urban Extended scorecard is for urban projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of I-17 and include some new right-of-way, temporary construction easements, or major construction work needed, ADOT evaluated this based off the 33 criteria available for the scorecard.

Based on the assessment completed for the INVEST scoring, the project received a score of 88 points, which identifies the project as a gold rating. Attached to this memorandum is the "Project Scorecard," which shows all points and information related to the scoring of the project. Of the almost seventy-five INVEST scoring efforts less than 3% have achieved gold rating. These have become candidates for ADOT's Excellence in Sustainable Design Award Program.

Several notable points were documented for the following categories:

- **Economic Analysis**: Conducting economic analyses supports all of the triple bottom line sustainability principles by ensuring that agencies consider improvements where benefits exceed the investment costs for the project through analysis of impacts to local businesses, emissions, safety, and others. With planned Interstate 17 flex lanes between Black Canyon City and Sunset Point set for construction starting by 2021, the state budget approved by state lawmakers and signed by Governor Doug Ducey provides the additional funding needed to also complete widening I-17 south of where the flex system will be built. This $130 million investment to complete new third lanes in both directions of I-17 between Anthem and Black Canyon City is one of many in the budget that will expand and preserve transportation infrastructure across Arizona. More than $190 million was already committed to building flex lanes north of Black Canyon City as well as adding 7 miles of a third southbound lane directly south of that project. Investing an additional $130 million over three years will allow ADOT to complete all sections of new third lanes between Anthem and Black Canyon City. Combined with the flex lanes, this increased capacity will enhance safety and help address traffic flow challenges and backups that occur due to crashes and when many drivers are traveling to or from Arizona's high country on summer weekends. In order to facilitate the projected $330 million cost extensive cost benefit and due diligence was completed. The Maricopa Association of Governments is providing $50 million in regional funds to help fund the widening of I-17 between Black Canyon City and Anthem. To round out the funding needs

and reflect just how critical this corridor is to Arizona and the nation; Arizona has won a highly competitive $90 million federal highway grant, the Infrastructure for Rebuilding America (INFRA) grant, was awarded to the ADOT by the FHWA in July of 2019.

- **Context Sensitive Project Development**: Due to the fact that the project occurs on Bureau Land Management (BLM) land, context sensitive project development was needed to ensure the quality, cohesion, and character remained. The project required the ADOT and the BLM participation and partnering. The study segment is located in a rural area of Maricopa and Yavapai counties. The Agua Fria National Monument, administered by the BLM, is located immediately east of the I-17 right-of-way from approximately MP 245 to MP 260. In addition, the Upper Agua Fria Watershed Partnership (UAFWP) grew out of the Water Study Committee of the Big Bug Economic Development Alliance in early 2000. During the same period the Arizona Department of Water Resources (ADWR) began encouraging rural areas to form grassroots regional watershed groups to function as water study and management units outside the Active Management Areas (which are mostly urban). Coordination with this group is also ongoing as it relates to future construction phase water use.

- **Highway and Traffic Safety:** The I-17 horizontal and vertical alignments in this mountainous terrain present challenges related to steep grades and horizontal curves with limited sight distance. In addition, crashes can result in closures of I-17 that cause lengthy travel delays along the route. I-17 experiences heavy volumes during weekends and holidays as the main route for traffic between the Phoenix metropolitan area, Flagstaff, and recreational destinations to the north. The combination of large volumes of passenger cars, trucks, and recreational vehicles results in a substantial speed differential condition on the steep grades of the Black Canyon Hill. This condition affects the operational capacity of the interstate and results in congestion and long traffic back-ups. There are distant detour options for long-term closures; however, there are no alternate routes in the area for short-term closures.

  A Preliminary Traffic Report (March 2007), a traffic Technical Memorandum (November 2014), and an updated Preliminary Traffic Report (October 2017) were prepared in support of the development of the Design Concept Report for this project. The traffic analyses present traffic volume projections and roadway capacity analyses for mainline I-17 beginning at the I-17/Anthem Way TI and extending north to approximately MP 262, south of the Cordes Junction TI. The Highway Capacity Manual (HCM) was used to evaluate freeway capacity and level of service. The measure used to provide an estimate of freeway LOS is density expressed in terms of the number of equivalent passenger cars per mile per lane (pc/mi/ln).

  Two-Lane and Three-Lane Failure Year Sensitivity Analyses - As part of the capacity analysis, the last year during which each segment of the study area exhibits LOS D (the minimum acceptable design level of service) with two lanes and three lanes was determined. Utilizing the HCS, the maximum DDHV that corresponds with a density of 34.9 pc/mi/ln was calculated for each portion of the study area. Once the DDHV was calculated, the K and D factors were used to determine the AADT associated with the “failure

year." Failure year is defined as the last year in which forecasted traffic volumes result in the segment operating at an acceptable LOS D; the following year, operations deteriorate to LOS E. Upon determining the failure year AADT values, linear relationships between the 2016 and 2040 Saturday AADTs were used to estimate the failure year for peak weekend traffic conditions. The crash data was also sorted and grouped by MP location to identify potential high crash locations within the study area.

- **Site Vegetation, Maintenance and Irrigation:** The native plants surrounding the I-17 corridor are a significant resource that provide soil stabilization and wildlife habitat, and act as visual interest. During final design, efforts should be made in areas of disturbance to salvage and replant suitable species: young and healthy Carnegia gigantea (Saguaro 12-20 feet in height), Ferocactus fishhook (Barrel Cactus), and Olneya tesota (Ironwood), etc. Revegetation efforts should and the elevation of salvaged material should be considered when identifying disposition of replanted salvaged material.

  Native Plant Inventory: Prepare a native plant inventory of all saguaros, barrel cactus, ocotillos, and all healthy native trees within the disturbance areas meeting the requirements of the ADOT Native Plant Salvage and Replanting Guidelines. A Salvage Operations Plan should detail all used processes, methods, equipment, and materials for plant salvage, nursery set-up and operation, and replanting of salvaged plants. Native Seeding: All disturbed soils not paved, otherwise landscaped, or permanently stabilized by construction should be seeded using native species to the project vicinity. The various elevations, soil conditions, and drainage considerations may require that several seed mixes to be developed. Examples of project specific seed mixes include Low Grass & Forbs, Tall Background, and Wash Seed Mixes. Additionally, clear zone and background seed mixes may be needed.

  A Noxious and Invasive Species Control Plan (NISCP) will be required to assist with controlling noxious and invasive plant species within the project area. The work under the NISCP shall consist of the detection and eradication of noxious and invasive plants. Proposed method(s) of noxious plant control include either manual eradication or herbicide application by recommended methods for each plant species identified in the NISCP and will be in accordance with NEPA and state statutes. The project area will be surveyed following rain events and during plant germination and growth periods prior to and during construction, as well as post-construction activities. Construction best management practices will include items of operation that may minimize the spread of noxious species. The NISCP shall also include post-construction measures to prevent invasive species seeds from leaving the site.

  Permanent irrigation should be considered in urbanized areas planted with nursery and salvaged plants where potable water exists in adjacent municipal rights-of-way. Use of a temporary irrigation system should be considered for rural areas with salvaged and replanted landscaping and areas where no potable water exists. The final designer should coordinate with ADOT to develop performance criteria of temporary irrigation systems in the special provisions. No irrigation would be required for native seeding.

Landscaping costs at $390,000 per mile are based on the following assumptions:

• 50’ average disturbance both sides of I-17
• Permanent irrigation may be used in urbanized areas with available water. Temporary irrigation used for revegetation areas.
• Total disturbance of 315 acres.
• $200,000 per mile for native plant salvage, nursery storage, and replanting
• One to 1.5 percent of structures costs assumed for aesthetics and rustication.
• Salvage, store, and replace top 4-6” surface soil.
• 10% of rock cuts could be stained. • Includes herbicide and manual or mechanical weed removal of non-rock roadside areas. Herbicide has been applied to 55% of non-rock areas and manual or mechanical weed removal to 45% of non-rock areas.

- **Energy Efficiency:** Light Emitting Diode (LED) luminaires with a correlated color temperature of 3,000k and zero uplight should be used on this project to be in accordance with the Dark Skies recommendations. As part of the ADOT Sustainable Transportation Program Life Cycle Assessment (LCA) and Life Cycle Cost Analysis (LCCA) and the recent INVEST grant an LED LCA LCCA was executed to form the basis of all future LCA LCCA lightning.

  LCA is a technique that can be used for analyzing and quantifying the environmental impacts of a product, system, or process. LCA provides a comprehensive approach to evaluating the total environmental burden of a product or process by examining all of the inputs and outputs over the life cycle, from raw material production to end of life. This systematic approach identifies where the most relevant impacts occur and where the most significant improvements can be made while identifying potential trade-offs. LCA is a field of science that is still evolving, yet it has demonstrated real-world value over the last two decades by helping manufacturers, companies, governments and other groups identify what is environmentally important to them and then to define needed actions to improve their environmental impacts. The processes and rules for conducting an LCA are generally defined by the International Organization for Standardization (ISO) in its 14040 family of standards (ISO 2006). These standards are quite broad; thus, more precise guidance is needed for their application to a specific material or process. Such guidance is usually developed by the relevant industries and other stakeholders.

  LCCA is an analysis technique that uses economic analysis to evaluate the total cost of an investment option in constant dollars over an analysis period. As such, it is principally used to address the economic component of sustainability. LCCA does not directly address societal or environmental issues (e.g., clean air and water, habitat impacts, establishment of livable community conditions) unless such issues can be monetized. ADOT is developing sustainable pavement systems LCCA guidance and assisting FHWA in updating LCCA methodology as it relates to sustainable transportation activities.

- **ITS for System Operations:** ADOT's Intelligent Transportation Systems (ITS) requirements include, ITS Concepts for Rural Corridor Management, September 2007, and are now incorporated in the Statewide ITS Architecture. Section 3.1.5 of the design concept report outlines the Prescott District's main traffic management concerns. These include interagency communications, real-time traffic monitoring for the I-17 corridor, traveler information systems, and weather forecasting to give the driver real-time accurate information. Section 3.2, Table 4, "Districts Needs Matrix," details what ITS components are identified as significant or minor needs. Mentioned, but not covered under the types of devices, was the District's desired installation of wildlife detection and monitoring systems. The specific needs identified by the Northwest District that relate to the I-17 corridor are:

  - Real Time Traffic Monitoring of I-17
  - CCTV Monitoring
  - Budgetary Funding for ITS Maintenance
  - Wildlife Presence Detection
  - Additional Roadway Weather Information Sites
  - Flood Detection Sensors
  - Bridge Deck Icing Monitors
  - Additional Dynamic Message Sign Locations
  - Portable DMS
  - Improved Traveler Information
  - Comprehensive AZ 511 System
  - Portable Speed Display Trailers and Photo Enforcement Programs
  - Highway Advisory Radio for Work Zones
  - Motorist Assist Patrols for Major Construction Projects

While many of these ITS needs are beyond the scope of initial design, it is important to include a description or vision of the fully evolved ITS system so that ITS infrastructure elements can be included in future projects that will contribute to the long-term traffic management goals of the Department.

I-17 INVEST Lesson Learned and Next Steps

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area. Some opportunities that could be considered but will be considered in final design stage include items such as light pollution minimization, low impact development for storm water management, earthwork balance, and recycling of materials. Additionally, an ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with an emphasis on education to the public. The challenge will be to carry forward this effort as completed during the design concept report and environmental phases to final design and the anticipated general engineering contractor for construction.

Appendix: I-17 PD Module Scorecards

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

I-17, Anthem Way to Jct. SR 69 - Jun 18, 2019

Module: Project Development
Scorecard: Urban Extended
Points: 88
Achievement Level: Gold

Urban Extended Scorecard

Criteria Points

PD-01 **Economic Analyses** 5/5

Using the principles of benefit-cost analysis (BCA) or economic impact analysis (EIA), provide evidence that the benefits, including environmental, economic, and social benefits, justify the full life-cycle costs.

PD-01.1a Was a benefit-cost analysis (BCA) for the project completed using minimum acceptable industry practices?
Yes (2 points)

PD-01.1b Was an Economic Impact Analysis (EIA) completed that meets all the listed requirements?
Yes (3 points)

Scoring Notes
This $130 million investment to complete new third lanes in both directions of I-17 between Anthem and Black Canyon City is one of many in the budget that will expand and preserve transportation infrastructure across Arizona. Appropriations from the State General Fund include $10 million for an ADOT study on adding lanes to Interstate 10 between Phoenix and Tucson and $10.5 million for preserving state highways to extend the life of existing pavement.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-02 **Lifecycle Cost Analyses** 2/3

Reduce life-cycle costs and resource consumption through the informed use of life-cycle cost analyses of key project features during the decision-making process for the project.

PD-02.1a Was an LCCA performed for all pavement structure alternatives in accordance with the method described in the FHWA's Technical Bulletin for Life-Cycle Cost Analysis?
Yes (1 point)

PD-02.1b Was an LCCA performed for all stormwater infrastructure alternatives considered?
No (0 points)

PD-02.1c Was an LCCA performed for the project's major feature (bridges, tunnels, retaining walls, or other items not listed in the preceding options) for each of the alternatives considered?
Yes (1 point)

Scoring Notes
Per asset mngmtnt processes now in place all pvmt and bridge structures under go LCCA.

Next Actions

Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-03 **Context Sensitive Project Development** 10/10

Deliver projects that harmonize transportation requirements and community values through effective decision-making and thoughtful design.

PD-03.1 Did the project development process generally follow the six-step CSS framework described in NCHRP report 480 and NCHRP report 642, or an equivalent process?
Yes (2 points)

PD-03.2 Did the project development process feature a "cradle-to-grave" project team that included planners, traffic engineers, public involvement specialists, design engineers, environmental experts, safety specialists, landscape architects, right-of-way staff, freight experts, construction engineers, and others to work on projects who worked together to achieve the desired CSS-based vision for the project?
Yes (1 point)

PD-03.3 As a result of CSS-influenced project development process, were external "champions" for the project created in the affected community who were engaged and proactive in supporting it?
Yes (1 point)

PD-03.4 Was acceptance achieved among project stakeholders on the problems, opportunities, and needs that the project should address and the resulting vision or goals for addressing them?
Yes (1 point)

PD-03.5 Do project features consider the appropriate scale of the project?
Yes (1 point)

PD-03.6 Did the project remove objectionable or distracting views?
Yes, permanently (2 points)

PD-03.7 Did the project integrate context sensitive aesthetic treatments?
Yes (1 point)

PD-03.8 Were aethetics for structural items incorporated into the design of the project?
Yes (1 point)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-04 **Highway and Traffic Safety** 10/10

Safeguard human health by incorporating science-based quantitative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.

PD-04.1 Were human factors considerations incorporated?
Interactions between road users and the roadway using fundamentals captured in Chapter 2 of the Highway Safety Manual and the Human Factors Guideline for Road Systems (NCHRP Report 600 series) were evaluated, documented, and incorporated. (2 points)

PD-04.2 Was awareness built among the public regarding contributing factors to crashes?
Yes (1 point)

PD-04.3 Does the agency conduct explicit consideration of safety using quantitative, scientifically proven methods?
Yes (0 points)

PD-04.3a Was the project type established during scoping of project alternatives through a quantitative and statistically reliable process?
Yes (1 point)

PD-04.3b Were project design and/or operational alternatives developed and evaluated using explicit consideration of substantive safety through quantitative, statistically reliable methods?
Yes (2 points)

PD-04.3c Were quantitative and statistically reliable methods and knowledge used to assess substantive safety performance in the development of preliminary and final design details?
Yes (3 points)

PD-04.4 Was a statistically reliable, science-based method used to evaluate the safety effectiveness of the implemented project?
Yes (1 point)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-05 **Educational Outreach** 0/2

Increase public, agency, and stakeholder awareness of the integration of the principles of sustainability into roadway planning, design, and construction.

PD-05.1 Did this project incorporate public educational outreach that promotes and educates the public about sustainability by installing or performing a minimum of two different elements from Table PD-05.1.A?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-06 **Tracking Environmental Commitments** 0/5

Ensure that environmental commitments made by the project are completed and documented in accordance with all applicable laws, regulations, and issued permits.

PD-06.1a Was a comprehensive environmental compliance tracking system used for the project and related facilities?
No (0 points)

PD-06.2 Has the principal project constructor assigned an independent environmental compliance monitor who will provide quality assurance services and report directly to and make recommendations to the regulatory and Lead Agencies?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-07 **Habitat Restoration** 2/7

Avoid, minimize, rectify, reduce, and compensate the loss and alteration of natural (stream and terrestrial) habitat caused by project construction and/or restore, preserve, and protect natural habitat beyond regulatory requirements.

PD-07.1 Was project-specific mitigation or mitigation banking used on this project? Use Table PD-07.1.A to determine the points earned.
None (0 points)

PD-07.2 Were high quality aquatic resources (HQAR) avoided or were the impacts minimized on this project? Use Table PD-07.2.A to determine the points earned.
None (0 points)

PD-07.3 Were high quality environmental resources avoided or were the impacts minimized on this project? Use Table PD-07.3.A to determine the points earned.
2 Points (2 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-08 **Stormwater Quality and Flow Control** 3/6

Improve stormwater quality from the impacts of the project and control flow to minimize their erosive effects on receiving water bodies and related water resources, using management methods and practices that reduce the impacts associated with development and redevelopment.

PD-08.1 Did the project treat at least 80% of the total runoff volume? Use Tables PD-08.1.A and PD-08.1.B to determine points.
No (0 points)

PD-08.2 Did the project manage the flow from at least 80 percent of the total runoff volume, and is flow control based on controlling peak flows or durations from the project site? Use Tables PD-08.2.A and PD-08.1.B to determine points.
3 Points (3 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-09 **Ecological Connectivity** 3/4

Avoid, minimize, or enhance wildlife, amphibian, and aquatic species passage access, and mobility, and reduce vehicle-wildlife collisions and related accidents.

PD-09.1P Was a site-specific ecological assessment of the roadway project using GIS data or regional expertise conducted?
Yes (0 points)

PD-09.1 Were methods used to minimize impacts to ecological connectivity? Use Table PD-09.1.A to determine points.
2 (2 points)

PD-09.2 Did the project team engage natural resource and regulatory agencies throughout the planning process and ensure consistency with broader planning goals and objectives?

Yes (1 point)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-10 **Pedestrian Facilities** 0/3

Provide safe, comfortable, convenient, and connected pedestrian facilities for people of all ages and abilities within the project footprint.

PD-10.1P Were all facilities upgraded to meet ADA standards and do responses below exclude any projects to upgrade facilities to ADA standards?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-11 **Bicycle Facilities** 0/3

Provide safe, comfortable, convenient, and connected bicycling facilities within the project footprint.

PD-11.1 Were missing bicycle connections installed per master plan or other relevant documents?
No (0 points)

PD-11.2 Were bicycle features installed that are safe, comfortable, convenient and connected?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-12 **Transit and HOV Facilities** 0/5

Promote the use of public transit and carpools in communities by dedicating existing facilities to those uses, upgrading existing lanes, or providing new transit and high occupancy vehicle (HOV) facilities.

PD-12.1 Were Transit and HOV facilities installed on this project that are consistent with the need, purpose, and appropriateness for transit and HOV access within the project footprint? Use Table PD-12.1.A to determine points.
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-13 **Freight Mobility** 3/7

Enhance mobility of freight movements, decrease fuel consumption and emissions impacts, and reduce freight-related noise.

PD-13.1 Were freight facilities installed on this project consistent with the need, purpose, and appropriateness for freight mobility within the project footprint? Use Table PD-13.1.A to determine points.
3 Points (3 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-14 **ITS for System Operations** 4/5

Improve the efficiency of transportation systems through deployment of technology and without adding infrastructure capacity in order to reduce emissions and energy use, and improve economic and social needs.

PD-14.1 Were one or more allowable ITS applications installed? Use Table PD-14.1.A to determine points.
At least 1 application in 4 separate categories (4 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-15 **Historic, Archaeological, and Cultural Preservation** 3/3

Preserve, protect, or enhance cultural and historic assets, and/or feature National Scenic Byways Program (NSBP) historic, archaeological, or cultural intrinsic qualities in a roadway.

PD-15.1P Is any part of the project or resource listed in the NRHP or been determined eligible for the NHRP by a State, Local, or Tribal Historic Preservation Officer?
Yes (0 points)

> **PD-15.1 Has an effort been made to minimize impacts, avoid impacts, or enhance features?**
> PD-15.1c Actions have been taken to enhance features through the protection, preservation, and/or enhancement of historic, archaeological, or cultural resources. (3 points)

Scoring Notes
A federal monument is located at the northern end of the project and must be protected at all costs.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-16 **Scenic, Natural, or Recreational Qualities** 0/3

Preserve, protect, and/or enhance routes designated with significant scenic, natural, and/or recreational qualities in order to enhance the public enjoyment of facilities.

PD-16.1P Is any portion of the project along one of America's Byways®, a State Scenic Byway, an Indian Tribe Scenic Byway, or other route that was designated or officially recognized as such?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-17 **Energy Efficiency** 6/8

Reduce energy consumption of lighting systems through the installation of efficient fixtures and the creation and use of renewable energy.

PD-17.1 Were energy needs evaluated for the project?
Yes (0 points)

> **PD-17.1 Were alternatives implemented to reduce power consumption while still meeting lighting and safety standards?**
> Yes (1 point)

PD-17.2 Was the energy consumption on the project reduced through the installation of energy efficient lighting and signal fixtures and through the installation of autonomous, on-site, renewable power sources?
Yes (0 points)

> **PD-17.2 Points are awarded based on the percentage of reduced power use. Based on Table PD-17.2.A, how many points did the project earn?**
> 4 Points (4 points)

PD-17.3 Was a plan established for auditing energy use after project completion as part of operations and maintenance?
Yes (1 point)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-18 **Site Vegetation, Maintenance and Irrigation** 6/6

Promote sustainable site vegetation within the project footprint by selecting plants and maintenance methods that benefit the ecosystem.

PD-18.1P Does all site vegetation use non-invasive species only, use non-noxious species only, use seeding that does not require consistent mowing for a viable stand of grass, and minimize disturbance of native species?
Yes (0 points)

> **PD-18.1 Based on Table PD-18.1.A, how many points did the project earn? Points for features are additive, however this criterion shall not exceed a total of 3 points.**
> 3 Points (3 points)

> **PD-18.2 Based on Table PD-18.2.A, how many points did the project earn for vegetative maintenance? Points for features are cumulative, however this scoring requirement shall not exceed a total of 3 points.**
> 3 Points (3 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-19 **Reduce, Reuse and Repurpose Materials** 10/12

Reduce lifecycle impacts from extraction and production of virgin materials by recycling materials.

PD-19 Points for different methods are cumulative; however, this criterion shall not exceed a total of twelve points. Points exceeding twelve will not contribute to overall score.
I understand. (0 points)

PD-19.1 Was remaining service life increased through pavement preservation activities? Points are awarded per Table PD-19.1.A.
3 (3 points)

PD-19.2 Was the amount of new pavement materials needed reduced? Points are awarded per Table PD-19.2.A.
No (0 points)

PD-19.3 Was remaining service life increased through bridge preservation activities? Points are awarded per Table PD-19.3.A.
4 (4 points)

PD-19.4 Was remaining service life increased through retrofitting existing bridge structures? Points are awarded per Table PD-19.3.A.
3 (3 points)

PD-19.5 Were existing pavements, structures, or structural elements reused for a new use? Points are awarded per Table PD-19.5.A.
No (0 points)

PD-19.6a Were foundry sand or other industrial by-products used in pipe bedding and backfill?
No (0 points)

PD-19.7 Was a project-specific plan for the recycling and reuse plan developed as described?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-20 **Recycle Materials** 4/10

Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by recycling materials.

PD-20 Points for different methods are cumulative; however, this criterion shall not exceed a total of ten points. Points exceeding ten will not contribute to overall score.
I understand. (0 points)

PD-20.1 Was RAP or RCA used in new pavement lifts, granular base course, or embankments? Points are awarded per Tables PD-20.1.A or PD-20.1.B.
2 (2 points)

PD-20.2 Were pavement materials recycled in place using cold-in-place recycling, hot-in-place recycling, and full depth reclamation methods? Points are awarded per Table PD-20.2.A.
No (0 points)

PD-20.3 Did the project reuse subbase granular material as subgrade embankment or as part of the new subbase? Points are awarded per Table PD-20.3.A.

2 (2 points)

PD-20.4 Did the project relocate and reuse at least 90 percent of the minor structural elements, including existing luminaires, signal poles, and sign structures that are required to be removed and/or relocated onsite?
No (0 points)

PD-20.5 Did the project salvage or relocate existing buildings?
No (0 points)

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

PD-21 **Earthwork Balance** 2/5

Reduce the need for transport of earthen materials by balancing cut and fill quantities.

PD-21.1a Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10%?
No (0 points)

> **PD-21.1b Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10% if construction banking is used?**
> Yes (1 point)

PD-21.2 Has an earthwork management plan been established, implemented and actively managed on this project?
Yes (1 point)

PD-21.3 Has topsoil been preserved or reused on this projet?
No (0 points)

Scoring Notes
Initial estimate is 2,785,000 cu/yds of waste.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-22 **Long-Life Pavement** 7/7

Minimize life-cycle costs by designing long-lasting pavement structures.

PD-22 Points for different methods are cumulative; however, this criterion shall not exceed a total of seven points. Points exceeding seven will not contribute to overall score.
I understand. (0 points)

PD-22.1 Which of the following describes how long-life pavement was used on this project?
Long-life pavement was used for at least 75 percent of the surface area of regularly trafficked lanes. (5 points)

PD-22.2 Was the asphalt density of 100 percent of the total new or reconstructed pavement increased to a minimum of 94 percent?
Yes (5 points)

PD-22.3 Was a performance-based pay incentive for pavement smoothness used on this project?
Yes (2 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-23 **Reduced Energy and Emissions in Pavement Materials** 0/3

Reduce energy use in the production of pavement materials.

PD-23 Points for different methods are cumulative; however, this criterion shall not exceed a total of three points. Points exceeding three will not contribute to overall score.
I understand. (0 points)

PD-23.1 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from asphalt production?
No (0 points)

PD-23.2 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from cement production?
No, or it did not meet the minimum requirements in the options above. (0 points)

PD-23.3 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from concrete production?
No, or it did not meet the minimum requirements in the options above. (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-24 **Permeable Pavement** 0/2

Improve flow control and quality of stormwater runoff through use of permeable pavement technologies.

PD-24.1and2P Does the project include a maintenance plan for permeable pavements and are permeable pavements placed in areas where no sand will be used for snow and ice control or pavement sealing?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-25 **Construction Environmental Training** 0/1

Provide construction personnel with the knowledge to identify environmental issues and best practice methods to minimize impacts to the human and natural environment.

PD-25.1 Did the owner require the Contractor to plan and implement a formal environmental awareness training program during construction to ensure the project stay in compliance with environmental laws, regulations, and policies?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-26 **Construction Equipment Emission Reduction** 0/2

Reduce air emissions from non-road construction equipment.

PD-26.1 Were one or more methods implemented to reduce non-road emissions? Points are awarded per Table PD-26.1.A.
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-27 **Construction Noise Mitigation** 0/2

Reduce annoyance or disturbance to surrounding neighborhoods and environments from road construction noise.

PD-27.1 Is the contractor required to establish, implement, and maintain a formal Noise Mitigation Plan (NMP) during roadway construction?
No (0 points)

PD-27.2 Has the contractor monitored noise and the effectiveness of mitigation measures at the receptors throughout construction to ensure compliance with the NMP?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-28 **Construction Quality Control Plan** 5/5

Improve quality by requiring the contractor to have a formal Quality Control Plan (QCP).

PD-28.1 Is the Contractor required to plan and implement quality control measures throughout construction with care and for materials above and beyond what is typically required by specifications and regulations?
Yes (3 points)

PD-28.2 Does the contract leverage the use of Quality Price Adjustment Clauses to link payment and performance of the constructed products?
Yes (2 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-29 **Construction Waste Management** 0/4

Utilize a management plan for road construction waste materials to minimize the amount of construction-related waste destined for landfill.

PD-29.1 Is the contractor required to establish, implement, and maintain a formal Construction and Demolition Waste Management Plan (CWMP) during roadway construction, or its functional equivalent?
No (0 points)

PD-29.2 Can the owner demonstrate that a percentage of the construction waste has been diverted from landfills?
No, or diverted less than 50 percent of the construction waste from landfills (0 points)

PD-29.3 Were excess materials hauled directly to other project sites for recycling on those projects?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-30 **Low Impact Development** 0/3

Use low impact development stormwater management methods that reduce the impacts associated with development and redevelopment and that mimic natural hydrology.

PD-30.1 Did the project use effective BMPs or stormwater management techniques that mimic natural hydrology to treat pollutants? Use Tables PD-30.1.A and PD-30.1.B and PD-30.1.C to determine points.
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-31 **Infrastructure Resiliency Planning and Design** 0/12

Respond to vulnerabilities and risks associated with current and future hazards (including those associated with climate change) to ensure transportation system reliability and resiliency.

PD-31.1 Did the project incorporate consideration of climate change at a project-specific level in project development and environmental reviews?
No (0 points)

PD-31.2 Did the project incorporate future consideration of climate change effects in the design process?
No (0 points)

PD-31.3 Did the project mitigate the effects of GHG emissions through design efforts above and beyond requirements and regulations?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-32 **Light Pollution** 0/3

To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.

PD-32.1 Were the uplighting ratings met on this project per Table PD-32.1.A?
No (0 points)

PD-32.2 Were the backlighting ratings met on this project per Table PD-32.2.A?
No (0 points)

PD-32.3 Were the glare ratings met on this project per Table PD-32.3.A?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-33 **Noise Abatement** 3/5

Reduce traffic noise impacts to surrounding communities and environments.

PD-33 Points for different noise abatement methods are cumulative; however, this criterion shall not exceed a total of five points. Points exceeding five will not contribute to overall score.
I understand. (0 points)

PD-33.1 Was a specialized noise barrier used on this project?
No (0 points)

PD-33.2 Were traffic system management techniques used to reduce existing noise levels?
No (0 points)

PD-33.3 Were buffer zones provided for adjacent noise sensitive receptors?
No (0 points)

PD-33.4 Were quiet pavements used on the project? Use Table PD-33.4.A to determine the points earned.
Yes, 3 points. (3 points)

PD-33.5 Were plantings used as a sight screen to separate noise receptors from the project?
No (0 points)

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

INVEST Memorandum
State Route 30: Use of INVEST for Sustainable Project Development During the Design Concept Report and Environmental Assessment Phase
Arizona Department of Transportation

SEPTEMBER 2019

INVEST Score: SILVER (57 points)

State Route (SR) 30 Freeway:
SR 202L (South Mountain Freeway) to SR 303L (Loop 303)
NH-801-B(ARG)
801 MA 000 H6876 01L
Maricopa County, Arizona
Ultimate Freeway Proposed Cost: $1.7b

Background

Since 2005, the Arizona Department of Transportation (ADOT) has been studying State Route 30, a proposed new freeway corridor that would serve as an alternate route to Interstate 10. The study area extends from Sarival Avenue on the west to 59th Avenue on the east, and Lower Buckeye Road on the north to the Gila and Salt rivers on the south. The project spans about 13-miles and passes through the cities of Goodyear, Avondale, Phoenix and portions of unincorporated Maricopa County.

In early 2015, after several years of study, the ADOT presented the public with four build alternatives (North, Center, Hybrid, and South). All four (4) alternatives were evaluated with a comprehensive screening process using twenty-four (24) technical (environmental and engineering) criteria, eight (8) cost and right-of-way criteria, and seven (7) agency and public support criteria. Also considered was a No-Build Alternative, which explored the impacts of not building a transportation corridor in the study area.

In November 2017, ADOT held a public meeting that provided information on the four build alternatives and the No-Build Alternative, concluding with an announcement that only the No-Build Alternative and the Hybrid Alternative were being carried forward for detailed analysis and additional public input. The Hybrid Alternative would now be referred to as the Recommended Build Alternative (or RBA).

In early 2019, after carefully considering the findings from the multi-year screening process that evaluated twenty-four (24) environmental and engineering criteria, eight (8) cost and right of way criteria, and the public and agency feedback received during the Spring 2019 Public Hearing, the ADOT is recommending the RBA as the Recommended Alternative. A finding of no significant impact (FONSI) is anticipated upon air quality conformity in 2019.

What is INVEST?

The Federal Highway Administration (FHWA) INVEST program is a self-evaluation tool that measures the use of voluntary sustainability best practices that cover the full life cycle of transportation services, including system planning, project planning, design, construction, operation, and maintenance. The FHWA developed INVEST for voluntary use by transportation agencies to assess and enhance the sustainability of their projects and programs.

The INVEST program features sustainability criteria that are divided into four independent modules that are evaluated separately:

- System Planning for States (SPS) – This module is geared toward states, toll road agencies, and other local agencies that perform landscape-scale and corridor-wide planning and that typically own infrastructure.
- System Planning for Regions (SPR) – This module is geared toward metropolitan planning organizations, councils of governments, and other planning organizations that perform landscape-scale planning for a metropolitan area but typically do not own transportation infrastructure.
- Project Development (PD) – This module spans the entire project development process. It includes early project planning, alternatives analysis, environmental documentation, preliminary and final design, and construction. Although the criteria span all phases of project development, including construction activities, the project owner typically has control over the decisions and actions necessary to meet all of the criteria.
- Operations and Maintenance (OM) – This module evaluates the system-level operation and maintenance activities to determine how they contribute to the overall sustainability of the transportation infrastructure. The OM criteria score an agency's internal and system operations as well as any asset management and maintenance activities performed on the agency's infrastructure.

The system planning modules (SPS and SPR) focus on performing system-level analyses to assess the overall sustainability of the network and the individual projects programmed in a certain phase of the life cycle. The system planning criteria are primarily intended to score an agency's fiscally constrained long-range transportation plan, which is expected to include the agency's transportation planning process, project selection criteria, the transportation improvement program/state transportation improvement plan, and project programming. The PD and OM modules analyze individual projects, groups of similar projects, or programs specific to operating a system and are, therefore, more specific.

Although many agency and project efforts and practices can be considered sustainable, INVEST focuses on practices that go above and beyond those that are currently used. Overall, INVEST is a tool to use when attempting to capture current best management practices and document new sustainable objectives - visit: https://www.sustainablehighways.org/.

INVEST Goals

The FHWA built INVEST using input and advice from transportation professionals, with the specific needs of the aforementioned agencies in mind. ADOT was a 2010 INVEST beta-tester and has incorporated the tool through three subsequent FHWA grants. As a result, the information in INVEST is practical and tangible, and relates to the everyday activities of transportation organizations. It translates broad sustainability principles into specific actions, and provides transportation professionals a way to measure sustainability. INVEST helps transportation agencies go above and beyond minimum requirements to promote responsible stewardship.

Since INVEST became available, transportation agencies from around the country have used it to evaluate and improve their projects and programs and to accomplish agency-wide sustainability goals. As illustrated in Table 1, INVEST offers multiple approaches and applications to help transportation agencies achieve specific sustainability goals.

Table 1. Approaches to Achieving Sustainability Goals Using INVEST

Goal	Approach
Advance better business practices	Make a business case for sustainability
	Monitor performance and benchmark with INVEST
Integrate sustainability into projects and programs	Improve the sustainability of specific transportation projects
	Keep projects on track to meet your sustainability goals
	Provide contractors with incentives for maximizing sustainability
	Improve the planning process
	Conduct programmatic evaluations and modify agency guidelines to address sustainability
	Maximize sustainability of operation and maintenance programs
Improve education and understanding of sustainability	Change the perception of sustainability
	Provide a consistent reference for sustainable practices
	Motivate and encourage innovations
	Emphasize outcomes over score
	Build intellectual capacity
Facilitate internal and external communication and outreach	Encourage internal communication
	Facilitate external communication
	Demonstrate a commitment to sustainability and self-improvement

INVEST Version 1.3 Scoring Criteria

The current version of INVEST is Version 1.3, which is the result of extensive user input and collaboration that began in 2017. FHWA launched INVEST Version 1.0 in October 2012 with a national webcast. Upon the release of INVEST Version 1.0, FHWA solicited partnerships with transportation departments, metropolitan planning organizations, federal land managers, and local governments that chose to use INVEST Version 1.0 to assess and enhance the sustainability of their projects and programs. INVEST Versions 1.1 (released in January 2015) and 1.2 (released in September 2015) included revisions to INVEST based on extensive feedback received from these partnerships. Version 1.3 was launched in April 2018.

The basis for INVEST's sustainability scoring is its criteria. An INVEST criterion is a collection of results-based sustainable solutions or best practices, combined based on similarity in discipline or timing and including a goal, description, and requirements.

ADOT Sustainability Program and INVEST

Arizona's transportation infrastructure is spread over 114,000 square miles, operates from sea level to 8,000 feet, and withstands temperatures that range from below 0°F to over 120°F. Maintaining optimum health and performance of this infrastructure is critical to Arizona's economic vitality, quality of life, and natural and built environments. The ADOT recognizes the critical need to plan and prioritize resources more efficiently in order to maintain and operate a robust, economically beneficial transportation network. ADOT also recognizes the importance of delivering transportation solutions in a more sustainable manner to achieve economic, social, and environmental goals. ADOT has moved from the early stages of identifying sustainable strategies in 2010 to implementing a sustainable transportation program that encompasses core administrative, planning, design, construction, operation, and maintenance activities.

The three primary principles of sustainability focus on achieving an efficient, well-balanced use of economic, social, and environmental resources—commonly known as the triple bottom line (Figure 1). In theory, this will allow for proper use of funding while attaining all potential project needs and objectives. A sustainable highway, for example, will not only incorporate mobility and transportation alternatives but also consider safety, accessibility, livability, asset management, and environmental stewardship. As stated in the *Guidebook for Sustainability Performance Measurement for Transportation Agencies*;

> Often, a goal will support more than one principle. Yet no one goal in itself is sufficient to achieve sustainability - it takes multiple goals, pursued in concert, to promote sustainability. When a final set of goals is defined, it's important to crosscheck the package of goals to ensure that all of the principles are well addressed. In doing so, take care not to force-fit the goals to make them map to the principles. A balanced goal set, however, achieves comprehensive coverage of the basic principles of sustainability… (NCHRP Report 708, 2011, p. 20, p. 47).

Figure 1. Sustainable development across all disciplines

To support its sustainability program, the ADOT has made optimal use of the INVEST program. The ADOT initially became interested in using INVEST in 2010 while in the midst of updating two of its long-term planning documents, *Building a Quality Arizona (bqAZ)* and *What Moves You Arizona?* Arizona was—and is continuing to—go through a period of rapid demographic change and population growth. Simultaneously, many members of the public have become more informed about the transportation planning process and demand that transportation projects address more than just mobility and accessibility needs to also include environmental, social, and economic components. The ADOT began discussing sustainability principles as FHWA first sent out a call to state transportation departments to pilot the tool. INVEST provided the opportunity to connect the sustainability principles already under discussion at the ADOT with actual activities. Key outcomes of the ADOT's initial work with INVEST included:

- Scoring over 50 individual transportation projects using the PD module and developing recommendations for improvements to agency sustainability practices based on the evaluation;
- Integrating recommendations and sustainability concepts into ADOT manuals and guidance, including the ADOT *Complete Transportation Guidebook* completed in February 2016;
- Conducting sustainability training with internal ADOT departments and external stakeholders and partners; and
- Developing a sustainability award program to recognize ADOT projects and projects managers that go above and beyond, as measured by the INVEST score, best management practices, and collaboration.

ADOT continues to use, expand, and improve INVEST as one of the cornerstones of its Sustainable Transportation Program.

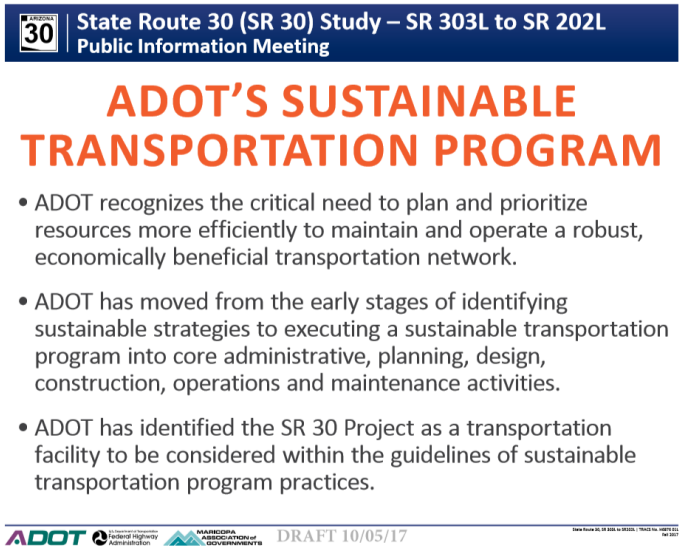
Purpose of the Memorandum

This memorandum describes the use of the INVEST PD module to analyze and score the ADOT State Route (SR) 30 project—an approximately 13-mile section of new freeway in the Phoenix metropolitan area. The new freeway would be built five (5) miles south of Interstate 10 and would run from Sarival Road in Goodyear east to Loop 202 (South Mountain Freeway) in the western section of Phoenix in Maricopa County, Arizona (Figure 2). SR 30 is a proposed new freeway managed by the ADOT that would eventually link with the proposed ADOT Interstate 11 project in western Maricopa County near Tonopah at its western terminus and with the existing Interstate 17 at the Durango Curve in Phoenix at its eastern terminus. The section of SR 30 analyzed and scored using INVEST is currently in the preliminary design and environmental assessment evaluation phase pursuant to the National Environmental Policy Act.

Using INVEST for the SR 30 project will add to the ADOT's body of knowledge of projects analyzed and scored with the PD module. As noted above, the ADOT has scored over 50 projects in the agency's 5-year construction program using the PD module—initially with a specific focus on statewide roundabout projects. The ADOT then expanded the scoring to projects ranging from pavement preservation, to bridge deck rehabilitation, to the addition of new lane miles. The ADOT was particularly interested in how INVEST could supplement the agency goals of furthering efforts surrounding sustainable infrastructure.

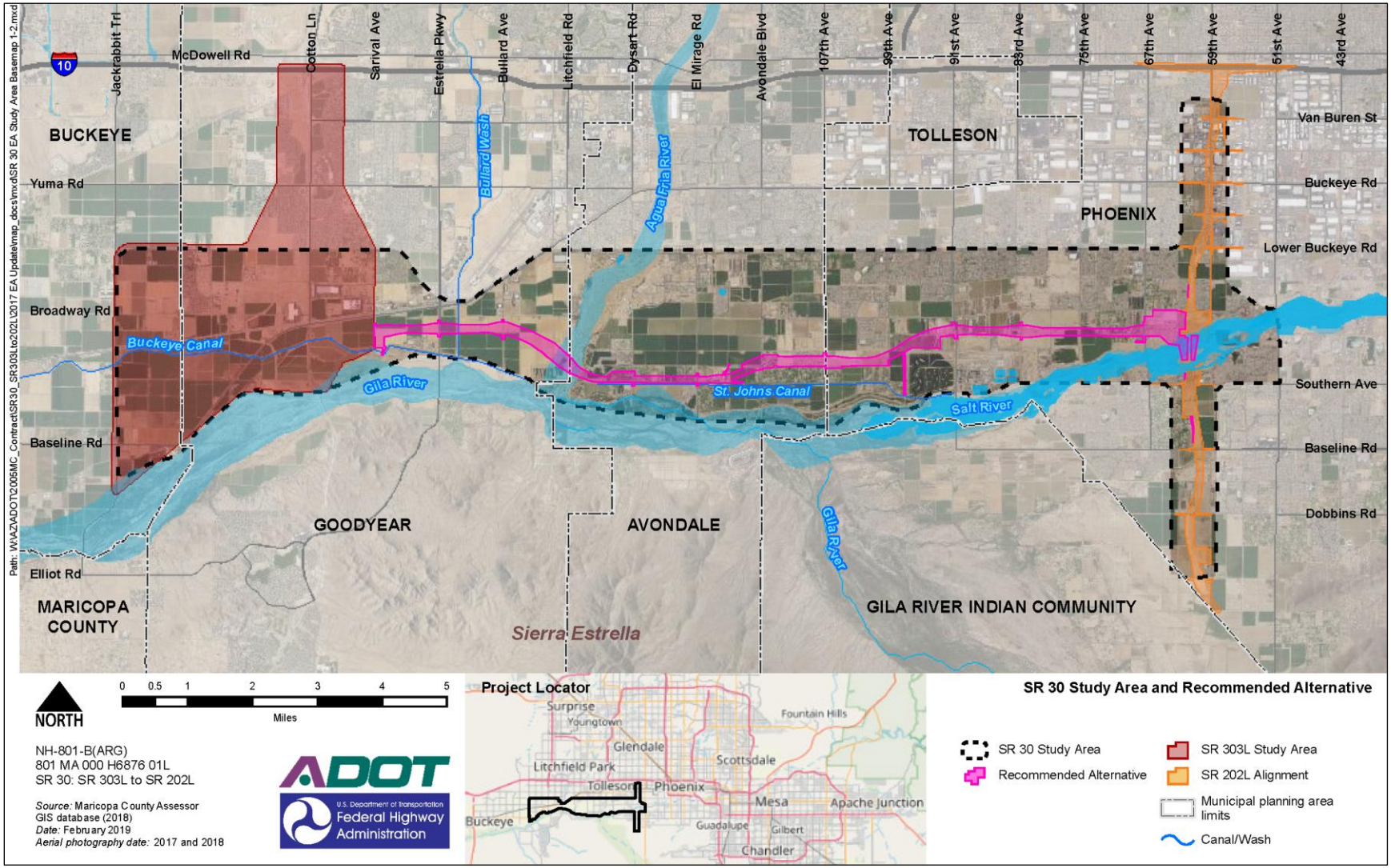
Connecting sustainability and NEPA

In addition to the extensive INVEST scoring effort and sustainability review, ADOT initiated an effort early in the Design Concept Report (DCR) and Environmental Assessment (EA) contract negotiations to have hours included for this effort but also to explore how sustainability and NEPA integrate. As such, step one was to designate this 13-mile regional transportation corridor project as ADOT's first ever sustainable transportation corridor of interest. Step two was to incorporate sustainable transportation language into the October 2017 public meeting.



Step 3 was to utilize the 100 INVEST hours incorporated into the DCR/EA scope of work to conduct the independent scoring and memorandum development. Step 4 was to conclude the scoring and create a baseline for considering sustainability in design. This baseline was especially important to establish a starting point once final design was started in this $1.7b freeway.

Figure 2. State Route 30, Sarival Avenue to Loop 202



Project Development Module Criteria

For SR 30, the INVEST PD module was used to score its current level of sustainability because it is an individual project. The PD module includes criteria that span the entire project development process from early planning, alternatives analysis, environmental documentation, preliminary and final design, to construction.

The PD module has 33 criteria organized into 6 fixed and 1 custom scorecard, as discussed below:

PD-01 Economic Analyses Using the principles of benefit-cost analysis (BCA) or economic impact analysis (EIA), provide evidence that the benefits, including environmental, economic, and social benefits, justify the full life-cycle costs.
PD-02 Lifecycle Cost Analyses Reduce life-cycle costs and resource consumption through the informed use of life-cycle cost analyses of key project features during the decision-making process for the project.
PD-03 Context Sensitive Project Development Deliver projects that harmonize transportation requirements and community values through effective decision-making and thoughtful design.
PD-04 Highway and Traffic Safety Safeguard human health by incorporating science-based quantitative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.
PD-05 Educational Outreach Increase public, agency, and stakeholder awareness of the integration of the principles of sustainability into roadway planning, design, and construction.
PD-06 Tracking Environmental Commitments Ensure that environmental commitments made by the project are completed and documented in accordance with all applicable laws, regulations, and issued permits.
PD-07 Habitat Restoration Avoid, minimize, rectify, reduce, and compensate the loss and alteration of natural (stream and terrestrial) habitat caused by project construction and/or restore, preserve, and protect natural habitat beyond regulatory requirements.
PD-08 Stormwater Quality and Flow Control Improve stormwater quality from the impacts of the project and control flow to minimize their erosive effects on receiving water bodies and related water resources, using management methods and practices that reduce the impacts associated with development and redevelopment.
PD-09 Ecological Connectivity Avoid, minimize, or enhance wildlife, amphibian, and aquatic species passage access, and mobility, and

reduce vehicle-wildlife collisions and related accidents.
PD-10 Pedestrian Facilities Provide safe, comfortable, convenient, and connected pedestrian facilities for people of all ages and abilities within the project footprint.
PD-11 Bicycle Facilities Provide safe, comfortable, convenient, and connected bicycling facilities within the project footprint.
PD-12 Transit and HOV Facilities Promote the use of public transit and carpools in communities by dedicating existing facilities to those uses, upgrading existing lanes, or providing new transit and high occupancy vehicle (HOV) facilities.
PD-13 Freight Mobility Enhance mobility of freight movements, decrease fuel consumption and emissions impacts, and reduce freight-related noise.
PD-14 ITS for System Operations Improve the efficiency of transportation systems through deployment of technology and without adding infrastructure capacity in order to reduce emissions and energy use, and improve economic and social needs.
PD-15 Historic, Archaeological, and Cultural Preservation Preserve, protect, or enhance cultural and historic assets, and/or feature National Scenic Byways Program (NSBP) historic, archaeological, or cultural intrinsic qualities in a roadway.
PD-16 Scenic, Natural, or Recreational Qualities Preserve, protect, and/or enhance routes designated with significant scenic, natural, and/or recreational qualities in order to enhance the public enjoyment of facilities.
PD-17 Energy Efficiency Reduce energy consumption of lighting systems through the installation of efficient fixtures and the creation and use of renewable energy.
PD-18 Site Vegetation, Maintenance and Irrigation Promote sustainable site vegetation within the project footprint by selecting plants and maintenance methods that benefit the ecosystem.
PD-19 Reduce, Reuse and Repurpose Materials Reduce lifecycle impacts from extraction and production of virgin materials by recycling materials.
PD-20 Recycle Materials Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by recycling materials.
PD-21 Earthwork Balance

Reduce the need for transport of earthen materials by balancing cut and fill quantities.
PD-22 Long-Life Pavement Minimize life-cycle costs by designing long-lasting pavement structures.
PD-23 Reduced Energy and Emissions in Pavement Materials Reduce energy use in the production of pavement materials.
PD-24 Permeable Pavement Improve flow control and quality of stormwater runoff through use of permeable pavement technologies.
PD-25 Construction Environmental Training Provide construction personnel with the knowledge to identify environmental issues and best practice methods to minimize impacts to the human and natural environment.
PD-26 Construction Equipment Emission Reduction Reduce air emissions from non-road construction equipment.
PD-27 Construction Noise Mitigation Reduce annoyance or disturbance to surrounding neighborhoods and environments from road construction noise.
PD-28 Construction Quality Control Plan Improve quality by requiring the contractor to have a formal Quality Control Plan (QCP).
PD-29 Construction Waste Management Utilize a management plan for road construction waste materials to minimize the amount of construction-related waste destined for landfill.
PD-30 Low Impact Development Use low impact development stormwater management methods that reduce the impacts associated with development and redevelopment and that mimic natural hydrology.
PD-31 Infrastructure Resiliency Planning and Design Respond to vulnerabilities and risks associated with current and future hazards (including those associated with climate change) to ensure transportation system reliability and resiliency.
PD-32 Light Pollution To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.
PD-33 Noise Abatement Reduce traffic noise impacts to surrounding communities and environments.

These criteria focus on project development, FHWA recognizes that not all criteria are applicable to all projects, so different combinations of these criteria were used to create seven scorecards for different types of projects in both rural and urban settings. The INVEST website is designed to enable selection of the project type and location, which identifies applicable criteria for consideration (see https://www.sustainablehighways.org/900/about-the-project-development-module.html to learn how the criteria are used for each type of project). Each PD scorecard includes a different combination of the thirty-three (33) PD criteria based on the project type. For projects that do not fit well into these categories, a custom scorecard option is available. The following describes each of the seven (7) scorecards:

- Paving – This scorecard is for projects that are devoted exclusively to pavement preservation, restoration projects that extend the service life of existing facilities and enhance safety, or pavement restoration projects that restore pavement structure, ride quality, and spot safety. The scorecard is used for paving projects in both rural and urban locations.
- Basic Rural – This scorecard is for small, rural reconstruction or rural bridge replacement projects that do not expand the capacity of the roadway.
- Basic Urban – This scorecard is for small urban reconstruction or urban bridge replacement projects that do not expand the capacity of the roadway.
- Extended Rural – This scorecard is for rural projects for a new roadway facility, structure projects where nothing of its type currently exists, and major reconstruction projects that add travel lanes to an existing roadway or bridge.
- Extended Urban – This scorecard is for urban projects for a new roadway facility, structure projects where nothing of its type currently exists, and major reconstruction projects that add travel lanes to an existing roadway or bridge.
- Recreational and Scenic – This scorecard is for projects on recreational and scenic roads, such as those on federal lands.
- Custom – This scorecard is for projects that do not fit any of the predefined scorecard options. It allows the user to develop a unique set of criteria that is most appropriate for the project being evaluated.

SR 30 INVEST PD Module Criteria Scoring Results and Basis for Scores

The first step in the ADOT SR 30 PD process was to determine the type of project, based on the scorecards described above. The SR 30 study area is located in a rapidly growing and urbanizing area in the western part of Phoenix and the adjacent towns of Avondale and Goodyear. Agricultural land currently exists within the SR 30 study area, but it is rapidly transitioning to residential subdivision and commercial land uses. By the proposed SR 30 design year in 2040, the general plans for Phoenix, Avondale, and Goodyear anticipate that much of the existing agricultural land will have been developed into urban land uses.

The scorecard that best meets the needs of the SR 30 project is Urban Extended. The Urban Extended scorecard requires that all thirty-three (33) criteria of the PD module be evaluated and scored. The

evaluation and scoring of the PD module for the SR 30 project was conducted by a consultant design engineering firm retained by the ADOT to conduct preliminary design, engineering, National Environmental Policy Act compliance, and public involvement for the project. The personnel involved with the design, engineering, and environmental assessment of SR 30 conducted the evaluation and scoring to ensure all aspects of the project's sustainability were considered for each PD module criterion.

The PD module scorecard for the SR 30 project—which includes how each criterion was scored, scoring notes, and next actions—can be reviewed in the appendix. The score for the SR 30 project was 57 points, which was Silver on the INVEST Achievement Level. The INVEST scoring levels are, in ascending order, Bronze, Silver, Gold, and Platinum.

Key findings of the independent PD module evaluation and scoring for the SR 30 project, regarding ADOT's sustainability practice areas of strength, are discussed below:

PD-03 Context Sensitive Project Development (Points available: 10, Points awarded: 7) – Context-sensitive solution principles were incorporated into the SR 30 design to address identified constraints to the extent possible. The ADOT typically adds landscaping and artistic treatments to structures on every freeway project, so credit is taken for that normal course of project development.

PD-07 Habitat Restoration (Points available: 7, Points awarded: 5) – The Salt, Gila, and Agua Fria Rivers are within the SR 30 study area but have only intermittent annual flow. Much of the natural riparian habitat has been disturbed by other uses, such as quarry operations. The Tres Rios Flow Regulated Wetlands Complex is a High Quality Aquatic Resource located between 99th and 91st Avenues and adjacent to the City of Phoenix 91st Avenue Wastewater Treatment Plant. The SR 30 Recommended Alternative was aligned to avoid impacts on this complex and is located within 100 feet of its boundary, which is worth 4 points. Additionally, the Recommended Alternative includes a drainage facility to drain stormwater away from the complex on its western boundary, thus preventing potential freeway runoff from affecting the complex.

PD-08 Stormwater Quality and Flow Control (Points available: 6, Points awarded: 3) – Given the location of SR 30 in relation to the Salt, Gila, and Agua Fria Rivers and other resources that include the Tres Rios wetlands and levee in the SR 30 study area, drainage was an important consideration in the development of the stormwater management system. The flow control was developed using a peak flow basis, using a worst-case scenario of a 100-year flood, although the ADOT standard is a 50-year flood. For water quality, the on-site stormwater collection system was developed based on ADOT Best Management Practices. Runoff collected in the catch basins would be conveyed in storm drains. First flush volumes would be treated for both sedimentation and petroleum products within the basins, but the volume of water treated would not exceed 80 percent of the total runoff volume, so no credit is applicable. With regard to managing the runoff volume, this project is managing 100 percent of the flows from the project site and, in addition, is collecting and managing the off-site flows that cross the

corridor. This provides flood control protection for all property from the project corridor south to the Salt and Gila Rivers. This constitutes a far greater managed flow protection than 124 percent, thus the 3-point score.

PD-09 Ecological Connectivity (Points available: 4, Points awarded: 2) – The Recommended Alternative was selected over the Southern Alternative, which would have been located in close proximity to the Salt River. Also, ADOT is in the process of preparing a Biological Evaluation to both minimize and avoid biological impacts from the SR 30 project. Wildlife connectivity was evaluated in the Biological Evaluation and Draft Environmental Assessment. The U.S. Fish and Wildlife Service and Arizona Department of Environmental Quality have been and will continue to be involved throughout the SR 30 planning, design, engineering, and environmental process.

PD-12 Transit and HOV Facilities (Points available: 2, Points awarded: 2) – The third phase of the SR 30 project implementation, which is not yet programmed, would widen the 3+0 section (three general purpose lanes in each direction) constructed in the second phase to a 4+1 section (four general purpose lanes and one HOV lane in each direction) in the median of SR 30 when travel demand warrants it, and when funding is available. The fourth and final phase would involve a high-capacity transit corridor, the space for which is being preserved inside the SR 30 right-of-way footprint for some future date and future mode.

PD-13 Freight Mobility (Points available: 7, Points awarded: 3) – SR 30 satisfies PD-13.1g – *Increase transportation efficiencies for moving freight*, because this is a new limited-access freeway with grade-separated crossings and interchanges with arterial streets and a crossing of the Agua Fria River. This new facility would reduce truck traffic on the local arterial street system and would provide an alternative route to Interstate 10, which currently accommodates a high percentage of trucks with a poor level of service during peak travel times.

PD-14 ITS for System Operations (Points available: 5, Points awarded: 3) – This score is based on the ITS applications typically used on the Phoenix freeway system that are constructed, operated, and maintained by ADOT. Specifically, items PD-14.1d – *Information Dissemination*, g – *Ramp Control*, and i – *Surveillance*.

PD-18 Site Vegetation, Maintenance and Irrigation (Points available: 6, Points awarded: 6) – ADOT has a native plant-only seeding policy within right-of-way areas. ADOT requires contract specifications for the control of noxious and invasive plant species. The specification requires the contractor to identify and remove any designated invasive or noxious plant species prior to any earthwork activities. Additionally, these requirements have been diversified from just grass seeding for erosion control to now include annual and perennial wildflowers, forbs, and shrubs to more closely resemble Arizona's diversified native roadside vegetation.

PD-22 Long Life Pavement (Points available: 12, Points awarded: 7) – The Design Elements section of the SR 30 Design Concept Report states that the entire ultimate SR 30 roadway typical section would be

paved with long-lasting Portland cement concrete pavement (PCCP) and overlaid with a rubber asphalt friction course. The friction course may have to be replaced every 10 to 15 years, but the PCCP materials traditionally last at least 40 years in the Phoenix area. ADOT standard specifications include a pay incentive for pavement smoothness for both the PCCP and the asphalt friction course.

PD-28 Construction Quality Control Plan (Points available: 5, Points awarded: 5) – ADOT construction contracts pay for a contractor quality control item to ensure quality compliance beyond field inspection. ADOT will also pay premiums for material quality that far exceeds the minimum.

SR 30 is currently in the preliminary design and environmental assessment phase of the project. ADOT will have the ability to review and reassess the sustainability aspects of SR 30 through the use of the INVEST PD Scoring Module as it progresses through the various stages of design and public involvement through final design and construction. It is possible that the SR 30 project may achieve a higher sustainability score through the use of current INVEST PD best practices that ADOT may choose to adopt or new ones that may be added to the PD Scoring Module in newer INVEST versions that FHWA develops in the future.

Appendix: SR 30 PD Module Scorecard

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

StateRoute 30 Ultimate - Jan 30, 2019

Module: Project Development
Points: 57
Achievement Level: Silver

All Scorecards

Criteria | Points

PD-01 Economic Analyses — 0/5

Using the principles of benefit-cost analysis (BCA) or economic impact analysis (EIA), provide evidence that the benefits, including environmental, economic, and social benefits, justify the full life-cycle costs.

PD-01.1a Was a benefit-cost analysis (BCA) for the project completed using minimum acceptable industry practices?
No (0 points)

PD-01.1b Was an Economic Impact Analysis (EIA) completed that meets all the listed requirements?
No (0 points)

Scoring Notes
The planning and design for the SR 30 project was started in 2005 long before ADOT EP started the Sustainable Transportation Program using INVEST as a scoring tool.

Next Actions
Determine if a BCA and/or an EIA are required to meet ADOT Sustainability requirements for the SR 30 project.

PD-02 Lifecycle Cost Analyses — 0/3

Reduce life-cycle costs and resource consumption through the informed use of life-cycle cost analyses of key project features during the decision-making process for the project.

PD-02.1a Was an LCCA performed for all pavement structure alternatives in accordance with the method described in the FHWA's Technical Bulletin for Life-Cycle Cost Analysis?
No (0 points)

PD-02.1b Was an LCCA performed for all stormwater infrastructure alternatives considered?
No (0 points)

PD-02.1c Was an LCCA performed for the project's major feature (bridges, tunnels, retaining walls, or other items not listed in the preceding options) for each of the alternatives considered?
No (0 points)

Scoring Notes
None

Next Actions
Determine if the LCCAs noted in this module are required to meet ADOT Sustainability requirements for the SR 30 project.

PD-03 Context Sensitive Project Development — 7/10

Deliver projects that harmonize transportation requirements and community values through effective decision-making and

thoughtful design.

PD-03.1 Did the project development process generally follow the six-step CSS framework described in NCHRP report 480 and NCHRP report 642, or an equivalent process?
Yes (2 points)

PD-03.2 Did the project development process feature a "cradle-to-grave" project team that included planners, traffic engineers, public involvement specialists, design engineers, environmental experts, safety specialists, landscape architects, right-of-way staff, freight experts, construction engineers, and others to work on projects who worked together to achieve the desired CSS-based vision for the project?
Yes (1 point)

PD-03.3 As a result of CSS-influenced project development process, were external "champions" for the project created in the affected community who were engaged and proactive in supporting it?
No (0 points)

PD-03.4 Was acceptance achieved among project stakeholders on the problems, opportunities, and needs that the project should address and the resulting vision or goals for addressing them?
Yes (1 point)

PD-03.5 Do project features consider the appropriate scale of the project?
Yes (1 point)

PD-03.6 Did the project remove objectionable or distracting views?
No (0 points)

PD-03.7 Did the project integrate context sensitive aesthetic treatments?
Yes (1 point)

PD-03.8 Were aethetics for structural items incorporated into the design of the project?
Yes (1 point)

Scoring Notes
CSS principles were incorporated into the design around the constraints that were identified to the extent possible. ADOT typically landscapes and adds art to structures on every freeway project, so credit is taken for that normal course of project development.

Next Actions
None

PD-04 **Highway and Traffic Safety** 0/10

Safeguard human health by incorporating science-based quantitative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.

PD-04.1 Were human factors considerations incorporated?
The project relied solely on published design and operational performance standards during the project development process. (0 points)

PD-04.2 Was awareness built among the public regarding contributing factors to crashes?
No (0 points)

PD-04.3 Does the agency conduct explicit consideration of safety using quantitative, scientifically proven methods?
No (0 points)

PD-04.4 Was a statistically reliable, science-based method used to evaluate the safety effectiveness of the implemented project?
No (0 points)

Scoring Notes
No statistically reliable, science-based method was used during this study to evaluate any element of the project. However, ADOT's design guidelines were applied and they inherently account for many safety factors. When these design guidelines are coupled with

experienced engineering judgement and appropriate application, this creates a safe facility. It should be noted that this is not a final design. It is a scoping level study and associated documentation meant to define a corridor for a new limited access freeway type facility, which are inherently safer that local surface streets to move vehicles.

Next Actions
Determine if a quantified safety analysis will be required for any future phase of this project.

PD-05 **Educational Outreach** 2/2

Increase public, agency, and stakeholder awareness of the integration of the principles of sustainability into roadway planning, design, and construction.

PD-05.1 Did this project incorporate public educational outreach that promotes and educates the public about sustainability by installing or performing a minimum of two different elements from Table PD-05.1.A?
Yes (2 points)

Scoring Notes
At least two of the criteria in Table PD-05.1.A were applied to this project, including the project website, and the development and evaluation of the alternatives to minimize impacts and harmonize with the community's vision.

Next Actions
None

PD-06 **Tracking Environmental Commitments** 0/5

Ensure that environmental commitments made by the project are completed and documented in accordance with all applicable laws, regulations, and issued permits.

PD-06.1a Was a comprehensive environmental compliance tracking system used for the project and related facilities?
No (0 points)

PD-06.2 Has the principal project constructor assigned an independent environmental compliance monitor who will provide quality assurance services and report directly to and make recommendations to the regulatory and Lead Agencies?
No (0 points)

Scoring Notes
ADOT does not have a formal comprehensive Environmental Compliance Tracking System (ECTS). It uses multiple systems to comply with State and federal requirements each year. ADOT is moving toward identifying all environmental commitments on a single list, as OM-06 alludes to in the ADOT O&M Invest Module (April 2016), but this has not yet been fully established.

Next Actions
Overall, ADOT recognizes the need to comprehensively define what it needs to track for environmental purposes and integrate this tracking into its existing processes. Need to keep current on ADOT's progress on developing an ETCS.

PD-07 **Habitat Restoration** 5/7

Avoid, minimize, rectify, reduce, and compensate the loss and alteration of natural (stream and terrestrial) habitat caused by project construction and/or restore, preserve, and protect natural habitat beyond regulatory requirements.

PD-07.1 Was project-specific mitigation or mitigation banking used on this project? Use Table PD-07.1.A to determine the points earned.
2 Points (2 points)

PD-07.2 Were high quality aquatic resources (HQAR) avoided or were the impacts minimized on this project? Use Table PD-07.2.A to determine the points earned.
1 Point (1 point)

PD-07.3 Were high quality environmental resources avoided or were the impacts minimized on this project? Use Table PD-07.3.A to determine the points earned.

2 Points (2 points)

Scoring Notes
The Salt, Gila, and Agua Fria Rivers are located within the SR 30 Study Area but only have intermittent annual flow. Much of the natural riparian habitat has been disturbed by other uses such as quarry operations. The Tres Rios Flow Regulated Wetlands Complex is a HQAR located between 99th and 91st Avenues and adjacent to the COP 91st Avenue WWTP. The SR 30 RBA was aligned to avoid impacts to this complex and is located within 100' of its boundary, which is worth a total of 4 points. Additionally, the RBA includes a drainage facility to drain away storm water from the complex on its western boundary.

Next Actions
Verify this module was scored accurately with ADOT.

PD-08 **Stormwater Quality and Flow Control** 3/6

Improve stormwater quality from the impacts of the project and control flow to minimize their erosive effects on receiving water bodies and related water resources, using management methods and practices that reduce the impacts associated with development and redevelopment.

PD-08.1 Did the project treat at least 80% of the total runoff volume? Use Tables PD-08.1.A and PD-08.1.B to determine points.
No (0 points)

PD-08.2 Did the project manage the flow from at least 80 percent of the total runoff volume, and is flow control based on controlling peak flows or durations from the project site? Use Tables PD-08.2.A and PD-08.1.B to determine points.
3 Points (3 points)

Scoring Notes
Given the location of SR 30 in relation to the Salt, Gila, and Agua Fria Rivers and other resources that include the Tres Rios wetlands and levee in the SR 30 Study Area, drainage was an important consideration in the development of the storm water management system. The flow control was based on a peak flow basis using a worst-case scenario of a 100-year flood, although the ADOT standard is a 50-year event. For water quality, the on-site storm water collection system was developed based on ADOT Best Management Practices. Runoff collected in the catch basins would be conveyed in storm drains. First flush volumes are treated for both sedimentation and petroleum products with the basins, but the volume of water treated does not exceed 80% of the total runoff volume, so no credit is applicable. With regards to managing the runoff volume, this project is managing 100% of the flows from the project site, and in addition, is collecting and managing the off-site flows that cross the corridor. This provides flood control protection for all property from the project corridor south to the Salt and Gila Rivers. This constitutes far great managed flow protection than 124%, thus the 3 point score.

Next Actions
Unless ADOT's Best Practices for water quality changes, no additional actions are anticipated.

PD-09 **Ecological Connectivity** 3/4

Avoid, minimize, or enhance wildlife, amphibian, and aquatic species passage access, and mobility, and reduce vehicle-wildlife collisions and related accidents.

PD-09.1P Was a site-specific ecological assessment of the roadway project using GIS data or regional expertise conducted?
Yes (0 points)

PD-09.1 Were methods used to minimize impacts to ecological connectivity? Use Table PD-09.1.A to determine points.
2 (2 points)

PD-09.2 Did the project team engage natural resource and regulatory agencies throughout the planning process and ensure consistency with broader planning goals and objectives?
Yes (1 point)

Scoring Notes

The Recommended Build Alternative was selected over the Southern Alternative which would have been located in close proximity to the Salt River. Also ADOT is in the process of preparing a BE to both minimize and avoid biological impacts from the SR 30 project. Wildlife connectivity was evaluated in the BE and Draft EA. The USFWS and ADEQ have been involved throughout the SR 30 planning and environmental process.

Next Actions
Include the BE when it is finalized and approved.

PD-10 **Pedestrian Facilities** 0/3

Provide safe, comfortable, convenient, and connected pedestrian facilities for people of all ages and abilities within the project footprint.

PD-10.1P Were all facilities upgraded to meet ADA standards and do responses below exclude any projects to upgrade facilities to ADA standards?
No (0 points)

Scoring Notes
Bicycle and pedestrian facilities in the corridor generally fall into two categories—those that fall on the arterial roadways and those that have dedicated trails or paths. The intent of the SR 30 corridor is to perpetuate and/or accommodate existing and planned bicycle and pedestrian facilities that cross the corridor based the cities' general plans and roadway classification maps. These facilities would not be installed as part of the SR 30 project itself, however.

Next Actions
Verify with ADOT.

PD-11 **Bicycle Facilities** 0/3

Provide safe, comfortable, convenient, and connected bicycling facilities within the project footprint.

PD-11.1 Were missing bicycle connections installed per master plan or other relevant documents?
No (0 points)

PD-11.2 Were bicycle features installed that are safe, comfortable, convenient and connected?
No (0 points)

Scoring Notes
Bicycle and pedestrian facilities in the corridor generally fall into two categories—those that fall on the arterial roadways and those that have dedicated trails or paths. The intent of the SR 30 corridor is to perpetuate and/or accommodate existing and planned bicycle and pedestrian facilities that cross the corridor based the cities' general plans and roadway classification maps. These facilities would not be installed as part of the SR 30 project itself, however.

Next Actions
Verify with ADOT.

PD-12 **Transit and HOV Facilities** 2/5

Promote the use of public transit and carpools in communities by dedicating existing facilities to those uses, upgrading existing lanes, or providing new transit and high occupancy vehicle (HOV) facilities.

PD-12.1 Were Transit and HOV facilities installed on this project that are consistent with the need, purpose, and appropriateness for transit and HOV access within the project footprint? Use Table PD-12.1.A to determine points.
2 Points (2 points)

Scoring Notes
The third phase of the SR 30 project, which is not yet programmed, implementation would widen the 3+0 section constructed in the second phase to a 4+1 section (four general purpose lanes and one HOV lane in each direction) in the median of SR 30 when travel demand warrants it, and when funding is available. The fourth and final phase would involve a high capacity transit corridor, the space for which is being preserved inside the SR 30 ROW footprint for some future date.

Next Actions
Continue to monitor the status of phases 3 and 4 of the SR 30 project.

PD-13 **Freight Mobility** 3/7

Enhance mobility of freight movements, decrease fuel consumption and emissions impacts, and reduce freight-related noise.

PD-13.1 Were freight facilities installed on this project consistent with the need, purpose, and appropriateness for freight mobility within the project footprint? Use Table PD-13.1.A to determine points.
3 Points (3 points)

Scoring Notes
SR 30 satisfies PD-13.1g as this is a new limited access freeway with grade separated crossings and interchanges with arterials and a dry river crossing of the Agua Fria River. This new facility will reduce the truck traffic on the local arterial system and would provide an alternate route to I-10, which currently accommodates a high percentage of trucks with a poor level of service during peak times.

Next Actions
None.

PD-14 **ITS for System Operations** 3/5

Improve the efficiency of transportation systems through deployment of technology and without adding infrastructure capacity in order to reduce emissions and energy use, and improve economic and social needs.

PD-14.1 Were one or more allowable ITS applications installed? Use Table PD-14.1.A to determine points.
At least 1 application in 3 separate categories (3 points)

Scoring Notes
This score is based on the ITS application typically used on the Phoenix freeway system that is constructed, operated, and maintained by ADOT. Specifically, items PD-14.1d, g, and i.

Next Actions
Verify all ITS applications for the SR 30 project.

PD-15 **Historic, Archaeological, and Cultural Preservation** 2/3

Preserve, protect, or enhance cultural and historic assets, and/or feature National Scenic Byways Program (NSBP) historic, archaeological, or cultural intrinsic qualities in a roadway.

PD-15.1P Is any part of the project or resource listed in the NRHP or been determined eligible for the NHRP by a State, Local, or Tribal Historic Preservation Officer?
Yes (0 points)

PD-15.1 Has an effort been made to minimize impacts, avoid impacts, or enhance features?
PD-15.1b Measures have been taken to specifically avoid impacts to the features from PD-15.1P. (2 points)

Scoring Notes
The last 4 build alternatives evaluated prior to the selection of the Recommended Build Alternative - North, Center, Hybrid, and South - each affected approximately the same number of archeological or historic features, so the effort was primarily to minimize impacts.

Next Actions
N/A

PD-16 **Scenic, Natural, or Recreational Qualities** 0/3

Preserve, protect, and/or enhance routes designated with significant scenic, natural, and/or recreational qualities in order to enhance the public enjoyment of facilities.

PD-16.1P Is any portion of the project along one of America's Byways®, a State Scenic Byway, an Indian Tribe Scenic

Byway, or other route that was designated or officially recognized as such?
No (0 points)

Scoring Notes
None are located within or near the SR 30 Study Area.

Next Actions
N/A

PD-17 **Energy Efficiency** 3/8

Reduce energy consumption of lighting systems through the installation of efficient fixtures and the creation and use of renewable energy.

PD-17.1 Were energy needs evaluated for the project?
No (0 points)

PD-17.2 Was the energy consumption on the project reduced through the installation of energy efficient lighting and signal fixtures and through the installation of autonomous, on-site, renewable power sources?
Yes (0 points)

> **PD-17.2 Points are awarded based on the percentage of reduced power use. Based on Table PD-17.2.A, how many points did the project earn?**
> 2 Points (2 points)

PD-17.3 Was a plan established for auditing energy use after project completion as part of operations and maintenance?
Yes (1 point)

Scoring Notes
Score based ADOT Sustainable O&M INVEST Report, April 2016 and specifically OM-02: Electrical Energy Efficiency and Use, regarding energy reduction plan development,goals, and progress monitoring for transportation facility operations and maintenance.

Next Actions
Verify with ADOT.

PD-18 **Site Vegetation, Maintenance and Irrigation** 6/6

Promote sustainable site vegetation within the project footprint by selecting plants and maintenance methods that benefit the ecosystem.

PD-18.1P Does all site vegetation use non-invasive species only, use non-noxious species only, use seeding that does not require consistent mowing for a viable stand of grass, and minimize disturbance of native species?
Yes (0 points)

> **PD-18.1 Based on Table PD-18.1.A, how many points did the project earn? Points for features are additive, however this criterion shall not exceed a total of 3 points.**
> 3 Points (3 points)

> **PD-18.2 Based on Table PD-18.2.A, how many points did the project earn for vegetative maintenance? Points for features are cumulative, however this scoring requirement shall not exceed a total of 3 points.**
> 3 Points (3 points)

Scoring Notes
This criterion is a major success area for ADOT for many years and is continuing to implement new, more robust actions going forward

Next Actions
Verify with ADOT.

PD-19 **Reduce, Reuse and Repurpose Materials** 0/12

Reduce lifecycle impacts from extraction and production of virgin materials by recycling materials.

PD-19 Points for different methods are cumulative; however, this criterion shall not exceed a total of twelve points. Points exceeding twelve will not contribute to overall score.
I understand. (0 points)

PD-19.1 Was remaining service life increased through pavement preservation activities? Points are awarded per Table PD-19.1.A.
No (0 points)

PD-19.2 Was the amount of new pavement materials needed reduced? Points are awarded per Table PD-19.2.A.
No (0 points)

PD-19.3 Was remaining service life increased through bridge preservation activities? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.4 Was remaining service life increased through retrofitting existing bridge structures? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.5 Were existing pavements, structures, or structural elements reused for a new use? Points are awarded per Table PD-19.5.A.
No (0 points)

PD-19.6a Were foundry sand or other industrial by-products used in pipe bedding and backfill?
No (0 points)

PD-19.7 Was a project-specific plan for the recycling and reuse plan developed as described?
No (0 points)

Scoring Notes
The ADOT Pavement Management System (OM-7) and Reuse & Recycle (OM-4) criteria for the ADOT O&M Report seem geared to managing existing pavement through the ADOT O&M program and recycling materials from ADOT maintenance shops, as opposed to project-specific actions. Also, SR 30 would be constructed on new ROW, where no existing pavement, structures, bridges, etc. exist. It was noted in the ADOT Sustainable Transportation Program Case Study Using INVEST, where over 50 projects were INVEST-scored, for PD-19: Reduce & Reuse Materials and PD-20: Recycle Materials that improved waste management and materials recycling guidance would be incorporated into ADOT Standard Specs for Road & Bridge Construction. The specs on the ADOT website, however, are dated 2008.

Next Actions
Verify with ADOT.

PD-20 **Recycle Materials** 1/10

Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by recycling materials.

PD-20 Points for different methods are cumulative; however, this criterion shall not exceed a total of ten points. Points exceeding ten will not contribute to overall score.
I understand. (0 points)

PD-20.1 Was RAP or RCA used in new pavement lifts, granular base course, or embankments? Points are awarded per Tables PD-20.1.A or PD-20.1.B.
1 (1 point)

PD-20.2 Were pavement materials recycled in place using cold-in-place recycling, hot-in-place recycling, and full depth reclamation methods? Points are awarded per Table PD-20.2.A.

No (0 points)

PD-20.3 Did the project reuse subbase granular material as subgrade embankment or as part of the new subbase? Points are awarded per Table PD-20.3.A.
No (0 points)

PD-20.4 Did the project relocate and reuse at least 90 percent of the minor structural elements, including existing luminaires, signal poles, and sign structures that are required to be removed and/or relocated onsite?
No (0 points)

PD-20.5 Did the project salvage or relocate existing buildings?
No (0 points)

Next Actions
Verify with ADOT.

Scoring Notes
The top 1-inch of surfacing will be a asphalt-rubber wearing surface that uses off-site recycled bit rubber for PD-20.1. The SR 30 project would be constructed on new ROW, where no existing pavement, bridges, etc. exist, other than the existing local street network. It was noted in the ADOT Sustainable Transportation Program Case Study Using INVEST, where over 50 projects were INVEST-scored, for PD-19: Reduce & Reuse Materials and PD-20: Recycle Materials that improved waste management and materials recycling guidance would be incorporated into ADOT Standard Specs for Road & Bridge Construction. The specs on the ADOT website, however, are dated 2008.

PD-21 **Earthwork Balance** 1/5

Reduce the need for transport of earthen materials by balancing cut and fill quantities.

PD-21.1a Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10%?
No (0 points)

PD-21.1b Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10% if construction banking is used?
No (0 points)

PD-21.2 Has an earthwork management plan been established, implemented and actively managed on this project?
No (0 points)

PD-21.3 Has topsoil been preserved or reused on this projet?
Yes (1 point)

Scoring Notes
Due to shallow groundwater, this project requires about 90% of the material to be imported borrow so no credits for balance can be taken. The project is planned is a heavily agricultural area so existing topsoil will be stripped and reused as applicable on the new slopes.

Next Actions
None

PD-22 **Long-Life Pavement** 7/7

Minimize life-cycle costs by designing long-lasting pavement structures.

PD-22 Points for different methods are cumulative; however, this criterion shall not exceed a total of seven points. Points exceeding seven will not contribute to overall score.
I understand. (0 points)

PD-22.1 Which of the following describes how long-life pavement was used on this project?
Long-life pavement was used for at least 75 percent of the surface area of regularly trafficked lanes. (5 points)

PD-22.2 Was the asphalt density of 100 percent of the total new or reconstructed pavement increased to a minimum of 94

percent?
No (0 points)

PD-22.3 Was a performance-based pay incentive for pavement smoothness used on this project?
Yes (2 points)

Scoring Notes
The Design Elements section of the DCR states that the entire ultimate SR 30 roadway typical section would be paved with long-lasting PCCP and overlaid with a rubber asphalt friction course. The friction course may have to be replaced every 10-15 years, but the PCCP materials traditionally last at least 40 years in the Phoenix area. ADOT standard specifications includes a pay incentive for pavement smoothness for both PCCP and the friction course.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-23 **Reduced Energy and Emissions in Pavement Materials** 0/3

Reduce energy use in the production of pavement materials.

PD-23 Points for different methods are cumulative; however, this criterion shall not exceed a total of three points. Points exceeding three will not contribute to overall score.
I understand. (0 points)

PD-23.1 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from asphalt production?
No (0 points)

PD-23.2 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from cement production?
No, or it did not meet the minimum requirements in the options above. (0 points)

PD-23.3 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from concrete production?
No, or it did not meet the minimum requirements in the options above. (0 points)

Scoring Notes
Since project has not been built yet, it is not possible to know exactly which materials plants were used and what mix designs were approved. No credit can be taken at this time, but may be able to add as construction occurs.

Next Actions
Update as applicable once construction is complete and materials and material production is know.

PD-24 **Permeable Pavement** 0/2

Improve flow control and quality of stormwater runoff through use of permeable pavement technologies.

PD-24.1and2P Does the project include a maintenance plan for permeable pavements and are permeable pavements placed in areas where no sand will be used for snow and ice control or pavement sealing?
No (0 points)

Scoring Notes
ADOT does not use permeable pavements for their roadways at this time.

Next Actions
None.

PD-25 **Construction Environmental Training** 1/1

Provide construction personnel with the knowledge to identify environmental issues and best practice methods to minimize

impacts to the human and natural environment.

PD-25.1 Did the owner require the Contractor to plan and implement a formal environmental awareness training program during construction to ensure the project stay in compliance with environmental laws, regulations, and policies?
Yes (1 point)

Scoring Notes
It is assumed that ADOT provides this training to construction personnel and contractors based on the ADOT Sustainability Implementation Report Using INVEST, April 2014. The scoring summary for criterion PD-25: Construction Environmental Training stated that a training program was under development at the time the final report was prepared.

Next Actions
Verify with ADOT.

PD-26 **Construction Equipment Emission Reduction** 0/2

Reduce air emissions from non-road construction equipment.

PD-26.1 Were one or more methods implemented to reduce non-road emissions? Points are awarded per Table PD-26.1.A.
No (0 points)

Scoring Notes
The ADOT Sustainability Implementation Report Using INVEST, April 2014, stated discussions would be had with ADOT executive management as a means to implement this criterion. Could not find anything that it has been implemented to-date.

Next Actions
Coordinate with ADOT on the status of this criterion, regarding the ADOT Sustainable Transportation Plan.

PD-27 **Construction Noise Mitigation** 0/2

Reduce annoyance or disturbance to surrounding neighborhoods and environments from road construction noise.

PD-27.1 Is the contractor required to establish, implement, and maintain a formal Noise Mitigation Plan (NMP) during roadway construction?
No (0 points)

PD-27.2 Has the contractor monitored noise and the effectiveness of mitigation measures at the receptors throughout construction to ensure compliance with the NMP?
No (0 points)

Scoring Notes
The ADOT Sustainability Implementation Report Using INVEST, April 2014, stated discussions would be had with ADOT executive management as a means to implement this criterion. Could not find anything where it has been implemented to-date.

Next Actions
Coordinate with ADOT on this criterion's status, regarding the ADOT Sustainable Transportation Plan.

PD-28 **Construction Quality Control Plan** 5/5

Improve quality by requiring the contractor to have a formal Quality Control Plan (QCP).

PD-28.1 Is the Contractor required to plan and implement quality control measures throughout construction with care and for materials above and beyond what is typically required by specifications and regulations?
Yes (3 points)

PD-28.2 Does the contract leverage the use of Quality Price Adjustment Clauses to link payment and performance of the constructed products?
Yes (2 points)

Scoring Notes

ADOT construction contracts specifically pay for a contractor quality control item to ensure quality compliance beyond field inspection. Furthermore, ADOT will pay premiums for material quality that far exceeds the minimums.

Next Actions
None

PD-29 **Construction Waste Management** 0/4

Utilize a management plan for road construction waste materials to minimize the amount of construction-related waste destined for landfill.

PD-29.1 Is the contractor required to establish, implement, and maintain a formal Construction and Demolition Waste Management Plan (CWMP) during roadway construction, or its functional equivalent?
No (0 points)

PD-29.2 Can the owner demonstrate that a percentage of the construction waste has been diverted from landfills?
No, or diverted less than 50 percent of the construction waste from landfills (0 points)

PD-29.3 Were excess materials hauled directly to other project sites for recycling on those projects?
No (0 points)

Scoring Notes
It was noted in the ADOT Sustainable Transportation Program Case Study Using INVEST, where over 50 projects were INVEST-scored, that the requirements of this criterion would be incorporated into ADOT Standard Specs for Road & Bridge Construction. The specs on the ADOT website, however, are dated 2008.

Next Actions
Coordinate with ADOT of the status of this criterion, regarding the ADOT Sustainable Transportation Plan.

PD-30 **Low Impact Development** 0/3

Use low impact development stormwater management methods that reduce the impacts associated with development and redevelopment and that mimic natural hydrology.

PD-30.1 Did the project use effective BMPs or stormwater management techniques that mimic natural hydrology to treat pollutants? Use Tables PD-30.1.A and PD-30.1.B and PD-30.1.C to determine points.
No (0 points)

Scoring Notes
This criterion was not included as part of the ADOT Sustainability Implementation Report Using INVEST, April 2014, or the ADOT Sustainable Transportation Program Case Study Using INVEST. Could not find anything where it has been implemented to-date.

Next Actions
Coordinate with ADOT on this criterion's status, regarding the ADOT Sustainable Transportation Plan.

PD-31 **Infrastructure Resiliency Planning and Design** 0/12

Respond to vulnerabilities and risks associated with current and future hazards (including those associated with climate change) to ensure transportation system reliability and resiliency.

PD-31.1 Did the project incorporate consideration of climate change at a project-specific level in project development and environmental reviews?
No (0 points)

PD-31.2 Did the project incorporate future consideration of climate change effects in the design process?
No (0 points)

PD-31.3 Did the project mitigate the effects of GHG emissions through design efforts above and beyond requirements and regulations?
No (0 points)

Scoring Notes
This criterion was not included as part of the ADOT Sustainability Implementation Report Using INVEST, April 2014, or the ADOT Sustainable Transportation Program Case Study Using INVEST. Although ADOT has developed a Sustainable Resilience Plan as part of its Sustainable Transportation Plan,could not find anything where it has been implemented to-date at the project level based on this criterion.

Next Actions
Coordinate with ADOT on this criterion's status, regarding the ADOT Sustainable Transportation Program and project-level resilience actions for climate change.

PD-32 **Light Pollution** 0/3

To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.

PD-32.1 Were the uplighting ratings met on this project per Table PD-32.1.A?
No (0 points)

PD-32.2 Were the backlighting ratings met on this project per Table PD-32.2.A?
No (0 points)

PD-32.3 Were the glare ratings met on this project per Table PD-32.3.A?
No (0 points)

Scoring Notes
This criterion was not included as part of the ADOT Sustainability Implementation Report Using INVEST, April 2014, or the ADOT Sustainable Transportation Program Case Study Using INVEST. Could not find anything where it has been implemented at the project level to-date. Special lights poles that minimize uplighting under the Goodyear airport runway approach around Estrella Parkway is noted in the concept design, but is only necessary in that area. This does not appear to receive any credit from the guidance.

Next Actions
As final design evolves, this metric should be revisited with the help of a lighting engineer to determine if additional credit can be gained.

PD-33 **Noise Abatement** 3/5

Reduce traffic noise impacts to surrounding communities and environments.

PD-33 Points for different noise abatement methods are cumulative; however, this criterion shall not exceed a total of five points. Points exceeding five will not contribute to overall score.
I understand. (0 points)

PD-33.1 Was a specialized noise barrier used on this project?
No (0 points)

PD-33.2 Were traffic system management techniques used to reduce existing noise levels?
No (0 points)

PD-33.3 Were buffer zones provided for adjacent noise sensitive receptors?
No (0 points)

PD-33.4 Were quiet pavements used on the project? Use Table PD-33.4.A to determine the points earned.
Yes, 3 points. (3 points)

PD-33.5 Were plantings used as a sight screen to separate noise receptors from the project?
No (0 points)

Scoring Notes
This criterion was not included as part of the ADOT Sustainability Implementation Report Using INVEST, April 2014, or the ADOT

Sustainable Transportation Program Case Study Using INVEST. ADOT has a Quiet Pavement and Noise Program as part of its Sustainable Transportation Program, but it does not include specifics required for PD-33.4 - Design Quiet Pavements. Provided a score of 3 points at this time based on ADOT's used of rubberized asphalt as a means to reduce traffic noise in Arizona for nearly 100% of the freeway pavement area and no exceedances of 98 dBA.

Next Actions
None

PD-IN-01 **Example** 0/1

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-01 **Lisa Reid Test Innovation 1** 0/3

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-01 **Test** 0/1

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-01 **test test test** 0/3

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-01 **test test** 0/1

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-01 **test test test** 0/3

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-02 **test test test** 0/1

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-02 **test test test test** 0/1

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

PD-IN-03 **test test test test test** 0/2

Scoring Notes

Next Actions

What is your score for this Innovative Criteria?

INVEST Memorandum
Interstate 10 (I-10), Broadway Curve: Interstate 17 (Split) to Loop 202 (Santan Freeway)
Arizona Department of Transportation

February 2020

INVEST Score: Silver (73 points)

Background

The project is located along Interstate 10 (I-10) is located within the cities of Phoenix, Tempe, Chandler, and Town of Guadalupe in Maricopa County, Arizona. The Arizona Department of Transportation (ADOT), Federal Highway Administration (FHWA), and Maricopa Association of Governments (MAG) has evaluated improvements to I-10 through this corridor for numerous years through various studies. The preferred design alternative concepts that were identified in the past studies and evaluated in the current Environmental Assessment (EA) include the construction of collector-distributor roads (C-D), with other improvements such as the addition of general purpose lanes, high-occupancy vehicle lanes (HOV), reconstruction of interchanges, and other improvements such as pedestrian facilities and improved infrastructure technology systems. The project is in the Final EA stage and includes the Preferred Alternative recommendations and will proceed under a design-build alternative construction delivery method in 2020. The project cost is estimated at approximately $534,000,000.

What is INVEST?

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by the Federal Highway Administration (FHWA) as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects.

The INVEST web-based tool allows users to self-evaluate programs or projects using these criteria to obtain a snapshot of the sustainability of the program or project in time. The tool also allows the user to include notes on scoring and implementation actions that can assist the user in integrating criteria and making progress over time. Although many agency efforts could already be considered sustainable, INVEST is focused on "above and beyond" efforts. Efforts that are typically required, such as National Environmental Policy Act (NEPA) resource analysis areas, are not included within the INVEST criteria.

INVEST considers the full lifecycle of projects and has four modules to self-evaluate the entire lifecycle of transportation services, including System Planning for States or Regions (SPS or SPR), Project Development (PD), and Operations and Maintenance (OM). Each of these modules is based on a separate collection of criteria and can be evaluated separately.

Purpose of the Memorandum

ADOT, in partnership with FHWA has utilized the latest version of INVEST (1.3) on numerous agency projects and programs in varying stages of development to document, explore, and identify sustainability elements of projects for incorporation, as well as provide feedback on the current INVEST 1.3 version of the tool. The goal of this project INVEST memorandum is to document the use of the INVEST scoring application on the I-10 Broadway Curve project using the Project Development (PD) using the Urban Extended Scorecard.

INVEST Scoring

INVEST may be used to score a project based on total points achieved. In the INVEST tool, FHWA does not recognize a project as having met the achievement level of sustainability based on scores; but rather recognizes that the user has self-evaluated their project and met the indicated achievement level.

The total points a project earns can be compared to several "achievement levels" that serve as relative benchmarks for sustainability accomplishments. The figure below shows the minimum number of points necessary to meet each achievement level for the PD module.

For the PD Urban Extended scorecard, a total of 168 points are available, broken down into the following scoring for each achievement level:

I-10 Broadway Curve INVEST PD Module Criteria Scoring Results and Basis for Scores

According to the INVEST User Guide;

> The Project Development module spans the entire project development process. It includes early project planning, alternatives analysis, environmental documentation, preliminary and final design, and construction. Although the criteria span all phases of project development, including construction activities, the project owner typically has control over the decisions and actions necessary to meet all of the criteria. Scoring The Project Development Module of INVEST has 7 project scorecards available for the evaluation of projects. This approach allows for flexibility, since not all of the criteria will apply to every project. Six of the scorecards are based on both the type of project (paving, basic, extended, or scenic/recreational) and the location (rural or urban) and include a defined subset of the 33 total criteria relevant to the type and location of the project.
>
> There is also a custom scorecard that includes 11 core criteria plus user-selected criteria to make a custom self-evaluation for projects that don't fit well into the standard identified scorecards. The Project Development module contains the 33 criteria listed below, used in various combinations to create the 7 different scorecards.

Table 1. INVEST User Guide P.4

Project Development by Criteria Scorecard

	Paving	Urban Basic	Urban Extended	Rural Basic	Rural Extended	Scenic and Recreational	Custom Core Criteria [1]
PD-1 Economic Analyses			●		●		
PD-2 Life-Cycle Cost Analyses	●	●	●	●	●		●
PD-3 Context Sensitive Project Development		●	●	●	●	●	
PD-4 Highway and Traffic Safety	●	●	●	●	●	●	●
PD-5 Educational Outreach		●	●	●	●	●	
PD-6 Tracking Environmental Commitments	●	●	●	●	●	●	●
PD-7 Habitat Restoration		●	●	●	●	●	
PD-8 Stormwater Quality and Flow Control		●	●	●	●	●	
PD-9 Ecological Connectivity			●	●	●	●	
PD-10 Pedestrian Facilities		●	●			●	
PD-11 Bicycle Facilities		●	●			●	
PD-12 Transit & HOV Facilities		●	●			●	
PD-13 Freight Mobility			●		●		
PD-14 ITS for System Operations		●	●		●		
PD-15 Historical, Archaeological, and Cultural Preservation		●	●	●	●	●	
PD-16 Scenic, Natural, or Recreational Qualities			●	●	●	●	
PD-17 Energy Efficiency		●	●	●	●		
PD-18 Site Vegetation, Maintenance, and Irrigation		●	●	●	●	●	
PD-19 Reduce, Reuse, and Repurpose Materials	●	●	●	●	●	●	●
PD-20 Recycle Materials	●	●	●	●	●	●	●
PD-21 Earthwork Balance			●		●	●	
PD-22 Long-Life Pavement	●	●	●	●	●	●	●
PD-23 Reduced Energy and Emissions in Pavement Materials	●	●	●	●	●	●	●
PD-24 Permeable Pavement	●	●	●	●	●	●	●
PD-25 Construction Environmental Training		●	●	●	●	●	
PD-26 Construction Equipment Emission Reduction	●	●	●	●	●	●	●
PD-27 Construction Noise Mitigation		●	●			●	
PD-28 Construction Quality Control Plan	●	●	●	●	●	●	●
PD-29 Construction Waste Management	●	●	●	●	●	●	●
PD-30 Low Impact Development		●	●	●	●	●	
PD-31 Infrastructure Resiliency Planning and Design			●		●	●	
PD-32 Light Pollution		●	●	●	●		
PD-33 Noise Abatement		●	●				
Total Number of Criteria in Scorecard	11	27	34	23	29	27	11

([1]) Indicates the core criteria that must be included in the custom scorecard. The user may choose as many additional criteria as desired.

The Project Development – Urban Extended Scorecard was used for the INVEST scoring of this project. Project Development (PD) is traditionally the second step in the lifecycle of a transportation project, where specific projects are planned, designed, and constructed. The PD module in the current INVEST tool includes a total of thirty-three criteria that are generally organized from planning to design to construction. The PD criteria are further organized into seven scorecards for the evaluation of projects. The scorecards are designed to identify applicable criteria based on the project type (paving, small/spot improvements, new facility/corridor project) and location (urban/rural). Six of these scorecards pre-identify criteria that are most likely to be applicable for the project type and location.

The Urban Extended scorecard is for urban projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of I-10 through a major metropolitan area, includes new right-of-way, temporary construction easements, and major construction and traffic control work needed, ADOT evaluated this based off the 34 criteria available for the scorecard.

To achieve a minimum bronze rating for the Project Development Urban Extended scorecard, a project needs to be awarded a minimum of 52 points. Based on the assessment completed for the INVEST scoring, the project received a score of 73 points, which identifies the project as a silver rating. Attached to this memorandum is the "Project Scorecard," which shows all points and information related to the scoring of the project.

Several notable points were documented for the following categories:

- **Context Sensitive Project Development**: Although the study area is in a highly developed industrial and business area within the metropolitan Phoenix area, context sensitive design and coordination with stakeholders was an important part of the project development process. The study area has an average daily count of over 200,000 vehicles a day and is an important regional corridor for the Maricopa County region, so context sensitive design through the implementation of new pedestrian features, bridges, sound walls, traffic control planning, and comprehensive planning for public engagement through construction. A robust team of technical experts from environmental, local jurisdictions, design engineers, and public involvement specialists were involved in the planning of this project.

- **Pedestrian Facilities:** New pedestrian facilities were considered at two locations within the study area to accommodate existing pedestrian linkages and public park facilities. Additionally, upgrades to existing facilities were incorporated into the project as well. These facilities were included as a result of public and stakeholder feedback on the project, and design and aesthetics of new pedestrian structures will be coordinated with the public for their input as well.

- **Habitat Restoration / Ecological Connectivity:** As previously mentioned, the study area is in a highly developed industrial and business area within the metropolitan Phoenix area. Although the mostly developed, consideration of minimizing impacts to aquatic resources was required due to the area being within the Salt River and Tempe Drain. The project team assessed alternatives to avoid impacts to

aquatic features such as wetlands within the study area. After further consideration from design team, an alternative was chosen that would avoid all impacts to high quality aquatic resources (HQAR).

- **ITS for System Operations:** Due to the fact that this project's purpose and need focused on maintaining the functionality of this major corridor, the study team sought to identify strategies that would improve the efficiency of movement through this area through the deployment of intelligent transportation systems (ITS) technology. Measures identified as a result of this effort include traffic incident management ITS systems, information dissemination systems such as new dynamic messaging system (DMS) signage, and ramp control metering devices.

- **Construction Noise Mitigation:** As previously mentioned, the study area is in a highly developed industrial, residential, and business area within the metropolitan Phoenix area. The project will proceed under a design-build alternative construction delivery method in 2020. Due to the high amount of residential and businesses within the study area, the ADOT project team has implemented requirements in the technical provisions and Final EA for the developer of the design-build process to implement a construction noise assessment memorandum that will address noise sensitive areas and identify project specific mitigation measures to reduce noise complaints and conflicts during construction. In addition to this, the contractor will monitor noise throughout construction at noise sensitive locations and follow all local jurisdiction noise ordinances.

- **Construction Quality Control Plan:** Due to the design-build alternative construction delivery method on this project, the ADOT project team has identified requirements in the developer's technical provision contract for the creation and implementation of a construction quality control management plan. This plan will cover a number of design, environmental, and ADOT standard procedure topics, and will focus on implementing this large scale project with assurance for quality and efficiency during the construction period of the project.

Summary of I-10 Broadway Curve Scoring

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area. Some opportunities that could be considered that were not in this final design stage include items such as:

- Low impact development for storm water management
- Earthwork balance
- Recycling of materials
- Lifecycle cost analysis
- Educational outreach
- Long-life pavements

Due to the location of this project, some of these sustainability criteria mentioned were difficult to implement due to the limited amount of right-of-way (ROW) currently available within the project area and other local area

constraints. Additionally, some criteria identified for freight mobility, and scenic, natural, and recreation qualities were specific to certain elements that were outside of the scope of the project and so therefore could not be considered for scoring of this project. Others not accounted for in this scoring effort such as lifecycle cost analysis and long-life pavement could be considered as beneficial for consideration in future ADOT projects within this study area due to the high traffic counts and overall use of the transportation system within this area.

The alternative construction delivery method of this project as a design-build allowed for opportunities to consider the social, environmental, and economic aspects of the project in more detail as opposed to the traditional design and construction advertisement process; for example, consideration of construction noise mitigation, pedestrian and bike facilities, and HOV facilities items were incorporated into this project as a result of ADOT's focus on public and stakeholder input as part of the design process. In addition, although the project was in a highly developed residential, industrial, and business area, ADOT focused on minimizing and eliminating impacts to high quality aquatic resources and cultural preservation of major historical features within the study area. Although these items are seen environmental and social considerations that ADOT considered, they also have an economic consideration benefit to the agency when considering the positive outcomes from less environmental mitigation costs, construction noise complaints response time savings, and overall support from important stakeholders on the project. An ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with an emphasis on education to the public of the social, economic, and environmental benefits of considering sustainability in design.

Appendix: I-10 Broadway Curve PD Module Scorecard

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

Project Scorecard

Broadway Curve - Feb 28, 2020

Module: Project Development
Scorecard: Urban Extended
Points: 73
Achievement Level: Silver

Urban Extended Scorecard

Criteria Points

PD-01 **Economic Analyses** 5/5

Using the principles of benefit-cost analysis (BCA) or economic impact analysis (EIA), provide evidence that the benefits, including environmental, economic, and social benefits, justify the full life-cycle costs.

PD-01.1a Was a benefit-cost analysis (BCA) for the project completed using minimum acceptable industry practices?
Yes (2 points)

PD-01.1b Was an Economic Impact Analysis (EIA) completed that meets all the listed requirements?
Yes (3 points)

Scoring Notes
An Economic Impact Analysis was done as part of the NEPA process for the project through the Environmental Assessment Completed. The work informed the inclusion of considerations for business and public outreach on multiple aspects of the project. A benefit cost analysis was completed for the project in 2017 through a separate but parallel effort of the I-17 Maricopa Association of Governments/ADOT Spine Corridor Study that was completed. This analysis looked at a larger regional Maricopa County Area, including the area of the current I-10 Broadway Curve project.

Next Actions
N/A

PD-02 **Lifecycle Cost Analyses** 1/3

Reduce life-cycle costs and resource consumption through the informed use of life-cycle cost analyses of key project features during the decision-making process for the project.

PD-02.1a Was an LCCA performed for all pavement structure alternatives in accordance with the method described in the FHWA's Technical Bulletin for Life-Cycle Cost Analysis?
No (0 points)

PD-02.1b Was an LCCA performed for all stormwater infrastructure alternatives considered?
Yes (1 point)

PD-02.1c Was an LCCA performed for the project's major feature (bridges, tunnels, retaining walls, or other items not listed in the preceding options) for each of the alternatives considered?
No (0 points)

Scoring Notes
Design and installation of post-construction controls will be done for this project in accordance with the recommendations provided in the ADOT Post Construction Best Management Practices (BMP) memo.

Next Actions
N/A

PD-03 **Context Sensitive Project Development** 8/10

Deliver projects that harmonize transportation requirements and community values through effective decision-making and thoughtful design.

PD-03.1 Did the project development process generally follow the six-step CSS framework described in NCHRP report 480 and NCHRP report 642, or an equivalent process?
Yes (2 points)

PD-03.2 Did the project development process feature a "cradle-to-grave" project team that included planners, traffic engineers, public involvement specialists, design engineers, environmental experts, safety specialists, landscape architects, right-of-way staff, freight experts, construction engineers, and others to work on projects who worked together to achieve the desired CSS-based vision for the project?
Yes (1 point)

PD-03.3 As a result of CSS-influenced project development process, were external "champions" for the project created in the affected community who were engaged and proactive in supporting it?
Yes (1 point)

PD-03.4 Was acceptance achieved among project stakeholders on the problems, opportunities, and needs that the project should address and the resulting vision or goals for addressing them?
Yes (1 point)

PD-03.5 Do project features consider the appropriate scale of the project?
Yes (1 point)

PD-03.6 Did the project remove objectionable or distracting views?
No (0 points)

PD-03.7 Did the project integrate context sensitive aesthetic treatments?
Yes (1 point)

PD-03.8 Were aethetics for structural items incorporated into the design of the project?
Yes (1 point)

Scoring Notes
Context Sensitive design and solutions were a fundamental part of the project as this area is a major corridor through the metropolitan Phoenix area with an average daily traffic count of over 200,000 vehicles. The project team consisted of ADOT technical experts, local experts, and community engagement throughout the project through public meetings and business forums. Context sensitive design through aesthetics are considered for all new pedestrian features, bridges, and sound walls being implemented.

Next Actions
N/A

PD-04 **Highway and Traffic Safety** 4/10

Safeguard human health by incorporating science-based quantitative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.

PD-04.1 Were human factors considerations incorporated?
The project relied solely on published design and operational performance standards during the project development process. (0 points)

PD-04.2 Was awareness built among the public regarding contributing factors to crashes?
Yes (1 point)

PD-04.3 Does the agency conduct explicit consideration of safety using quantitative, scientifically proven methods?
Yes (0 points)

> **PD-04.3a Was the project type established during scoping of project alternatives through a quantitative and statistically reliable process?**
> Yes (1 point)
>
> **PD-04.3b Were project design and/or operational alternatives developed and evaluated using explicit consideration of substantive safety through quantitative, statistically reliable methods?**
> Yes (2 points)
>
> **PD-04.3c Were quantitative and statistically reliable methods and knowledge used to assess substantive safety performance in the development of preliminary and final design details?**
> No (0 points)

PD-04.4 Was a statistically reliable, science-based method used to evaluate the safety effectiveness of the implemented project?
No (0 points)

Scoring Notes
ADOT, FHWA, and MAG have been developing aspects of this project concept regarding safety and operations for many years through different alternatives. Improvements to this segment of I-10, including the Collector-Distributor (C-D) roadway concept were introduced as early as 1988 to address safety and operational movements through the area. Communication with the public on this topic has been shared at public meetings and in documents as a way to enhance operations, safety, and reduce weaving movements through the corridor.

Next Actions
N/A

PD-05 **Educational Outreach** 0/2

Increase public, agency, and stakeholder awareness of the integration of the principles of sustainability into roadway planning, design, and construction.

PD-05.1 Did this project incorporate public educational outreach that promotes and educates the public about sustainability by installing or performing a minimum of two different elements from Table PD-05.1.A?
No (0 points)

Scoring Notes
This was not done for the project.

Next Actions
N/A

PD-06 **Tracking Environmental Commitments** 2/5

Ensure that environmental commitments made by the project are completed and documented in accordance with all applicable laws, regulations, and issued permits.

PD-06.1a Was a comprehensive environmental compliance tracking system used for the project and related facilities?
No (0 points)

PD-06.2 Has the principal project constructor assigned an independent environmental compliance monitor who will provide quality assurance services and report directly to and make recommendations to the regulatory and Lead Agencies?
Yes (2 points)

Scoring Notes
The Environmental Compliance Manager for the project is responsible for coordinating the environmental permitting requirements for Developer and ensuring that issues are resolved before and during Construction work. This individual shall work directly for the Developer and report to the Construction Manager at ADOT.

Next Actions

N/A

PD-07 **Habitat Restoration** 6/7

Avoid, minimize, rectify, reduce, and compensate the loss and alteration of natural (stream and terrestrial) habitat caused by project construction and/or restore, preserve, and protect natural habitat beyond regulatory requirements.

PD-07.1 Was project-specific mitigation or mitigation banking used on this project? Use Table PD-07.1.A to determine the points earned.
2 Points (2 points)

PD-07.2 Were high quality aquatic resources (HQAR) avoided or were the impacts minimized on this project? Use Table PD-07.2.A to determine the points earned.
2 Points (2 points)

PD-07.3 Were high quality environmental resources avoided or were the impacts minimized on this project? Use Table PD-07.3.A to determine the points earned.
2 Points (2 points)

Scoring Notes
Although this project is an urban area with large development, consideration of environmental resources and efforts to avoid and minimize impacts for environmental resources was important to ADOT. The study area included areas of HQAR such as wetlands, and high quality environmental resources such as Tradtional Cultural Properties (TCPs). ADOT sought to avoid wetlands and TCP's through this area by establishing avoidance areas and identifying other alternative design methods to impacting the resources.

Next Actions
N/A

PD-08 **Stormwater Quality and Flow Control** 0/6

Improve stormwater quality from the impacts of the project and control flow to minimize their erosive effects on receiving water bodies and related water resources, using management methods and practices that reduce the impacts associated with development and redevelopment.

PD-08.1 Did the project treat at least 80% of the total runoff volume? Use Tables PD-08.1.A and PD-08.1.B to determine points.
No (0 points)

PD-08.2 Did the project manage the flow from at least 80 percent of the total runoff volume, and is flow control based on controlling peak flows or durations from the project site? Use Tables PD-08.2.A and PD-08.1.B to determine points.
No (0 points)

Scoring Notes
A Stormwater Pollution Prevention Plan will be created in final design to documented that will explain the erosion control methods, impervious surface area, and flow control methods. Due to the preliminary stage in design, this has not been completed yet so calculations for flow control and runoff volume are not known yet.

Next Actions

N/A

PD-09 **Ecological Connectivity** 1/4

Avoid, minimize, or enhance wildlife, amphibian, and aquatic species passage access, and mobility, and reduce vehicle-wildlife collisions and related accidents.

PD-09.1P Was a site-specific ecological assessment of the roadway project using GIS data or regional expertise conducted?
Yes (0 points)

PD-09.1 Were methods used to minimize impacts to ecological connectivity? Use Table PD-09.1.A to determine points.
No (0 points)

PD-09.2 Did the project team engage natural resource and regulatory agencies throughout the planning process and ensure consistency with broader planning goals and objectives?
Yes (1 point)

Scoring Notes
ADOT's standard is to complete ecological analysis for resources and coordinate with natural resources and regulatory agencies throughout the project development process.

Next Actions
N/A

PD-10 **Pedestrian Facilities** 3/3

Provide safe, comfortable, convenient, and connected pedestrian facilities for people of all ages and abilities within the project footprint.

PD-10.1P Were all facilities upgraded to meet ADA standards and do responses below exclude any projects to upgrade facilities to ADA standards?
Yes (0 points)

PD-10.1 Were missing pedestrian connections installed per master plan or other relevant documents?
Yes (1 point)

PD-10.2 Were pedestrian features installed that are safe, comfortable, convenient and connected?
PD-10.2b Yes, new pedestrian facilities were developed. (2 points)

Scoring Notes
New pedestrian facilities were considered for the project at two locations within the project, and upgrades to existing pedestrian facilities were included as well. These pedestrian facilities were included as a result of past public input and stakeholder feedback on the project.

Next Actions

N/A

PD-11 **Bicycle Facilities** 3/3

Provide safe, comfortable, convenient, and connected bicycling facilities within the project footprint.

PD-11.1 Were missing bicycle connections installed per master plan or other relevant documents?
Yes (1 point)

PD-11.2 Were bicycle features installed that are safe, comfortable, convenient and connected?
PD-11.2b Yes, new bicycle facilities were developed. (2 points)

Scoring Notes
Upgrades to existing pedestrian features will be incorporated for bicycle features, and will be done to accommodate the new pedestrian facilities as well.

Next Actions
N/A

PD-12 **Transit and HOV Facilities** 2/5

Promote the use of public transit and carpools in communities by dedicating existing facilities to those uses, upgrading existing lanes, or providing new transit and high occupancy vehicle (HOV) facilities.

PD-12.1 Were Transit and HOV facilities installed on this project that are consistent with the need, purpose, and appropriateness for transit and HOV access within the project footprint? Use Table PD-12.1.A to determine points.
2 Points (2 points)

Scoring Notes
A component of this project is to install additional HOV lanes to accommodate traffic growth and bus linkages and systems within the Phoenix Metropolitan area. Providing reliable access for system mobility was a consideration in purpose and need documentation for the project.

Next Actions
N/A

PD-13 **Freight Mobility** 0/7

Enhance mobility of freight movements, decrease fuel consumption and emissions impacts, and reduce freight-related noise.

PD-13.1 Were freight facilities installed on this project consistent with the need, purpose, and appropriateness for freight mobility within the project footprint? Use Table PD-13.1.A to determine points.
No (0 points)

Scoring Notes
Freight was not a consideration for this project.

Next Actions
N/A

PD-14 **ITS for System Operations** 3/5

Improve the efficiency of transportation systems through deployment of technology and without adding infrastructure capacity in order to reduce emissions and energy use, and improve economic and social needs.

PD-14.1 Were one or more allowable ITS applications installed? Use Table PD-14.1.A to determine points.
At least 1 application in 3 separate categories (3 points)

Scoring Notes
For this project traffic incident management ITS systems, information dissemination systems, ramp control metering devices will be installed for the project.

Next Actions
N/A

PD-15 **Historic, Archaeological, and Cultural Preservation** 2/3

Preserve, protect, or enhance cultural and historic assets, and/or feature National Scenic Byways Program (NSBP) historic, archaeological, or cultural intrinsic qualities in a roadway.

PD-15.1P Is any part of the project or resource listed in the NRHP or been determined eligible for the NHRP by a State, Local, or Tribal Historic Preservation Officer?
Yes (0 points)

> **PD-15.1 Has an effort been made to minimize impacts, avoid impacts, or enhance features?**
> PD-15.1b Measures have been taken to specifically avoid impacts to the features from PD-15.1P. (2 points)

Scoring Notes
The project incorporates design commitments to avoid impacts to cultural resource locations within the project area that are significant such as Traditional Cultural Properties.

Next Actions
N/A

PD-16 **Scenic, Natural, or Recreational Qualities** 0/3

Preserve, protect, and/or enhance routes designated with significant scenic, natural, and/or recreational qualities in order to enhance the public enjoyment of facilities.

PD-16.1P Is any portion of the project along one of America's Byways®, a State Scenic Byway, an Indian Tribe Scenic Byway, or other route that was designated or officially recognized as such?
No (0 points)

Scoring Notes
There are no Byways within the project area.

Next Actions
N/A

PD-17 **Energy Efficiency** 2/8

Reduce energy consumption of lighting systems through the installation of efficient fixtures and the creation and use of renewable energy.

PD-17.1 Were energy needs evaluated for the project?
Yes (0 points)

> **PD-17.1 Were alternatives implemented to reduce power consumption while still meeting lighting and safety standards?**
> Yes (1 point)

PD-17.2 Was the energy consumption on the project reduced through the installation of energy efficient lighting and signal fixtures and through the installation of autonomous, on-site, renewable power sources?
Yes (0 points)

> **PD-17.2 Points are awarded based on the percentage of reduced power use. Based on Table PD-17.2.A, how many points did the project earn?**
> 1 Point (1 point)

PD-17.3 Was a plan established for auditing energy use after project completion as part of operations and maintenance?
No (0 points)

Scoring Notes
All existing luminaire lights within the project limits will be replaced with LED luminaire lighting or LED fixtures.

Next Actions
N/A

PD-18 **Site Vegetation, Maintenance and Irrigation** 4/6

Promote sustainable site vegetation within the project footprint by selecting plants and maintenance methods that benefit the ecosystem.

PD-18.1P Does all site vegetation use non-invasive species only, use non-noxious species only, use seeding that does not require consistent mowing for a viable stand of grass, and minimize disturbance of native species?

Yes (0 points)

PD-18.1 Based on Table PD-18.1.A, how many points did the project earn? Points for features are additive, however this criterion shall not exceed a total of 3 points.
3 Points (3 points)

PD-18.2 Based on Table PD-18.2.A, how many points did the project earn for vegetative maintenance? Points for features are cumulative, however this scoring requirement shall not exceed a total of 3 points.
1 Point (1 point)

Scoring Notes
This project incorporates standard ADOT procedures for using native plant species and control of invasive and noxious plant species.

Next Actions
N/A

PD-19 **Reduce, Reuse and Repurpose Materials** 4/12

Reduce lifecycle impacts from extraction and production of virgin materials by recycling materials.

PD-19 Points for different methods are cumulative; however, this criterion shall not exceed a total of twelve points. Points exceeding twelve will not contribute to overall score.
I understand. (0 points)

PD-19.1 Was remaining service life increased through pavement preservation activities? Points are awarded per Table PD-19.1.A.
2 (2 points)

PD-19.2 Was the amount of new pavement materials needed reduced? Points are awarded per Table PD-19.2.A.
No (0 points)

PD-19.3 Was remaining service life increased through bridge preservation activities? Points are awarded per Table PD-19.3.A.
2 (2 points)

PD-19.4 Was remaining service life increased through retrofitting existing bridge structures? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.5 Were existing pavements, structures, or structural elements reused for a new use? Points are awarded per Table PD-19.5.A.
No (0 points)

PD-19.6a Were foundry sand or other industrial by-products used in pipe bedding and backfill?
No (0 points)

PD-19.7 Was a project-specific plan for the recycling and reuse plan developed as described?

No (0 points)

Scoring Notes
Crack sealing methods will be used on the project for bridges and pavement methods.

Next Actions
N/A

PD-20 **Recycle Materials** 2/10

Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by recycling materials.

PD-20 Points for different methods are cumulative; however, this criterion shall not exceed a total of ten points. Points exceeding ten will not contribute to overall score.
I understand. (0 points)

PD-20.1 Was RAP or RCA used in new pavement lifts, granular base course, or embankments? Points are awarded per Tables PD-20.1.A or PD-20.1.B.
No (0 points)

PD-20.2 Were pavement materials recycled in place using cold-in-place recycling, hot-in-place recycling, and full depth reclamation methods? Points are awarded per Table PD-20.2.A.
No (0 points)

PD-20.3 Did the project reuse subbase granular material as subgrade embankment or as part of the new subbase? Points are awarded per Table PD-20.3.A.
No (0 points)

PD-20.4 Did the project relocate and reuse at least 90 percent of the minor structural elements, including existing luminaires, signal poles, and sign structures that are required to be removed and/or relocated onsite?
No (0 points)

PD-20.5 Did the project salvage or relocate existing buildings?
Yes (2 points)

Next Actions
N/A

Scoring Notes
The project will relocate an ADOT Facility that will be impacted by construction.

PD-21 **Earthwork Balance** 1/5

Reduce the need for transport of earthen materials by balancing cut and fill quantities.

PD-21.1a Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10%?
No (0 points)

PD-21.1b Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10% if construction banking is used?
No (0 points)

PD-21.2 Has an earthwork management plan been established, implemented and actively managed on this project?
No (0 points)

PD-21.3 Has topsoil been preserved or reused on this projet?
Yes (1 point)

Scoring Notes
A Topsoil Report will be developed by the contractor to document the proposed plans for preservation, storage, and use of topsoil.

Next Actions
N/A

PD-22 **Long-Life Pavement** 2/7

Minimize life-cycle costs by designing long-lasting pavement structures.

PD-22 Points for different methods are cumulative; however, this criterion shall not exceed a total of seven points. Points exceeding seven will not contribute to overall score.
I understand. (0 points)

PD-22.1 Which of the following describes how long-life pavement was used on this project?
No long-life pavement was used or it was and did not meet the minimum requirements of the options below. (0 points)

PD-22.2 Was the asphalt density of 100 percent of the total new or reconstructed pavement increased to a minimum of 94 percent?
No (0 points)

PD-22.3 Was a performance-based pay incentive for pavement smoothness used on this project?
Yes (2 points)

Scoring Notes
A performance based measure for pavement smoothness was required for the contractor on this project.

Next Actions
N/A

PD-23 **Reduced Energy and Emissions in Pavement Materials** 0/3

Reduce energy use in the production of pavement materials.

PD-23 Points for different methods are cumulative; however, this criterion shall not exceed a total of three points. Points exceeding three will not contribute to overall score.
I understand. (0 points)

PD-23.1 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from asphalt production?
No (0 points)

PD-23.2 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from cement production?
No, or it did not meet the minimum requirements in the options above. (0 points)

PD-23.3 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from concrete production?
No, or it did not meet the minimum requirements in the options above. (0 points)

Scoring Notes
This was not completed for this project.

Next Actions
N/A

PD-24 **Permeable Pavement** 0/2

Improve flow control and quality of stormwater runoff through use of permeable pavement technologies.

PD-24.1and2P Does the project include a maintenance plan for permeable pavements and are permeable pavements placed in areas where no sand will be used for snow and ice control or pavement sealing?
No (0 points)

Scoring Notes
This was not done for this project.

Next Actions
N/A

PD-25 **Construction Environmental Training** 1/1

Provide construction personnel with the knowledge to identify environmental issues and best practice methods to minimize impacts to the human and natural environment.

PD-25.1 Did the owner require the Contractor to plan and implement a formal environmental awareness training program during construction to ensure the project stay in compliance with environmental laws, regulations, and policies?
Yes (1 point)

Scoring Notes
There will be a general overview environmental awareness training required by the Contractor and related to other specific tasks such as hazardous materials, erosion, etc.

Next Actions
N/A

PD-26 **Construction Equipment Emission Reduction** 1/2

Reduce air emissions from non-road construction equipment.

PD-26.1 Were one or more methods implemented to reduce non-road emissions? Points are awarded per Table PD-26.1.A.
1 (1 point)

Scoring Notes
The contractor for the project will be informed of no idling policy for project specific areas and machinery to be used on the project.

Next Actions
N/A

PD-27 **Construction Noise Mitigation** 2/2

Reduce annoyance or disturbance to surrounding neighborhoods and environments from road construction noise.

PD-27.1 Is the contractor required to establish, implement, and maintain a formal Noise Mitigation Plan (NMP) during roadway construction?
Yes (1 point)

PD-27.2 Has the contractor monitored noise and the effectiveness of mitigation measures at the receptors throughout construction to ensure compliance with the NMP?
Yes (1 point)

Scoring Notes
The contractor will prepare a construction noise assessment memo that will address noise sensitive areas and identified mitigation measures to reduce noise complaints and conflicts during construction. The contractor will monitor noise throughout construction at certain noise sensitive locations.

Next Actions
N/A

PD-28 **Construction Quality Control Plan** 5/5

Improve quality by requiring the contractor to have a formal Quality Control Plan (QCP).

PD-28.1 Is the Contractor required to plan and implement quality control measures throughout construction with care and for materials above and beyond what is typically required by specifications and regulations?
Yes (3 points)

PD-28.2 Does the contract leverage the use of Quality Price Adjustment Clauses to link payment and performance of the constructed products?
Yes (2 points)

Scoring Notes
The contractor is required to develop a Construction Quality Control Management Plan that will cover a number of topics and identify processes to be completed during construction to ensure quality.

Next Actions
N/A

PD-29 **Construction Waste Management** 0/4

Utilize a management plan for road construction waste materials to minimize the amount of construction-related waste destined for landfill.

PD-29.1 Is the contractor required to establish, implement, and maintain a formal Construction and Demolition Waste Management Plan (CWMP) during roadway construction, or its functional equivalent?
No (0 points)

PD-29.2 Can the owner demonstrate that a percentage of the construction waste has been diverted from landfills?
No, or diverted less than 50 percent of the construction waste from landfills (0 points)

PD-29.3 Were excess materials hauled directly to other project sites for recycling on those projects?
No (0 points)

Scoring Notes
This is not being completed for this project.

Next Actions
N/A

PD-30 **Low Impact Development** 0/3

Use low impact development stormwater management methods that reduce the impacts associated with development and redevelopment and that mimic natural hydrology.

PD-30.1 Did the project use effective BMPs or stormwater management techniques that mimic natural hydrology to treat pollutants? Use Tables PD-30.1.A and PD-30.1.B and PD-30.1.C to determine points.
No (0 points)

Scoring Notes

This is not being completed for this project.

Next Actions
N/A

PD-31 **Infrastructure Resiliency Planning and Design** 2/12

Respond to vulnerabilities and risks associated with current and future hazards (including those associated with climate change) to ensure transportation system reliability and resiliency.

PD-31.1 Did the project incorporate consideration of climate change at a project-specific level in project development and environmental reviews?
Yes (2 points)

PD-31.2 Did the project incorporate future consideration of climate change effects in the design process?
No (0 points)

PD-31.3 Did the project mitigate the effects of GHG emissions through design efforts above and beyond requirements and regulations?
No (0 points)

Scoring Notes
Consideration of climate change was discussed in the Environmental Assessment as a resource consideration for air quality in a qualitative context.

Next Actions
N/A

PD-32 **Light Pollution** 2/3

To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.

PD-32.1 Were the uplighting ratings met on this project per Table PD-32.1.A?
Yes (1 point)

PD-32.2 Were the backlighting ratings met on this project per Table PD-32.2.A?
No (0 points)

PD-32.3 Were the glare ratings met on this project per Table PD-32.3.A?
Yes (1 point)

Scoring Notes
This project is incorporating mitigation standards for glare and uplight as a result of the new LED lights installation to be incorporated into the project.

Next Actions
N/A

PD-33 **Noise Abatement** 5/5

Reduce traffic noise impacts to surrounding communities and environments.

PD-33 Points for different noise abatement methods are cumulative; however, this criterion shall not exceed a total of five points. Points exceeding five will not contribute to overall score.
I understand. (0 points)

PD-33.1 Was a specialized noise barrier used on this project?
Yes (2 points)

PD-33.2 Were traffic system management techniques used to reduce existing noise levels?
Yes (2 points)

PD-33.3 Were buffer zones provided for adjacent noise sensitive receptors?
Yes (2 points)

PD-33.4 Were quiet pavements used on the project? Use Table PD-33.4.A to determine the points earned.
No (0 points)

PD-33.5 Were plantings used as a sight screen to separate noise receptors from the project?
No (0 points)

Scoring Notes
Specialized barriers in the form of earthen berms will be used for the project, and consideration was given to sensitive noise receptors for minimizing new ROW and TI's within areas of noise sensitivity. In addition, the new capacity additions for the road way will enhance free flow traffic with the addition of HOV lanes and C-D lanes.

Next Actions
N/A

INVEST Memorandum
SR 179, I-17 Red Rock Vista
Arizona Department of Transportation

September 2019 **INVEST Score: Silver (49 points)**

Background

The project is located along SR 179 from approximately MP 299 to MP 305 in Yavapai County, Arizona. The project length is approximately six (6) miles on SR 179 from MP 302.5 near Dry Beaver Creek Bridge and north through the project area is part of the National Scenic Byway System – Red Rock Scenic Byway. The project scope of work includes a variety of preservation activities such as pavement preservation, striping, rumble strips, guardrails, access turnouts and more. The project construction is estimated to cost $5,520,000.

What is INVEST?

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by the Federal Highway Administration (FHWA) as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects.

The INVEST web-based tool allows users to self-evaluate programs or projects using these criteria to obtain a snapshot of the sustainability of the program or project in time. The tool also allows the user to include notes on scoring and implementation actions that can assist the user in integrating criteria and making progress over time. Although many agency efforts could already be considered sustainable, INVEST is focused on "above and beyond" efforts. Efforts that are typically required, such as National Environmental Policy Act (NEPA) resource analysis areas, are not included within the INVEST criteria.

INVEST considers the full lifecycle of projects and has four modules to self-evaluate the entire lifecycle of transportation services, including System Planning for States or Regions (SPS or SPR), Project Development (PD), and Operations and Maintenance (OM). Each of these modules is based on a separate collection of criteria and can be evaluated separately.

Purpose of the Memorandum

ADOT, in partnership with FHWA has utilized the latest version of INVEST (1.3) on numerous agency projects and programs in varying stages of development to document, explore, and identify sustainability elements of projects for incorporation, as well as provide feedback on the current INVEST 1.3 version of the tool. The goal of this project INVEST memorandum is to document the use of the INVEST scoring application on the SR179, I- 17 – Red Rock Vista pavement preservation project using the Project Development (PD) using the Rural Basic Scorecard.

INVEST Scoring

INVEST may be used to score a project based on total points achieved. In the INVEST tool, FHWA does not recognize a project as having met the achievement level of sustainability based on scores; but rather recognizes that the user has self-evaluated their project and met the indicated achievement level.

The total points a project earns can be compared to several "achievement levels" that serve as relative benchmarks for sustainability accomplishments. The figure below shows the minimum number of points necessary to meet each achievement level for the PD module.

SR 179 INVEST PD Module Criteria Scoring Results and Basis for Scores

According to the INVEST User Guide;

> The Project Development module spans the entire project development process. It includes early project planning, alternatives analysis, environmental documentation, preliminary and nal design, and construction. Although the criteria span all phases of project development, including construction activities, the project owner typically has control over the decisions and actions necessary to meet all of the criteria. Scoring The Project Development Module of INVEST has 7 project scorecards available for the evaluation of projects. This approach allows for flexibility, since not all of the criteria will apply to every project. Six of the scorecards are based on both the type of project (paving, basic, extended, or scenic/recreational) and the location (rural or urban) and include a defined subset of the 33 total criteria relevant to the type and location of the project. There is also a custom scorecard that includes 11 core criteria plus user-selected criteria to make a custom self-evaluation for projects that don't t well into the ve dened scorecards. The Project Development module contains the 33 criteria listed below, used in various combinations to create the 7 different scorecards.

Table 1. INVEST User Guide P.4

Project Development by Criteria Scorecard	Paving	Urban Basic	Urban Extended	Rural Basic	Rural Extended	Scenic and Recreational	Custom Core Criteria [1]
PD-1 Economic Analyses			●		●		
PD-2 Life-Cycle Cost Analyses	●	●	●	●	●		●
PD-3 Context Sensitive Project Development		●	●	●	●	●	
PD-4 Highway and Traffic Safety	●	●	●	●	●	●	●
PD-5 Educational Outreach		●	●	●	●	●	
PD-6 Tracking Environmental Commitments	●	●	●	●	●	●	●
PD-7 Habitat Restoration		●	●	●	●	●	
PD-8 Stormwater Quality and Flow Control		●	●	●	●	●	
PD-9 Ecological Connectivity			●	●	●	●	
PD-10 Pedestrian Facilities		●	●			●	
PD-11 Bicycle Facilities		●	●			●	
PD-12 Transit & HOV Facilities		●	●			●	
PD-13 Freight Mobility			●		●		
PD-14 ITS for System Operations		●	●		●		
PD-15 Historical, Archaeological, and Cultural Preservation		●	●	●	●	●	
PD-16 Scenic, Natural, or Recreational Qualities			●	●	●	●	
PD-17 Energy Efficiency		●	●	●	●		
PD-18 Site Vegetation, Maintenance, and Irrigation		●	●	●	●	●	
PD-19 Reduce, Reuse, and Repurpose Materials	●	●	●	●	●	●	●
PD-20 Recycle Materials	●	●	●	●	●	●	●
PD-21 Earthwork Balance			●		●	●	
PD-22 Long-Life Pavement	●	●	●	●	●	●	●
PD-23 Reduced Energy and Emissions in Pavement Materials	●	●	●	●	●	●	●
PD-24 Permeable Pavement	●	●	●	●	●	●	●
PD-25 Construction Environmental Training		●	●	●	●	●	
PD-26 Construction Equipment Emission Reduction	●	●	●	●	●	●	●
PD-27 Construction Noise Mitigation		●	●			●	
PD-28 Construction Quality Control Plan	●	●	●	●	●	●	●
PD-29 Construction Waste Management	●	●	●	●	●	●	●
PD-30 Low Impact Development		●	●	●	●	●	
PD-31 Infrastructure Resiliency Planning and Design			●		●	●	
PD-32 Light Pollution		●	●	●	●		
PD-33 Noise Abatement		●	●				
Total Number of Criteria in Scorecard	11	27	34	23	29	27	11

([1]) Indicates the core criteria that must be included in the custom scorecard. The user may choose as many additional criteria as desired.

The Project Development – Rural Basic Scorecard was used for the INVEST scoring of this project. Project Development (PD) is traditionally the second step in the lifecycle of a transportation project, where specific projects are planned, designed, and constructed. The PD module in the current INVEST tool includes a total of thirty-three criteria that are generally organized from planning to design to construction. The PD criteria are further organized into seven scorecards for the evaluation of projects. The scorecards are designed to identify applicable criteria based on the project type (paving, small/spot improvements, new facility/corridor project) and location (urban/rural). Six of these scorecards pre-identify criteria that are most likely to be applicable for the project type and location.

The Rural Basic scorecard is for small, rural reconstruction or rural bridge replacement projects that do not expand capacity of the roadway. As this project is a pavement preservation project with no new right-of- way, temporary construction easements, or major construction work needed, ADOT evaluated this based off the 23 criteria available for the scorecard.

Several notable points were documented for the following categories:

- **Context Sensitive Project Development**: Due to the fact that the project is located within an identified National Scenic Corridor (Red Rock All American Road) on Coconino National Forest, context sensitive project development was needed to ensure compliance with the US Forest Service scenic objectives, and compliance with the 2005 Corridor Management Plan. This design required consideration of color, texture, aesthetic considerations, and input from multiple federal agencies.
- **Habitat Restoration / Ecological Connectivity:** Biological, cultural, and visual analysis was a large focus for the ADOT design and environmental team since this the project was in an area with critical habitat and sensitive resources. The ADOT team designed the project to avoid impacts to sensitive water and biological resources during design.
- **Scenic, Natural, and Recreational Qualities:** As mentioned earlier, this project is located within a national Scenic Corridor (Red Rock All American Road) and required coordination with the Coconino National Forest to ensure efforts were made to preserve, protect, and enhance the features of the area during and after construction. Efforts for this were completed during final design and will be implemented as part of the project construction.
- **Long Life Pavement:** This criterion was met since the project is primarily pavement preservation and is focused on preservation of the pavement by application of long-lasting PCCP and overlaid with a rubber asphalt friction course. ADOT standard specifications include a pay incentive for pavement smoothness for both PCCP and the friction course as well.
- **Site Vegetation, Maintenance, and Irrigation:** Consideration and implementation of re-seeding with non-invasive and non-noxious species is a standard Best Management Practice (BMP) for ADOT and is followed for every project where needed. This is a success area for ADOT for many years, and was an especially important consideration on this project due to project area being within the Coconino National Forest and input from the Forest Service during the design phase.

Summary

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area. Some opportunities that could be considered that were not in this final design stage

include items such as earthwork balance, recycling of materials, and construction equipment emission reduction. Due to the location of this project within the Coconino National Forest and the limited scope of work, some of these criteria were difficult to implement because of the constraints of development, mobilization, and construction. However, the unique location of this project area could benefit from considerations of construction equipment emission reduction considerations, and a construction quality control plan since this area is in a highly scenic, biological, and cultural sensitive area. Additionally, an ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with emphasis on education to the public and stakeholders.

Appendix: SR 179 PD Module Scorecard

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

Project Scorecard

SR179, I-17 to Red Rock Vista - Jun 13, 2019

Module: Project Development
Scorecard: Rural Basic
Points: 49
Achievement Level: Silver

Rural Basic Scorecard

Criteria Point

PD-02 **Lifecycle Cost Analyses** 0/3

Reduce life-cycle costs and resource consumption through the informed use of life-cycle cost analyses of key project features during the decision-making process for the project.

PD-02.1a Was an LCCA performed for all pavement structure alternatives in accordance with the method described in the FHWA's Technical Bulletin for Life-Cycle Cost Analysis?
No (0 points)

PD-02.1b Was an LCCA performed for all stormwater infrastructure alternatives considered?
No (0 points)

PD-02.1c Was an LCCA performed for the project's major feature (bridges, tunnels, retaining walls, or other items not listed in the preceding options) for each of the alternatives considered?
No (0 points)

Scoring Notes
No economic analysis was completed as part of the project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-03 **Context Sensitive Project Development** 9/10

Deliver projects that harmonize transportation requirements and community values through effective decision-making and thoughtful design.

PD-03.1 Did the project development process generally follow the six-step CSS framework described in NCHRP report 480 and NCHRP report 642, or an equivalent process?
Yes (2 points)

PD-03.2 Did the project development process feature a "cradle-to-grave" project team that included planners, traffic engineers, public involvement specialists, design engineers, environmental experts, safety specialists, landscape architects, right-of-way staff, freight experts, construction engineers, and others to work on projects who worked together to achieve the desired CSS-based vision for the project?
Yes (1 point)

PD-03.3 As a result of CSS-influenced project development process, were external "champions" for the project

created in the affected community who were engaged and proactive in supporting it?
Yes (1 point)

PD-03.4 Was acceptance achieved among project stakeholders on the problems, opportunities, and needs that the project should address and the resulting vision or goals for addressing them?
No (0 points)

PD-03.5 Do project features consider the appropriate scale of the project?
Yes (1 point)

PD-03.6 Did the project remove objectionable or distracting views?
Yes, permanently (2 points)

PD-03.7 Did the project integrate context sensitive aesthetic treatments?
Yes (1 point)

PD-03.8 Were aethetics for structural items incorporated into the design of the project?
Yes (1 point)

Scoring Notes
The project incorporated team members from the Coconino National Forest, and incorporated many design features that would help maintain the viewer experience of this scenic road, while also implementing safety standards. Design included context sensitive design of road, shoulders, guardrail and other items.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-04 **Highway and Traffic Safety** 3/10

Safeguard human health by incorporating science-based quantitative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.

PD-04.1 Were human factors considerations incorporated?
Interactions between road users and the roadway using fundamentals captured in Chapter 2 of the Highway Safety Manual and the Human Factors Guideline for Road Systems (NCHRP Report 600 series) were evaluated, documented, and incorporated. (2points)

PD-04.2 Was awareness built among the public regarding contributing factors to crashes?
No (0 points)

PD-04.3 Does the agency conduct explicit consideration of safety using quantitative, scientifically proven methods?
Yes (0 points)

> **PD-04.3a Was the project type established during scoping of project alternatives through a quantitative and statistically reliable process?**
> No (0 points)
>
> **PD-04.3b Were project design and/or operational alternatives developed and evaluated using explicit consideration of substantive safety through quantitative, statistically reliable methods?**
> No (0 points)
>
> **PD-04.3c Were quantitative and statistically reliable methods and knowledge used to assess substantive safety performance in the development of preliminary and final design details?**
> No (0 points)

PD-04.4 Was a statistically reliable, science-based method used to evaluate the safety effectiveness of the

implemented project?
Yes (1 point)

Scoring Notes
The project relied solely on published design and operational performance standards during the project design process with input from the District and Coconino National Forest. Because this was a smaller project, no other alternatives were considered.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-05 Educational Outreach 0/2

Increase public, agency, and stakeholder awareness of the integration of the principles of sustainability into roadway planning, design, and construction.

PD-05.1 Did this project incorporate public educational outreach that promotes and educates the public about sustainability by installing or performing a minimum of two different elements from Table PD-05.1.A?
No (0 points)

Scoring Notes
Not incorporated for this project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-06 Tracking Environmental Commitments 0/5

Ensure that environmental commitments made by the project are completed and documented in accordance with all applicable laws, regulations, and issued permits.

PD-06.1a Was a comprehensive environmental compliance tracking system used for the project and related facilities?
No (0 points)

PD-06.2 Has the principal project constructor assigned an independent environmental compliance monitor who will provide quality assurance services and report directly to and make recommendations to the regulatory and Lead Agencies?
No (0 points)

Scoring Notes
ADOT does not have a formal comprehensive Environmental Compliance Tracking System (ECTS). It uses multiple systems to comply with State and federal requirements each year. ADOT is moving toward identifying all environmental commitments on a single list

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-07 Habitat Restoration 4/7

Avoid, minimize, rectify, reduce, and compensate the loss and alteration of natural (stream and terrestrial) habitat caused by project construction and/or restore, preserve, and protect natural habitat beyond regulatory requirements.

PD-07.1 Was project-specific mitigation or mitigation banking used on this project? Use Table PD-07.1.A to determine the points earned.
2 Points (2 points)

PD-07.2 Were high quality aquatic resources (HQAR) avoided or were the impacts minimized on this project? Use Table PD-07.2.A to determine the points earned.

None (0 points)

PD-07.3 Were high quality environmental resources avoided or were the impacts minimized on this project? Use Table PD-07.3.A to determine the points earned.
2 Points (2 points)

Scoring Notes
The original project assessment for the project recommended vegetation work beneath the Oak Creek Bridge, after analysis and coordination were considered the project team decided to avoid any unnecessary vegetation work underneath the bridge,

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-08 **Stormwater Quality and Flow Control** 0/6

Improve stormwater quality from the impacts of the project and control flow to minimize their erosive effects on receiving water bodies and related water resources, using management methods and practices that reduce the impacts associated with development and redevelopment.

PD-08.1 Did the project treat at least 80% of the total runoff volume? Use Tables PD-08.1.A and PD-08.1.B to determine points.
No (0 points)

PD-08.2 Did the project manage the flow from at least 80 percent of the total runoff volume, and is flow control based on controlling peak flows or durations from the project site? Use Tables PD-08.2.A and PD-08.1.B to determine points.
No (0 points)

Scoring Notes
This was outside the scope of the project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-09 **Ecological Connectivity** 3/4

Avoid, minimize, or enhance wildlife, amphibian, and aquatic species passage access, and mobility, and reduce vehicle-wildlife collisions and related accidents.

PD-09.1P Was a site-specific ecological assessment of the roadway project using GIS data or regional expertise conducted?
Yes (0 points)

PD-09.1 Were methods used to minimize impacts to ecological connectivity? Use Table PD-09.1.A to determine points.
2 (2 points)

PD-09.2 Did the project team engage natural resource and regulatory agencies throughout the planning process and ensure consistency with broader planning goals and objectives?
Yes (1 point)

Scoring Notes
The project team engage natural resource and regulatory agencies throughout the planning process,with a project agency biologist that was involved involved with the assessment. The analysis was done to evaluate and minimize impacts, in coordination with the USFWS.

Next Actions

Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-15 **Historic, Archaeological, and Cultural Preservation** 2/3

Preserve, protect, or enhance cultural and historic assets, and/or feature National Scenic Byways Program (NSBP) historic, archaeological, or cultural intrinsic qualities in a roadway.

PD-15.1P Is any part of the project or resource listed in the NRHP or been determined eligible for the NHRP by a State, Local, or Tribal Historic Preservation Officer?
Yes (0 points)

PD-15.1 Has an effort been made to minimize impacts, avoid impacts, or enhance features?
PD-15.1b Measures have been taken to specifically avoid impacts to the features from PD-15.1P. (2 points)

Scoring Notes
Measures have been taken to specifically avoid impacts to the features of the Red Rock All American Scenic Byway. Efforts to implement design that was sensitive in terms of color, texture, and consideration of recreational features was implemented.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-16 **Scenic, Natural, or Recreational Qualities** 3/3

Preserve, protect, and/or enhance routes designated with significant scenic, natural, and/or recreational qualities in order to enhance the public enjoyment of facilities.

PD-16.1P Is any portion of the project along one of America's Byways®, a State Scenic Byway, an Indian Tribe Scenic Byway, or other route that was designated or officially recognized as such?
Yes (0 points)

PD-16.2P Was existing access to scenic, natural, or recreational qualities not removed (i.e., maintained) as a part of this project unless it was specifically removed to protect the scenic, natural, and/or recreational qualities themselves?
Yes (0 points)

PD-16.1 Were efforts made to avoid or minimize impacts,or enhance features, of the scenic, natural, and/or recreational qualities?
PD-16.1d Efforts were made to protect, preserve, or enhance scenic, natural, or recreational qualities along the roadway. (3 points)

Scoring Notes
Access to scenic, natural, or recreational qualities were not removed as a part of this project within the Red Rock All American Scenic Byway. Efforts were made to protect, preserve, or enhance scenic, natural, or recreational qualities along the roadway by implementation of context sensitive design and recommendations for US Forest Service

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-17 **Energy Efficiency** 0/8

Reduce energy consumption of lighting systems through the installation of efficient fixtures and the creation and use of renewable energy.

PD-17.1 Were energy needs evaluated for the project?
No (0 points)

PD-17.2 Was the energy consumption on the project reduced through the installation of energy efficient lighting and signal fixtures and through the installation of autonomous, on-site, renewable power sources?
No (0 points)

PD-17.3 Was a plan established for auditing energy use after project completion as part of operations and maintenance?
No (0 points)

Scoring Notes
This criteria is outside the scope of the project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-18 **Site Vegetation, Maintenance and Irrigation** 6/6

Promote sustainable site vegetation within the project footprint by selecting plants and maintenance methods that benefit the ecosystem.

PD-18.1P Does all site vegetation use non-invasive species only, use non-noxious species only, use seeding that does not require consistent mowing for a viable stand of grass, and minimize disturbance of native species?
Yes (0 points)

> **PD-18.1 Based on Table PD-18.1.A, how many points did the project earn? Points for features are additive, however this criterion shall not exceed a total of 3 points.**
> 3 Points (3 points)
>
> **PD-18.2 Based on Table PD-18.2.A, how many points did the project earn for vegetative maintenance? Points for features are cumulative, however this scoring requirement shall not exceed a total of 3 points.**
> 3 Points (3 points)

Scoring Notes
This criterion is a major success area for ADOT for many years and the ADOT Roadside Development, Northcentral District, and US Forest Service worked together for this project to ensure native plant species, and maintenance.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-19 **Reduce, Reuse and Repurpose Materials** 4/12

Reduce lifecycle impacts from extraction and production of virgin materials by recycling materials.

PD-19 Points for different methods are cumulative; however, this criterion shall not exceed a total of twelve points. Points exceeding twelve will not contribute to overall score.
I understand. (0 points)

PD-19.1 Was remaining service life increased through pavement preservation activities? Points are awarded per Table PD-19.1.A.
4 (4 points)

PD-19.2 Was the amount of new pavement materials needed reduced? Points are awarded per Table PD-19.2.A.
No (0 points)

PD-19.3 Was remaining service life increased through bridge preservation activities? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.4 Was remaining service life increased through retrofitting existing bridge structures? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.5 Were existing pavements, structures, or structural elements reused for a new use? Points are awarded per Table PD-19.5.A.
No (0 points)

PD-19.6a Were foundry sand or other industrial by-products used in pipe bedding and backfill?
No (0 points)

PD-19.7 Was a project-specific plan for the recycling and reuse plan developed as described?
No (0 points)

Scoring Notes
This project includes preservation of the pavement through mill and fill activities, and fog coat.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-20 **Recycle Materials** 0/10

Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by recycling materials.

PD-20 Points for different methods are cumulative; however, this criterion shall not exceed a total of ten points. Points exceeding ten will not contribute to overall score.
I understand. (0 points)

PD-20.1 Was RAP or RCA used in new pavement lifts, granular base course, or embankments? Points are awarded per Tables PD-20.1.A or PD-20.1.B.
No (0 points)

PD-20.2 Were pavement materials recycled in place using cold-in-place recycling, hot-in-place recycling, and full depth reclamation methods? Points are awarded per Table PD-20.2.A.
No (0 points)

PD-20.3 Did the project reuse subbase granular material as subgrade embankment or as part of the new subbase? Points are awarded per Table PD-20.3.A.
No (0 points)

PD-20.4 Did the project relocate and reuse at least 90 percent of the minor structural elements, including existing luminaires, signal poles, and sign structures that are required to be removed and/or relocated onsite?
No (0 points)

PD-20.5 Did the project salvage or relocate existing buildings?
No (0 points)

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

Scoring Notes
No criteria implemented for project

PD-22 **Long-Life Pavement** 7/7

Minimize life-cycle costs by designing long-lasting pavement structures.

PD-22 Points for different methods are cumulative; however, this criterion shall not exceed a total of seven points. Points exceeding seven will not contribute to overall score.
I understand. (0 points)

PD-22.1 Which of the following describes how long-life pavement was used on this project?
Long-life pavement was used for at least 75 percent of the surface area of regularly trafficked lanes. (5 points)

PD-22.2 Was the asphalt density of 100 percent of the total new or reconstructed pavement increased to a minimum of 94 percent?
No (0 points)

PD-22.3 Was a performance-based pay incentive for pavement smoothness used on this project?
Yes (2 points)

Scoring Notes
The project will be paved with long-lasting PCCP and overlaid with a rubber asphalt friction course. The friction course may have to be replaced every 10-15 years, but the PCCP materials traditionally last at least 40 years in the Phoenix area. ADOT standard specifications includes a pay incentive for pavement smoothness for both PCCP and the friction course.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-23 **Reduced Energy and Emissions in Pavement Materials** 0/3

Reduce energy use in the production of pavement materials.

PD-23 Points for different methods are cumulative; however, this criterion shall not exceed a total of three points. Points exceeding three will not contribute to overall score.
I understand. (0 points)

PD-23.1 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from asphalt production?
No (0 points)

PD-23.2 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from cement production?
No, or it did not meet the minimum requirements in the options above. (0 points)

PD-23.3 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from concrete production?
No, or it did not meet the minimum requirements in the options above. (0 points)

Scoring Notes
Criteria not implemented for this project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-24 **Permeable Pavement** 0/2

Improve flow control and quality of stormwater runoff through use of permeable pavement technologies.

PD-24.1and2P Does the project include a maintenance plan for permeable pavements and are permeable pavements placed in areas where no sand will be used for snow and ice control or pavement sealing?
No (0 points)

Scoring Notes
N/A

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-25 **Construction Environmental Training** 1/1

Provide construction personnel with the knowledge to identify environmental issues and best practice methods to minimize impacts to the human and natural environment.

PD-25.1 Did the owner require the Contractor to plan and implement a formal environmental awareness training program during construction to ensure the project stay in compliance with environmental laws, regulations, and policies?
Yes (1 point)

Scoring Notes
ADOT provides this training to construction personnel and contractors based on the project specifics.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-26 **Construction Equipment Emission Reduction** 0/2

Reduce air emissions from non-road construction equipment.

PD-26.1 Were one or more methods implemented to reduce non-road emissions? Points are awarded per Table PD-26.1.A.
No (0 points)

Scoring Notes
Criteria not implemented for this project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-28 **Construction Quality Control Plan** 5/5

Improve quality by requiring the contractor to have a formal Quality Control Plan (QCP).

PD-28.1 Is the Contractor required to plan and implement quality control measures throughout construction with care and for materials above and beyond what is typically required by specifications and regulations?
Yes (3 points)

PD-28.2 Does the contract leverage the use of Quality Price Adjustment Clauses to link payment and performance of the constructed products?
Yes (2 points)

Scoring Notes
ADOT construction contracts specifically pay for a contractor quality control item to ensure quality compliance beyond field inspection. Furthermore, ADOT will pay premiums for material quality that far exceeds the minimums.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-29 **Construction Waste Management** 1/4

Utilize a management plan for road construction waste materials to minimize the amount of construction-related waste destined for landfill.

PD-29.1 Is the contractor required to establish, implement, and maintain a formal Construction and Demolition Waste Management Plan (CWMP) during roadway construction, or its functional equivalent?
No (0 points)

PD-29.2 Can the owner demonstrate that a percentage of the construction waste has been diverted from landfills?
No, or diverted less than 50 percent of the construction waste from landfills (0 points)

PD-29.3 Were excess materials hauled directly to other project sites for recycling on those projects?
Yes (1 point)

Scoring Notes
Excess material for the project was taken from the project area to a designated area for use on another ADOT project

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-30 **Low Impact Development** 0/3

Use low impact development stormwater management methods that reduce the impacts associated with development and redevelopment and that mimic natural hydrology.

PD-30.1 Did the project use effective BMPs or stormwater management techniques that mimic natural hydrology to treat pollutants? Use Tables PD-30.1.A and PD-30.1.B and PD-30.1.C to determine points.
No (0 points)

Scoring Notes
Not applicable for this project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-32 **Light Pollution** 1/3

To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.

PD-32.1 Were the uplighting ratings met on this project per Table PD-32.1.A?
Yes (1 point)

PD-32.2 Were the backlighting ratings met on this project per Table PD-32.2.A?
No (0 points)

PD-32.3 Were the glare ratings met on this project per Table PD-32.3.A?
No (0 points)

Scoring Notes
Uplighting ratings were maintained through the forest service areas in accordance with the Red Rock Scenic Management Plan.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

INVEST Memorandum
US 93, Tegner St – Wickenburg Ranch Way
Arizona Department of Transportation

SEPTEMBER 2019

INVEST Score: Silver (61 points)

Background

The project is located along United States Highway (US 93, near the town on Wickenburg, Yavapai County, Arizona. The Arizona Department of Transportation (ADOT), in coordination with the Federal Highway Administration (FHWA), previously completed a design concept report (DCR) and accompanying environmental assessment (EA) for safety and traffic improvements along US Highway 93 (US 93) from State Route 89 (SR 89) to Wickenburg Interim Bypass near Wickenburg, Maricopa and Yavapai counties in 2010. The preferred design alternative that was identified in the DCR and evaluated in the EA was the construction of a four-lane divided roadway for approximately five miles, with other improvements such as roundabouts, medians, and frontage roads. The project is now in final design and includes the Preferred Alternative recommendations and additional safety improvements for signage, drainage, and pavement. The project cost is estimated at $49,000,000.

What is INVEST?

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by the Federal Highway Administration (FHWA) as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects.

The INVEST web-based tool allows users to self-evaluate programs or projects using these criteria to obtain a snapshot of the sustainability of the program or project in time. The tool also allows the user to include notes on scoring and implementation actions that can assist the user in integrating criteria and making progress over time. Although many agency efforts could already be considered sustainable, INVEST is focused on "above and beyond" efforts. Efforts that are typically required, such as National Environmental Policy Act (NEPA) resource analysis areas, are not included within the INVEST criteria.

INVEST considers the full lifecycle of projects and has four modules to self-evaluate the entire lifecycle of transportation services, including System Planning for States or Regions (SPS or SPR), Project Development (PD), and Operations and Maintenance (OM). Each of these modules is based on a separate collection of criteria and can be evaluated separately.

Purpose of the Memorandum

ADOT, in partnership with FHWA has utilized the latest version of INVEST (1.3) on numerous agency projects and programs in varying stages of development to document, explore, and identify sustainability elements of projects for incorporation, as well as provide feedback on the current INVEST 1.3 version of the tool. The goal of this project INVEST memorandum is to document the use of the INVEST scoring application on the US 93, Tegner St – Wickenburg Ranch Way using the Project Development (PD) using the Rural Extended Scorecard.

INVEST Scoring

INVEST may be used to score a project based on total points achieved. In the INVEST tool, FHWA does not recognize a project as having met the achievement level of sustainability based on scores; but rather recognizes that the user has self-evaluated their project and met the indicated achievement level.

The total points a project earns can be compared to several "achievement levels" that serve as relative benchmarks for sustainability accomplishments. The figure below shows the minimum number of points necessary to meet each achievement level for the PD module.

For the PD Rural Extended scorecard, a total of 153 points are available, broken down into the following scoring for each achievement level:

US 93 INVEST PD Module Criteria Scoring Results and Basis for Scores

According to the INVEST User Guide;

> The Project Development module spans the entire project development process. It includes early project planning, alternatives analysis, environmental documentation, preliminary and nal design, and construction. Although the criteria span all phases of project development, including construction activities, the project owner typically has control over the decisions and actions necessary to meet all of the criteria. Scoring The Project Development Module of INVEST has 7 project scorecards available for the evaluation of projects. This approach allows for flexibility, since not all of the criteria will apply to every project. Six of the scorecards are based on both the type of project (paving, basic, extended, or scenic/recreational) and the location (rural or urban) and include a defined subset of the 33 total criteria relevant to the type and location of the project. There is also a custom scorecard that includes 11 core criteria plus user-selected criteria to make a custom self-evaluation for projects that don't t well into the ve dened scorecards. The Project Development module contains the 33 criteria listed below, used in various combinations to create the 7 different scorecards.

Table 1. INVEST User Guide P.4

Project Development by Criteria Scorecard	Paving	Urban Basic	Urban Extended	Rural Basic	Rural Extended	Scenic and Recreational	Custom Core Criteria [1]
PD-1 Economic Analyses			●		●		
PD-2 Life-Cycle Cost Analyses	●	●	●	●	●		●
PD-3 Context Sensitive Project Development		●	●	●	●	●	
PD-4 Highway and Traffic Safety	●	●	●	●	●	●	●
PD-5 Educational Outreach		●	●	●	●	●	
PD-6 Tracking Environmental Commitments	●	●	●	●	●	●	●
PD-7 Habitat Restoration		●	●	●	●	●	
PD-8 Stormwater Quality and Flow Control		●	●	●	●	●	
PD-9 Ecological Connectivity			●	●	●	●	
PD-10 Pedestrian Facilities		●	●			●	
PD-11 Bicycle Facilities		●	●			●	
PD-12 Transit & HOV Facilities		●	●			●	
PD-13 Freight Mobility			●		●		
PD-14 ITS for System Operations		●	●		●		
PD-15 Historical, Archaeological, and Cultural Preservation		●	●	●	●	●	
PD-16 Scenic, Natural, or Recreational Qualities			●	●	●	●	
PD-17 Energy Efficiency		●	●	●	●		
PD-18 Site Vegetation, Maintenance, and Irrigation		●	●	●	●	●	
PD-19 Reduce, Reuse, and Repurpose Materials	●	●	●	●	●	●	●
PD-20 Recycle Materials	●	●	●	●	●	●	●
PD-21 Earthwork Balance			●		●	●	
PD-22 Long-Life Pavement	●	●	●	●	●	●	●
PD-23 Reduced Energy and Emissions in Pavement Materials	●	●	●	●	●	●	●
PD-24 Permeable Pavement	●	●	●	●	●	●	●
PD-25 Construction Environmental Training		●	●	●	●	●	
PD-26 Construction Equipment Emission Reduction	●	●	●	●	●	●	●
PD-27 Construction Noise Mitigation		●	●			●	
PD-28 Construction Quality Control Plan	●	●	●	●	●	●	●
PD-29 Construction Waste Management	●	●	●	●	●	●	●
PD-30 Low Impact Development		●	●	●	●	●	
PD-31 Infrastructure Resiliency Planning and Design			●		●	●	
PD-32 Light Pollution		●	●	●	●		
PD-33 Noise Abatement		●	●				
Total Number of Criteria in Scorecard	11	27	34	23	29	27	11

([1]) Indicates the core criteria that must be included in the custom scorecard. The user may choose as many additional criteria as desired.

The Project Development – Rural Extended Scorecard was used for the INVEST scoring of this project. Project Development (PD) is traditionally the second step in the lifecycle of a transportation project, where specific projects are planned, designed, and constructed. The PD module in the current INVEST tool includes a total of thirty-three criteria that are generally organized from planning to design to construction. The PD criteria are further organized into seven scorecards for the evaluation of projects. The scorecards are designed to identify applicable criteria based on the project type (paving, small/spot improvements, new facility/corridor project) and location (urban/rural). Six of these scorecards pre-identify criteria that are most likely to be applicable for the project type and location.

The Rural Extended scorecard is for rural projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of US 93 and includes new right-of-way, temporary construction easements, or major construction work needed, ADOT evaluated this based off the 28 criteria available for the scorecard.

To achieve a minimum bronze rating for the Project Development Rural Extended scorecard, a project needs to be awarded a minimum of 46 points. Based on the assessment completed for the INVEST scoring, the project received a score of 61 points, which identifies the project as a silver rating. Attached to this memorandum is the "Project Scorecard," which shows all points and information related to the scoring of the project.

Several notable points were documented for the following categories:

- **Context Sensitive Project Development**: Due to the fact that the project passes through the Town of Wickenburg, context sensitive project development was needed to ensure the community cohesion and character of the community remained. This design required consideration of color, texture, aesthetic considerations, and input from the Town of Wickenburg and other stakeholders. Landscaping for roundabout features, art, and implementation of features such a multi-use path were part of the project design to ensure context sensitive development.

- **Highway and Traffic Safety:** One of the major purposes of this project was to improve traffic and safety operations through this stretch of US 93 to reduce the potential for crashes and allow for improved intersection movements. During the initial design concept and final design stages of this project, information related to safety was provided to the public by ADOT regarding the proposed improvements. A thorough safety and traffic analysis was completed as part of the project for each alternative assessed.
- **Habitat Restoration / Ecological Connectivity:** Biological analysis was a large focus for the project team since this the project was in areas near critical habitat and sensitive resources within the Hassayampa River. The design team avoided worked to avoid impacts to sensitive water and biological resources during design.

- **ITS for System Operations:** Due to the fact that this major project had a purpose of increasing the safety and traffic operations of US 93, ITS systems such as managed lanes, roundabouts, variable speed limits, and vehicle restrictions were implemented to facilitate proper speeds and safety through the project area.

- **Site Vegetation, Maintenance, and Irrigation:** Consideration and implementation of re-seeding with non-invasive and non-noxious species is a standard Best Management Practice (BMP) for ADOT and is followed for every project where needed. This is a success area for ADOT for many years.

Summary

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area. Some opportunities that could be considered that were not in this final design stage include items such as light pollution minimization, low impact development for storm water management, earthwork balance, and recycling of materials. Due to the rural location of this project, some of these sustainability criteria such as scenic, natural, and recreational qualities were difficult to implement. However, the rural project area could benefit from considerations of reduced light pollution, and low impact development near the Hassayampa River. Additionally, an ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with an emphasis on education to the public.

Appendix: US 93 PD Module Scorecard

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

Project Scorecard

US 93, Tegner St - Wickenburg Ranch Way - Jun 13, 2019

Module: Project Development
Scorecard: Rural Extended
Points: 61
Achievement Level: Silver

Rural Extended Scorecard

Criteria | Points

PD-01 **Economic Analyses** 0/5

Using the principles of benefit-cost analysis (BCA) or economic impact analysis (EIA), provide evidence that the benefits, including environmental, economic, and social benefits, justify the full life-cycle costs.

PD-01.1a Was a benefit-cost analysis (BCA) for the project completed using minimum acceptable industry practices?
No (0 points)

PD-01.1b Was an Economic Impact Analysis (EIA) completed that meets all the listed requirements?
No (0 points)

Scoring Notes
A general economic analysis was completed as part of the original EA documentation.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-02 **Lifecycle Cost Analyses** 0/3

Reduce life-cycle costs and resource consumption through the informed use of life-cycle cost analyses of key project features during the decision-making process for the project.

PD-02.1a Was an LCCA performed for all pavement structure alternatives in accordance with the method described in the FHWA's Technical Bulletin for Life-Cycle Cost Analysis?
No (0 points)

PD-02.1b Was an LCCA performed for all stormwater infrastructure alternatives considered?
No (0 points)

PD-02.1c Was an LCCA performed for the project's major feature (bridges, tunnels, retaining walls, or other items not listed in the preceding options) for each of the alternatives considered?
No (0 points)

Scoring Notes
The planning and initial design for this project was started in 2006 before ADOT began the Sustainable Transportation Program

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-03 **Context Sensitive Project Development** 8/10

Deliver projects that harmonize transportation requirements and community values through effective decision-making and thoughtful design.

PD-03.1 Did the project development process generally follow the six-step CSS framework described in NCHRP report 480 and NCHRP report 642, or an equivalent process?
Yes (2 points)

PD-03.2 Did the project development process feature a "cradle-to-grave" project team that included planners, traffic engineers, public involvement specialists, design engineers, environmental experts, safety specialists, landscape architects, right-of-way staff, freight experts, construction engineers, and others to work on projects who worked together to achieve the desired CSS-based vision for the project?
Yes (1 point)

PD-03.3 As a result of CSS-influenced project development process, were external "champions" for the project created in the affected community who were engaged and proactive in supporting it?
Yes (1 point)

PD-03.4 Was acceptance achieved among project stakeholders on the problems, opportunities, and needs that the project should address and the resulting vision or goals for addressing them?
Yes (1 point)

PD-03.5 Do project features consider the appropriate scale of the project?
Yes (1 point)

PD-03.6 Did the project remove objectionable or distracting views?
No (0 points)

PD-03.7 Did the project integrate context sensitive aesthetic treatments?
Yes (1 point)

PD-03.8 Were aethetics for structural items incorporated into the design of the project?
Yes (1 point)

Scoring Notes
Context sensitive design and principles were used throughout the initial and final design stages of this project to the extent possible. ADOT design regularly landscapes and adds art to structures for major projects, so this is a normal process in project development and for this project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-04 **Highway and Traffic Safety** 7/10

Safeguard human health by incorporating science-based quantitative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.

PD-04.1 Were human factors considerations incorporated?
The project relied solely on published design and operational performance standards during the project development process. (0 points)

PD-04.2 Was awareness built among the public regarding contributing factors to crashes?
Yes (1 point)

PD-04.3 Does the agency conduct explicit consideration of safety using quantitative, scientifically proven methods?
Yes (0 points)

PD-04.3a Was the project type established during scoping of project alternatives through a quantitative and statistically reliable process?
Yes (1 point)

PD-04.3b Were project design and/or operational alternatives developed and evaluated using explicit consideration of substantive safety through quantitative, statistically reliable methods?
Yes (2 points)

PD-04.3c Were quantitative and statistically reliable methods and knowledge used to assess substantive safety performance in the development of preliminary and final design details?
Yes (3 points)

PD-04.4 Was a statistically reliable, science-based method used to evaluate the safety effectiveness of the implemented project?
No (0 points)

Scoring Notes
The DCR and Final Design of the project incorporated quantitative and statistically reliable methods and knowledge for each of the alternatives assessed in the DCR and the final alternative selected.

Next Actions
Check for safety analysis

PD-05 **Educational Outreach** 0/2

Increase public, agency, and stakeholder awareness of the integration of the principles of sustainability into roadway planning, design, and construction.

PD-05.1 Did this project incorporate public educational outreach that promotes and educates the public about sustainability by installing or performing a minimum of two different elements from Table PD-05.1.A?
No (0 points)

Scoring Notes
N/A

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-06 **Tracking Environmental Commitments** 0/5

Ensure that environmental commitments made by the project are completed and documented in accordance with all applicable laws, regulations, and issued permits.

PD-06.1a Was a comprehensive environmental compliance tracking system used for the project and related facilities?
No (0 points)

PD-06.2 Has the principal project constructor assigned an independent environmental compliance monitor who will provide quality assurance services and report directly to and make recommendations to the regulatory and Lead Agencies?
No (0 points)

Scoring Notes

ADOT does not have a formal environmental commitment tracking system. ADOT uses multiple processes to track federal and state environmental requirements, and is moving towards updating procedures.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-07 **Habitat Restoration** 4/7

Avoid, minimize, rectify, reduce, and compensate the loss and alteration of natural (stream and terrestrial) habitat caused by project construction and/or restore, preserve, and protect natural habitat beyond regulatory requirements.

PD-07.1 Was project-specific mitigation or mitigation banking used on this project? Use Table PD-07.1.A to determine the points earned.
1 Point (1 point)

PD-07.2 Were high quality aquatic resources (HQAR) avoided or were the impacts minimized on this project? Use Table PD-07.2.A to determine the points earned.
2 Points (2 points)

PD-07.3 Were high quality environmental resources avoided or were the impacts minimized on this project? Use Table PD-07.3.A to determine the points earned.
1 Point (1 point)

Scoring Notes
The project area features habitat for the Sonoran Desert Tortoise and is within the Hassayampa River floodway. The final design of project will minimize and avoid impacts to the floodway.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-08 **Stormwater Quality and Flow Control** 4/6

Improve stormwater quality from the impacts of the project and control flow to minimize their erosive effects on receiving water bodies and related water resources, using management methods and practices that reduce the impacts associated with development and redevelopment.

PD-08.1 Did the project treat at least 80% of the total runoff volume? Use Tables PD-08.1.A and PD-08.1.B to determine points.
1 Point (1 point)

PD-08.2 Did the project manage the flow from at least 80 percent of the total runoff volume, and is flow control based on controlling peak flows or durations from the project site? Use Tables PD-08.2.A and PD-08.1.B to determine points.
3 Points (3 points)

Scoring Notes
With the Hassayampa River floodway within the project limits, storm drainage was an important consideration in the development of the project. Using ADOT BMP's, runoff volumes will be managed through the use of catch basins, and is managing off site flows for the project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-09 **Ecological Connectivity** 3/4

Avoid, minimize, or enhance wildlife, amphibian, and aquatic species passage access, and mobility, and reduce vehicle-wildlife collisions and related accidents.

PD-09.1P Was a site-specific ecological assessment of the roadway project using GIS data or regional expertise conducted?
Yes (0 points)

PD-09.1 Were methods used to minimize impacts to ecological connectivity? Use Table PD-09.1.A to determine points.
2 (2 points)

PD-09.2 Did the project team engage natural resource and regulatory agencies throughout the planning process and ensure consistency with broader planning goals and objectives?
Yes (1 point)

Scoring Notes
ADOT completed a biological evaluation in the early stages of design and is updating the biological evaluation for this final design stage to confirm the original findings and sensitive habitat areas. Coordination with the Arizona Game and Fish occurred during the initial and final design stages throughout the project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-13 **Freight Mobility** 3/7

Enhance mobility of freight movements, decrease fuel consumption and emissions impacts, and reduce freight-related noise.

PD-13.1 Were freight facilities installed on this project consistent with the need, purpose, and appropriateness for freight mobility within the project footprint? Use Table PD-13.1.A to determine points.
3 Points (3 points)

Scoring Notes
PD 13.1c and 13.1d was completed through the implementation of safety signage and speed warning signs and systems as freight vehicles enter into the City of Wickenburg and in roundabout locations. Flashing signs, rumble strips are also safety installations for freight vehicles as well.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-14 **ITS for System Operations** 3/5

Improve the efficiency of transportation systems through deployment of technology and without adding infrastructure capacity in order to reduce emissions and energy use, and improve economic and social needs.

PD-14.1 Were one or more allowable ITS applications installed? Use Table PD-14.1.A to determine points.
At least 1 application in 3 separate categories (3 points)

Scoring Notes
PD-14.1c, PD14.1f, and PD14.1j all had at least 1 application these categories. For this project, speed enforcement through the use of managed lanes, roundabouts, variable speed limits, and vehicle restrictions were implemented for safety restrictions and traffic management.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-15 **Historic, Archaeological, and Cultural Preservation** 2/3

Preserve, protect, or enhance cultural and historic assets, and/or feature National Scenic Byways Program (NSBP) historic, archaeological, or cultural intrinsic qualities in a roadway.

PD-15.1P Is any part of the project or resource listed in the NRHP or been determined eligible for the NHRP by a State, Local, or Tribal Historic Preservation Officer?
Yes (0 points)

PD-15.1 Has an effort been made to minimize impacts, avoid impacts, or enhance features?
PD-15.1b Measures have been taken to specifically avoid impacts to the features from PD-15.1P. (2 points)

Scoring Notes
There were identified eligible properties within the study area that have been avoided through the project design.

Next Actions
Put in Section 106 consultation for project that shows minimization/avoidance.

PD-16 **Scenic, Natural, or Recreational Qualities** 0/3

Preserve, protect, and/or enhance routes designated with significant scenic, natural, and/or recreational qualities in order to enhance the public enjoyment of facilities.

PD-16.1P Is any portion of the project along one of America's Byways®, a State Scenic Byway, an Indian Tribe Scenic Byway, or other route that was designated or officially recognized as such?
No (0 points)

Scoring Notes
None are located within or near the project area.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-17 **Energy Efficiency** 1/8

Reduce energy consumption of lighting systems through the installation of efficient fixtures and the creation and use of renewable energy.

PD-17.1 Were energy needs evaluated for the project?
No (0 points)

PD-17.2 Was the energy consumption on the project reduced through the installation of energy efficient lighting and signal fixtures and through the installation of autonomous, on-site, renewable power sources?
Yes (0 points)

PD-17.2 Points are awarded based on the percentage of reduced power use. Based on Table PD-17.2.A, how many points did the project earn?
1 Point (1 point)

PD-17.3 Was a plan established for auditing energy use after project completion as part of operations and maintenance?
No (0 points)

Scoring Notes
LED lighting was used as a project feature for the installation of lighting at roundabouts within the project limits.

Next Actions
Reconfirm answer to #2, check if any auditing will occur post design.

PD-18 **Site Vegetation, Maintenance and Irrigation** 6/6

Promote sustainable site vegetation within the project footprint by selecting plants and maintenance methods that benefit the ecosystem.

PD-18.1P Does all site vegetation use non-invasive species only, use non-noxious species only, use seeding that does not require consistent mowing for a viable stand of grass, and minimize disturbance of native species?
Yes (0 points)

PD-18.1 Based on Table PD-18.1.A, how many points did the project earn? Points for features are additive, however this criterion shall not exceed a total of 3 points.
3 Points (3 points)

PD-18.2 Based on Table PD-18.2.A, how many points did the project earn for vegetative maintenance? Points for features are cumulative, however this scoring requirement shall not exceed a total of 3 points.
3 Points (3 points)

Scoring Notes
This is a standard practice for ADOT through the use of BMP's and implemented guidance and agency standardized processes.

Next Actions
Confirm source of water for irrigation and PD18.1

PD-19 **Reduce, Reuse and Repurpose Materials** 5/12

Reduce lifecycle impacts from extraction and production of virgin materials by recycling materials.

PD-19 Points for different methods are cumulative; however, this criterion shall not exceed a total of twelve points. Points exceeding twelve will not contribute to overall score.
I understand. (0 points)

PD-19.1 Was remaining service life increased through pavement preservation activities? Points are awarded per Table PD-19.1.A.
4 (4 points)

PD-19.2 Was the amount of new pavement materials needed reduced? Points are awarded per Table PD-19.2.A.
No (0 points)

PD-19.3 Was remaining service life increased through bridge preservation activities? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.4 Was remaining service life increased through retrofitting existing bridge structures? Points are awarded per Table PD-19.3.A.
No (0 points)

PD-19.5 Were existing pavements, structures, or structural elements reused for a new use? Points are awarded per Table PD-19.5.A.
1 (1 point)

PD-19.6a Were foundry sand or other industrial by-products used in pipe bedding and backfill?
No (0 points)

PD-19.7 Was a project-specific plan for the recycling and reuse plan developed as described?
No (0 points)

Scoring Notes
New asphaltic concrete pavement, friction course, fog coat, and shoulder buildup pavement preservation activities were implemented for the projects. Additionally, existing and new asphaltic concrete pavement re-purposed for multi-use path.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-20 **Recycle Materials** 0/10

Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by recycling materials.

PD-20 Points for different methods are cumulative; however, this criterion shall not exceed a total of ten points. Points exceeding ten will not contribute to overall score.
I understand. (0 points)

PD-20.1 Was RAP or RCA used in new pavement lifts, granular base course, or embankments? Points are awarded per Tables PD-20.1.A or PD-20.1.B.
No (0 points)

PD-20.2 Were pavement materials recycled in place using cold-in-place recycling, hot-in-place recycling, and full depth reclamation methods? Points are awarded per Table PD-20.2.A.
No (0 points)

PD-20.3 Did the project reuse subbase granular material as subgrade embankment or as part of the new subbase? Points are awarded per Table PD-20.3.A.
No (0 points)

PD-20.4 Did the project relocate and reuse at least 90 percent of the minor structural elements, including existing luminaires, signal poles, and sign structures that are required to be removed and/or relocated onsite?
No (0 points)

PD-20.5 Did the project salvage or relocate existing buildings?
No (0 points)

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

Scoring Notes
Track your scoring notes here. For example, "Based on May 2, 2012 Technical Report (attached)."

PD-21 **Earthwork Balance** 1/5

Reduce the need for transport of earthen materials by balancing cut and fill quantities.

PD-21.1a Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10%?
No (0 points)

> **PD-21.1b Are the design cut and fill volumes or the actual construction cut and fill volumes balanced to within 10% if construction banking is used?**
> No (0 points)

PD-21.2 Has an earthwork management plan been established, implemented and actively managed on this project?
No (0 points)

PD-21.3 Has topsoil been preserved or reused on this projet?
Yes (1 point)

Scoring Notes
Topsoil will be stripped and reused as applicable on new slopes.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-22 **Long-Life Pavement** 7/7

Minimize life-cycle costs by designing long-lasting pavement structures.

PD-22 Points for different methods are cumulative; however, this criterion shall not exceed a total of seven points. Points exceeding seven will not contribute to overall score.
I understand. (0 points)

PD-22.1 Which of the following describes how long-life pavement was used on this project?
Long-life pavement was used for at least 75 percent of the surface area of regularly trafficked lanes. (5 points)

PD-22.2 Was the asphalt density of 100 percent of the total new or reconstructed pavement increased to a minimum of 94 percent?
No (0 points)

PD-22.3 Was a performance-based pay incentive for pavement smoothness used on this project?
Yes (2 points)

Scoring Notes
The roadway typical section would be paved with long-lasting PCCP and overlaid with a rubber asphalt friction course. ADOT standard specifications includes a pay incentive for pavement smoothness for both applications

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-23 **Reduced Energy and Emissions in Pavement Materials** 0/3

Reduce energy use in the production of pavement materials.

PD-23 Points for different methods are cumulative; however, this criterion shall not exceed a total of three points. Points exceeding three will not contribute to overall score.
I understand. (0 points)

PD-23.1 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from asphalt production?
No (0 points)

PD-23.2 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from cement production?
No, or it did not meet the minimum requirements in the options above. (0 points)

PD-23.3 Was at least 50 percent of the total project pavement material (by weight) a low-energy material from concrete production?
No, or it did not meet the minimum requirements in the options above. (0 points)

Scoring Notes
Since this project is not at the construction phase, this information has not been determined yet.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-24 **Permeable Pavement** 0/2

Improve flow control and quality of stormwater runoff through use of permeable pavement technologies.

PD-24.1and2P Does the project include a maintenance plan for permeable pavements and are permeable pavements placed in areas where no sand will be used for snow and ice control or pavement sealing?
No (0 points)

Scoring Notes
ADOT does not have this technology at this time.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-25 **Construction Environmental Training** 1/1

Provide construction personnel with the knowledge to identify environmental issues and best practice methods to minimize impacts to the human and natural environment.

PD-25.1 Did the owner require the Contractor to plan and implement a formal environmental awareness training program during construction to ensure the project stay in compliance with environmental laws, regulations, and policies?
Yes (1 point)

Scoring Notes
ADOT provides pre-construction meetings with environmental awareness training as part of the standard processes. Environmental compliance discussions are critical to these meetings to ensure understanding of all laws, policies, regulations.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-26 **Construction Equipment Emission Reduction** 0/2

Reduce air emissions from non-road construction equipment.

PD-26.1 Were one or more methods implemented to reduce non-road emissions? Points are awarded per Table PD-26.1.A.
No (0 points)

Scoring Notes
No methods identified to date for project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-28 **Construction Quality Control Plan** 5/5

Improve quality by requiring the contractor to have a formal Quality Control Plan (QCP).

PD-28.1 Is the Contractor required to plan and implement quality control measures throughout construction with care and for materials above and beyond what is typically required by specifications and regulations?
Yes (3 points)

PD-28.2 Does the contract leverage the use of Quality Price Adjustment Clauses to link payment and performance of the constructed products?
Yes (2 points)

Scoring Notes
ADOT construction contracts include a contractor quality control system to ensure quality compliance. ADOT will also pay premiums for material quality that exceeds minimum standards.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-29 **Construction Waste Management** 1/4

Utilize a management plan for road construction waste materials to minimize the amount of construction-related waste destined for landfill.

PD-29.1 Is the contractor required to establish, implement, and maintain a formal Construction and Demolition Waste Management Plan (CWMP) during roadway construction, or its functional equivalent?
No (0 points)

PD-29.2 Can the owner demonstrate that a percentage of the construction waste has been diverted from landfills?
No, or diverted less than 50 percent of the construction waste from landfills (0 points)

PD-29.3 Were excess materials hauled directly to other project sites for recycling on those projects?
Yes (1 point)

Scoring Notes
Excess materials will be hauled to another project site for use on the other project.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-30 **Low Impact Development** 0/3

Use low impact development stormwater management methods that reduce the impacts associated with development and redevelopment and that mimic natural hydrology.

PD-30.1 Did the project use effective BMPs or stormwater management techniques that mimic natural hydrology to treat pollutants? Use Tables PD-30.1.A and PD-30.1.B and PD-30.1.C to determine points.
No (0 points)

Scoring Notes
No information for this criteria.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-31 **Infrastructure Resiliency Planning and Design** 0/12

Respond to vulnerabilities and risks associated with current and future hazards (including those associated with climate change) to ensure transportation system reliability and resiliency.

PD-31.1 Did the project incorporate consideration of climate change at a project-specific level in project development and environmental reviews?
No (0 points)

PD-31.2 Did the project incorporate future consideration of climate change effects in the design process?
No (0 points)

PD-31.3 Did the project mitigate the effects of GHG emissions through design efforts above and beyond requirements and regulations?
No (0 points)

Scoring Notes
Not incorporated into this project at this time.

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

PD-32 **Light Pollution** 0/3

To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.

PD-32.1 Were the uplighting ratings met on this project per Table PD-32.1.A?
No (0 points)

PD-32.2 Were the backlighting ratings met on this project per Table PD-32.2.A?
No (0 points)

PD-32.3 Were the glare ratings met on this project per Table PD-32.3.A?
No (0 points)

Scoring Notes
N/A

Next Actions
Record future actions here. For example, "Coordinate with HQ and ensure specifications meet requirements."

INVEST Memorandum
State Route 189 (SR 189), International Border to Grand Avenue
Arizona Department of Transportation

April 2020

INVEST Score: Bronze (68 points)

Background

The project is located in the City of Nogales in Santa Cruz County, Arizona. The project begins at the SR 189 southern terminus at milepost (MP) 0.6, north of the Mariposa Port-of-Entry (POE), and extends north-northeast to the existing SR 189/I-19 TI, continuing past the TI to end at the intersection with Grand Avenue (MP 3.75). The project area also includes approximately 1.3 miles of I-19 from approximately MP 2.6 north to MP 3.9 and approximately 0.5 mile of Grand Avenue from approximately MP 2.5 north to MP 3.0. SR 189 provides direct access between the Mariposa POE and the numerous warehousing and light industrial centers in Nogales.

The project will improve vehicular access, circulation, mobility, and level-of-service (LOS) and help reduce vehicle conflicts on SR 189 from the Mariposa POE to the Mariposa TI and beyond to Grand Avenue by:

- Providing sufficient capacity and LOS on SR 189 to accommodate the expansion of the Mariposa POE and future industrial and commercial growth along the SR 189 corridor
- Improving vehicular demand distribution to and from I-19 by providing additional egress and ingress to Prevent overburdening the existing TI on this critical trade route
- Reducing vehicle conflicts and improving traveler safety by implementing limited access controls and intersection improvements (traffic signals, widening, eliminating selected driveways, etc.), and
- Providing access to industrial and commercial land use growth areas in the SR 189 corridor, including the Mariposa International Commerce and Industry Park and Centro Commercial areas.

The project is in the final design stage with an alternative delivery method of construction, with construction starting in 2020. The scope of work features major elements such as:

- Construction of two fly-over ramps widen or replace the existing SR 189 bridge
- Construction of a raised median to replace the continuous left-turn lane that separates opposing traffic flows
- Pavement widening along SR 189 to allow for construction of a 16-foot-wide median,
- Driveway modifications and right-in/right-out driveways,
- Construction of a roundabout at SR 189

What is INVEST?

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by the Federal Highway Administration (FHWA) as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects.

The INVEST web-based tool allows users to self-evaluate programs or projects using these criteria to obtain a snapshot of the sustainability of the program or project in time. The tool also allows the user to include notes on scoring and implementation actions that can assist the user in integrating criteria and making progress over time. Although many agency efforts could already be considered sustainable, INVEST is focused on "above and

beyond" efforts. Efforts that are typically required, such as National Environmental Policy Act (NEPA) resource analysis areas, are not included within the INVEST criteria.

INVEST considers the full lifecycle of projects and has four modules to self-evaluate the entire lifecycle of transportation services, including System Planning for States or Regions (SPS or SPR), Project Development (PD), and Operations and Maintenance (OM). Each of these modules is based on a separate collection of criteria and can be evaluated separately.

Purpose of the Memorandum

ADOT, in partnership with FHWA has utilized the latest version of INVEST (1.3) on numerous agency projects and programs in varying stages of development to document, explore, and identify sustainability elements of projects for incorporation, as well as provide feedback on the current INVEST 1.3 version of the tool. The goal of this project INVEST memorandum is to document the use of the INVEST scoring application on the SR189, International Border to Grand Avenue project with the Project Development (PD) criteria using the Urban Extended Scorecard.

INVEST Scoring

INVEST may be used to score a project based on total points achieved. In the INVEST tool, FHWA does not recognize a project as having met the achievement level of sustainability based on scores; but rather recognizes that the user has self-evaluated their project and met the indicated achievement level.

The total points a project earns can be compared to several “achievement levels” that serve as relative benchmarks for sustainability accomplishments. The figure below shows the minimum number of points necessary to meet each achievement level for the PD module.

For the PD Urban Extended scorecard, a total of 168 points are available, broken down into the following scoring for each achievement level:

SR189 International Border to Grand Avenue, INVEST PD Module Criteria Scoring Results and Basis for Scores

According to the INVEST User Guide;

> The Project Development module spans the entire project development process. It includes early project planning, alternatives analysis, environmental documentation, preliminary and final design, and construction. Although the criteria span all phases of project development, including construction activities, the project owner typically has control over the decisions and actions necessary to meet all of the criteria. Scoring The Project Development Module of INVEST has 7 project scorecards available for the evaluation of projects. This approach allows for flexibility, since not all of the criteria will apply to every project. Six of the scorecards are based on both the type of project (paving, basic, extended, or scenic/recreational) and the location (rural or urban) and include a defined subset of the 33 total criteria relevant to the type and location of the project.

There is also a custom scorecard that includes 11 core criteria plus user-selected criteria to make a custom self-evaluation for projects that don't fit well into the standard identified scorecards. The Project Development module contains the 33 criteria listed below, used in various combinations to create the 7 different scorecards.

Table 1. INVEST User Guide P.4

Project Development by Criteria Scorecard

	Paving	Urban Basic	Urban Extended	Rural Basic	Rural Extended	Scenic and Recreational	Custom Core Criteria [1]
PD-1 Economic Analyses			●		●		
PD-2 Life-Cycle Cost Analyses	●	●	●	●	●		●
PD-3 Context Sensitive Project Development		●	●	●	●	●	
PD-4 Highway and Traffic Safety	●	●	●	●	●	●	●
PD-5 Educational Outreach		●	●	●	●	●	
PD-6 Tracking Environmental Commitments	●	●	●	●	●	●	●
PD-7 Habitat Restoration		●	●	●	●	●	
PD-8 Stormwater Quality and Flow Control		●	●	●	●	●	
PD-9 Ecological Connectivity			●	●	●	●	
PD-10 Pedestrian Facilities		●	●			●	
PD-11 Bicycle Facilities		●	●			●	
PD-12 Transit & HOV Facilities		●	●			●	
PD-13 Freight Mobility			●		●		
PD-14 ITS for System Operations		●	●		●		
PD-15 Historical, Archaeological, and Cultural Preservation		●	●	●	●	●	
PD-16 Scenic, Natural, or Recreational Qualities			●	●	●	●	
PD-17 Energy Efficiency		●	●	●	●		
PD-18 Site Vegetation, Maintenance, and Irrigation		●	●	●	●	●	
PD-19 Reduce, Reuse, and Repurpose Materials	●	●	●	●	●	●	●
PD-20 Recycle Materials	●	●	●	●	●	●	●
PD-21 Earthwork Balance			●		●	●	
PD-22 Long-Life Pavement	●	●	●	●	●	●	●
PD-23 Reduced Energy and Emissions in Pavement Materials	●	●	●	●	●	●	●
PD-24 Permeable Pavement	●	●	●	●	●	●	●
PD-25 Construction Environmental Training		●	●	●	●	●	
PD-26 Construction Equipment Emission Reduction	●	●	●	●	●	●	●
PD-27 Construction Noise Mitigation		●	●			●	
PD-28 Construction Quality Control Plan	●	●	●	●	●	●	●
PD-29 Construction Waste Management	●	●	●	●	●	●	●
PD-30 Low Impact Development		●	●	●	●	●	
PD-31 Infrastructure Resiliency Planning and Design			●		●	●	
PD-32 Light Pollution		●	●	●	●		
PD-33 Noise Abatement		●	●				
Total Number of Criteria in Scorecard	11	27	34	23	29	27	11

([1]) Indicates the core criteria that must be included in the custom scorecard. The user may choose as many additional criteria as desired.

The Project Development – Urban Extended Scorecard was used for the INVEST scoring of this project. Project Development (PD) is traditionally the second step in the lifecycle of a transportation project, where specific projects are planned, designed, and constructed. The PD module in the current INVEST tool includes a total of thirty-three criteria that are generally organized from planning to design to construction. The PD criteria are further organized into seven scorecards for the evaluation of projects. The scorecards are designed to identify applicable criteria based on the project type (paving, small/spot improvements, new facility/corridor project) and location (urban/rural). Six of these scorecards pre-identify criteria that are most likely to be applicable for the project type and location.

The Urban Extended scorecard is for urban projects for a new roadway facility; structure projects where nothing of its type currently exists; and major reconstruction projects that add travel lanes to an existing roadway or bridge. As this project is a project that will add capacity of I-10 through a major metropolitan area, includes new right-of-way, temporary construction easements, and major construction and traffic control work needed, ADOT evaluated this based off the 34 criteria available for the scorecard.

To achieve a minimum bronze rating for the Project Development Urban Extended scorecard, a project needs to be awarded a minimum of 52 points. Based on the assessment completed for the INVEST scoring, the project received a score of 68 points, which identifies the project as a bronze rating. Attached to this memorandum is the "Project Scorecard," which shows all points and information related to the scoring of the project.

Several notable points were documented for the following categories:

- **Context Sensitive Project Development**: Although the study area is in a highly developed industrial and business area within the southern Arizona region of Nogales, context sensitive design and coordination with stakeholders was an important part of the project development process through the completion of the EA and Design Concept Report (DCR). The study area has an average daily count of over 300,000 trucks a day and is an important regional corridor for the Arizona and southwest region for commercial and trade, so context sensitive design through the implementation of aesthetic consideration for new bridges was important for Mariposa International Commerce and Industry Park and Centro Commercial areas. A robust team of technical experts from environmental, local jurisdictions, design engineers, and public involvement specialists were involved in the planning of this project and will continue to be as the design progresses to construction.

- **Freight Mobility:** The projects proposed flyover ramps will provide commercial freight traffic the direct access needed between SR189 and Interstate 10 highway, and allow the local arterial roads to better service the transportation needs of the local community. In addition to this improvement in traffic flow, it will also have a positive benefit on freight movement and contribute to a reduction in freight-related noise in the local roads. Weigh-in-motion systems will be installed within the area as well.

- **ITS for System Operations:** Due to the fact that this project's purpose and need focused on maintaining the functionality of this major corridor, the study team sought to identify strategies that would improve

the efficiency of movement through this area through the deployment of intelligent transportation systems (ITS) technology. Measures identified as a result of this effort include fiber optic/wireless system technology, CCTV, speed detectors, and work zone management.

- **Highway and Traffic Safety:** Before this project, there have been several evaluations completed to evaluate the safety of the SR189 corridor. This included comprehensive studies like the 2008 Connector Route Study that evaluated the need for improved access and safety of the existing SR 189 area. For this current study and project, an additional quantitative evaluation was completed specifically for traffic operations in a 2016 traffic report for the project.

- **Stormwater Quality and Flow Control:** Due to the design-build alternative construction delivery method on this project, the ADOT project team has identified requirements in the developer's technical provision contract for the creation and implementation of treating runoff through the project area. As described in the contracting documents, the contractor will manage and treat approximately 80% percent of the runoff flow.

- **Construction Quality Control Plan:** Due to the design-build alternative construction delivery method on this project, the ADOT project team has identified requirements in the developer's technical provision contract for the implement a Construction Quality Management Plan for this project.

Summary of SR189, International Border to Grande Avenue

The evaluation of this project introduced opportunities for improvements in sustainability elements for future projects within this area. Some opportunities that could be considered going into the final design stage that were not in this preliminary design stage include items such as:

- Earthwork balance
- Recycling of materials
- Lifecycle cost analysis
- Educational outreach
- Long-life pavements

Due to the location of this project, some of these sustainability criteria mentioned were difficult to implement due to the limited amount of right-of-way (ROW) currently available within the project area and other local area constraints. Additionally, some criteria identified for pedestrian facilities, bicycle facilities, and scenic, natural, and recreation qualities were specific to certain elements that were outside of the scope of the project and so therefore could not be considered for scoring of this project. Others not accounted for in this scoring effort such as lifecycle cost analysis and long-life pavement could be considered as beneficial for consideration in future ADOT projects within this study area due to the high traffic counts and overall use of the transportation system within this area.

The alternative construction delivery method of this project as a design-build allowed for opportunities to consider the social, environmental, and economic aspects of the project in more detail as opposed to the traditional design and construction advertisement process; for example, consideration of freight mobility, and construction quality control plan were incorporated into this project as a result of ADOT's primary focus on traffic congestion and freight considerations as part of the design process. In addition, although the project was in a highly developed industrial and business area, ADOT focused on implementing aesthetic features into the consideration of new bridge structures through context sensitive development and ITS system improvements. Although these items are seen as social considerations that ADOT considered, they also have an economic consideration benefit to the agency when considering the positive outcomes from traffic congestion and local economy costs related to delays in freight movement, local community improvements from reduction of traffic on arterial roads, and overall support from important stakeholders on the project. An ADOT agency goal in future projects would be to introduce sustainability earlier into the early design concept and NEPA stage, with an emphasis on education to the public of the social, economic, and environmental benefits of considering sustainability in design.

Appendix: SR189, International Border to Grande Avenue PD Module Scorecard was not accessible

Appendix C – 2020 – 2021 Operational Focus Areas

2020 - 2021 Operational Focus Areas

Sustainable Transportation Planning

- MPD/MPO/COG sustainable transportation partnering
- Sonoran Corridor Tier 1 EIS Corridor INVEST use
- Sustainable outreach with Arizona Tribes through ADOT Tribal Liason
- Integrate sustainability elements into long range planning transportation planning (LRTP)
- Promote ADOT's Bicycle and Pedestrian Program

Sustainable Transportation Project Development

- EASPD Award Program
- Continue INVEST PD scoring
- Sustainable Earthwork
- Sustainable Project Design Checklist
- FHWA Every Day Counts initiatives adoption
- Establish Sustainable Project Management tools website and training
- Establish "Sustainabilty Working Group"

Sustainable Transportation TSMO

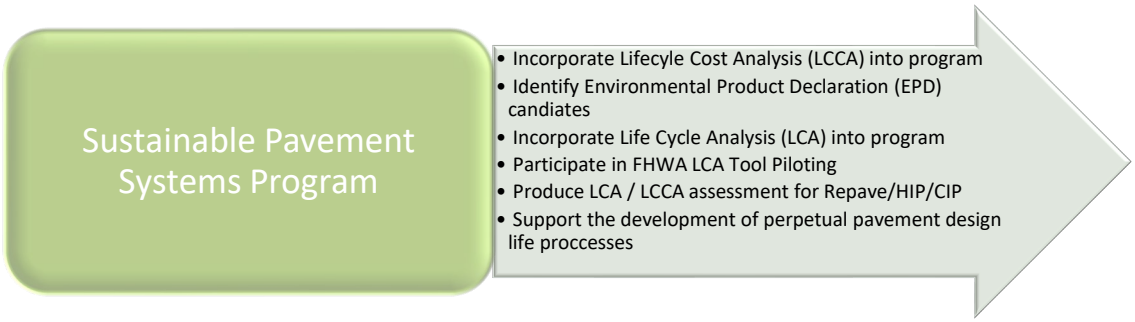
- TSMO case studies to advance national conversation (i.e pumphouse life cycle tool)
- Advance implementation of LED lighting
- Implement LCA / LCCA lighting tool
- Complete first LCA/LCCA assessment (LED Lighting)
- Develop solar energy using ADOT right-of-way

Sustainable Transportation Maintenance

- District Sustainability Working sub-group
- Leverage heavy equipment idling policy
- Expand strategy on integrated environmental commitments tracking
- Establish "Sustainabilty Working Group"
- Leverage maintence work order environmental clearances to include sustainability

Sustainable Transportation Administration

- Comprehensive Internal Sustainability Plan
- Consolidated energy efficiency and use plan
- Consolidated recycling plan
- Documenting ADOT Equipment Services activities
- Expand university outreach
- Maintain national leadership role
- Assist TRB in framing global sustainable tranportation


Sustainable Pavement Systems Program
• Incorporate Lifecyle Cost Analysis (LCCA) into program
• Identify Environmental Product Declaration (EPD) candiates
• Incorporate Life Cycle Analysis (LCA) into program
• Participate in FHWA LCA Tool Piloting
• Produce LCA / LCCA assessment for Repave/HIP/CIP
• Support the development of perpetual pavement design life proccesses

Appendix D – ADOT Sustainable Project Development Checklist

SUSTAINABLE PROJECT DEVELOPMENT CHECKLIST

This checklist is for use by the Arizona Department of Transportation (ADOT) to facilitate the project development process and engage relevant design areas to identify sustainable and resilience strategies for integration into the planning, scoping, and design stages of transportation projects. The checklist incorporates project development criteria from the Federal Highway Administration's (FHWA) INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) sustainable design evaluation process, along with elements for consideration from ADOT's Complete Transportation Guidebook. The criteria listed below include a comprehensive list of design elements, processes, and standards that can be considered during the final design stages of a project and used to identify areas of opportunity for sustainable transportation elements in the project development process.

Each section below included identified INVEST criteria and ADOT initiatives fulfill the Project Development module of the INVEST evaluation process. The associated links for the INVEST criteria should be used to determine the background and scoring requirements. In addition to the comprehensive list identified in this checklist, additional INVEST criteria for other projects, programs, or plans and the ADOT Complete Transportation Guidebook design considerations can be found on the associated ADOT and FHWA websites.

1. SOCIAL AND COMMUNITY DEVELOPMENT PROJECT DESIGN CRITERIA

- ☐ Consider safety in project development by implementing a formal safety analysis evaluation using TSMO (Transportation Systems Management and Operations) processes identified in their Road Safety Assessments Program and other elements of quantitative evaluation such as AASHTO SafetyAnalyst (INVEST Criteria PD-04)
- ☐ Increase public, agency, and stakeholder education through public involvement activities on the benefits of sustainability into project development and construction (INVEST Criteria PD -05)
- ☐ Develop project with context sensitive design that includes an interdisciplinary team and considers the social, aesthetic, economic, and environmental values in needs of a study area and local community, along with *ADOT's Complete Transportation Guidebook* (INVEST Criteria PD-03)
- ☐ Develop and design pedestrian facilities for people of all ages and abilities within the project area as described in *ADOT's Complete Transportation Guidebook* (INVEST Criteria PD -10)
- ☐ Provide bicycling facilities within the project footprint through methods such as filling gaps in bicycle network, enhancing existing bicycle features, or developing new facilities with consideration of *ADOT's Complete Transportation Guidebook* (INVEST Criteria PD-11)
- ☐ Enhance the use of public transit and carpooling by upgrading transit amenities, providing transit shelters, or providing increased HOV facilities and/or signage with consideration of *ADOT's Complete Transportation Guidebook* (INVEST Criteria PD-12)
- ☐ Include efforts to reduce traffic and noise impacts by implementing context sensitive methods such as specialized noise barriers (i.e earthen berms), incorporating traffic system management techniques such as signage and speed limit reductions, and consideration of quiet pavement design (INVEST Criteria PD-33, PD-14)
- ☐ Include efforts to reduce disturbance from road construction noise by implementing a construction noise mitigation plan that would outline the procedures and considerations to be followed for noise and construction activities (INVEST Criteria PD-27)
- ☐ Complete an benefit cost analysis (BCA) or economic impact analysis (EIA) that considers the environmental, social, and economic outcomes and provide rationale for the benefits of the project (INVEST Criteria PD-01)

2. INNOVATIVE PROJECT DESIGN AND CONSTRUCTION CRITERIA

- ☐ Implement technology improvements such as dust warning systems, wrong way detection technology, and traffic flow sensors identified in TSMO (Transportation Systems Management and Operations) Initiatives and Innovations (INVEST Criteria PD-14)
- ☐ Reduce lifecycle impacts from the extraction, production, and transportation of materials through methods such as cold or hot-in-place recycling , salvaging or relocating buildings, or reusing sub-base granular material (INVEST Criteria PD-20)
- ☐ Improve freight movements while decreasing fuel consumption and freight-related noise by implementing freight access features such as rest stop areas, design modifications for truck safety, and no-idling policies (INVEST Criteria PD-13)
- ☐ Evaluate and reduce energy consumption of lighting systems by installing efficient fixtures such as LED, retrofitting of energy efficient lighting systems, and replacement of signs with retro reflective signs (INVEST Criteria PD-17)
- ☐ Incorporate sustainable site vegetation by selecting native plant species for planting, identifying and removing non-invasive plant species, and/or implementing a plan for preventing invasive species (INVEST Criteria PD-18)
- ☐ Reduce lifecycle impacts from extraction, production, and transportation of virgin materials by implementing sustainable pavement and structures applications such as crack sealing, chip sealing, deck overlays, or re-purposing pavements and/or structures using AASHTO guidance (INVEST Criteria PD-19)
- ☐ Reduce energy use and air emissions from construction equipment by implementing standards such as no-idling policies and/or a materials hauling plan that minimizes waste from hauling materials (INVEST Criteria PD-26)

- ☐ Minimize life-cycle costs by designing long-lasting pavement structures with a service life of 20-40 years for bus lanes, regularly trafficked lanes, implementing a performance-based pay incentive for pavement smoothness, and/or an increase in asphalt concrete pavement density (INVEST Criteria PD-22)
- ☐ Improve quality by requiring contractors to have a formal Quality Control Plan (QCP) that considers elements such as procedures for materials handling. testing standards, and/or items to be monitored (INVEST Criteria PD-28)
- ☐ Reduce waste by requiring contractors to establish and implement a waste management plan that focuses on the diversion of waste from construction sites such as concrete, metals, and plastic that is destined for landfills to instead a recycling facility or other project location where materials can be used (INVEST Criteria PD-29)
- ☐ Consider storm water quality by implementing management methods that control flow, and mimic natural hydrology to treat pollutants such as permeable pavements, Best Management Practices (BMP),or a plan for maintenance (INVEST Criteria PD-30 , PD-24)
- ☐ Reduce the need for transporting materials by balancing cut and fill quantities. considering cut and fill volumes with and without construction stockpiles, preserving or reusing topsoil or spoils, and/or establishing an earthwork management plan (INVEST Criteria PD-21)
- ☐ Reduce energy use in the production of pavement materials by considering sustainable production methods such as such as warm mix asphalt or cement production using alternative materials such as recycled oil or limestone additives (INVEST Criteria PD-23)
- ☐ Complete a life-cycle cost analysis evaluation that considers the full indirect and direct costs throughout the life of the design alternatives for pavement structures, storm water, or other major design features such as bridges. (INVEST Criteria PD-02)
- ☐ Establish a formal environmental commitments tracking process through the use of a formal system or assigned environmental monitor during construction, and/or implement environmental awareness training for construction personnel (INVEST Criteria PD-06, PD-25)
- ☐ Consider qualitatively or quantitatively the full life-cycle risks and vulnerabilities of the project by incorporating an evaluation of extreme weather events as part of the design process for bridges, pavements, alignments, and other design elements (INVEST Criteria PD-31)

3. NATURAL AND BUILT ENVIRONMENT PROJECT DESIGN CRITERIA

- ☐ Avoid, minimize, or compensate the loss of natural habitat caused by construction, or protect natural habitat through design modifications during the project development stage or through mitigation activities such as species relocations or habitat restoration activities (INVEST Criteria PD-07)
- ☐ Preserve, protect, or enhance roadways designated with significant scenic, natural, and/or recreational qualities by enhancing existing roadway features such as scenic pullouts, providing access, and avoiding impacts (INVEST Criteria PD-16)
- ☐ Avoid, minimize, or enhance wildlife passage access, and reduce vehicle-wildlife collisions and related accidents by minimizations methods such as installing wildlife crossing structures, protective fencing, and/or modifications to design (INVEST Criteria PD-09)
- ☐ Preserve, protect, or enhance cultural and historic assets in a roadway by minimizing or avoiding impacts, or by enhancing the features of this historic feature through the installation of informational facilities (INVEST Criteria PD-15)
- ☐ Provide lighting improvements while minimizing blacklight, glare, or sky glow effects in communities through design considerations that focuses on design standards for lighting as considered in *ADOT's Complete Transportation Guidebook* (INVEST Criteria PD-32)
- ☐ Incorporate sustainable storm water quality practices into construction to minimize impacts to natural water bodies by treating target pollutants and runoff at an rate of at least 80% percent of the volume, and or/managing flow of runoff (INVEST Criteria PD-08)

COMMENTS AND/OR ADDITIONAL CRITERIA CONSIDERED

Appendix E – 2016 Final Report; Pavement Case Study

Sustainable Pavements Case Study

Sustainable Transportation Program

INVEST Operations & Maintenance

Operations and Maintenance (OM) is the third step in the lifecycle of a transportation project. This is where infrastructure planned, designed and constructed in prior steps is operated and maintained, resulting in needs for data collection and new project identification. This information is then passed back to the SP step, to complete the lifecycle of projects. This module focuses on performing system-level operations and maintenance activities in a manner that contributes to the overall sustainability of the highway network. The OM criteria are primarily written for the scoring of an agency's internal, system operations as well as, asset management and maintenance activities performed on the network infrastructure. The OM module contains 14 criteria and will constitutes the bulk of ADOT's 2015 sustainability efforts.

Goal

OM-07: Pavement Management System

Leverage a pavement management system to balance activities that extend the life and function of pavements with impacts to the human and natural environment.

Sustainability Linkage

Maintaining and using a pavement management system supports the environmental and economic principles by optimizing the management of pavements, including preservation, restoration, and replacement, to maximize their lifetime. This reduces costs, the environmental impacts of construction, and raw material usage.

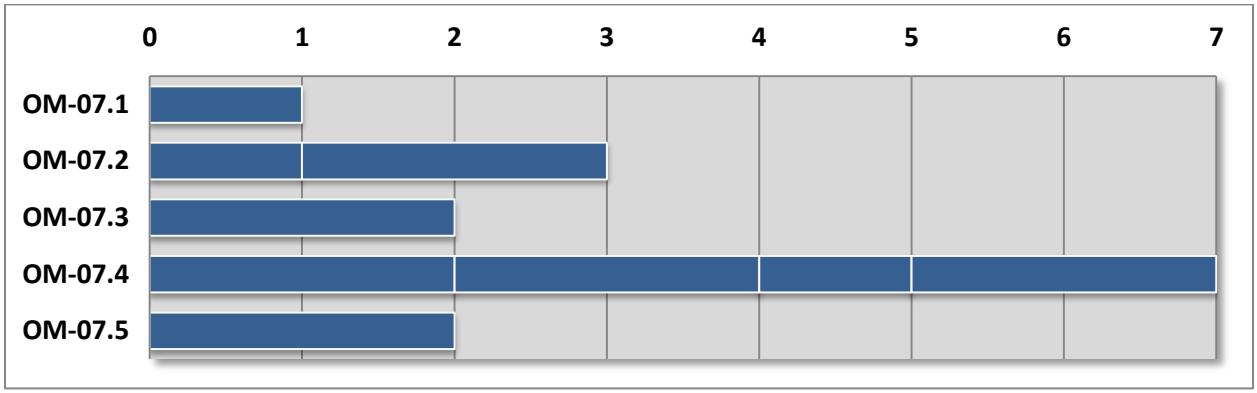
This criterion includes the following elements:

- Develop a Pavement Management System and Collect Data
- Track Pavement Network Performance
- Set Goals and Monitor Progress
- Leverage Data to Demonstrate Sustainable Outcomes
- Sustainable Specifications

Overall, ADOT views the INVEST OM Pavement Management System as contributing to sustainability by optimizing pavement life cycles to reduce costs, the environmental impacts of construction, and raw material usage.

ADOT OM-07 Performance

ADOT received all 15 points available for OM-07, and goes above and beyond INVEST goals.



-Requirement OM-07.1: Develop a Pavement Management System and Collect Data
1/1 point

ADOT has a system-wide Pavement Management System (PMS) which incorporates all required elements.

-Requirement OM-07.2: Track Pavement Network Performance
3/3 points

- *Requirement OM-07.2a: Use Common Metrics (1/1 point)*

  ADOT tracks pavement using common metrics, including IRI.

- *Requirement OM-07.2b: Measure Project Timelines (2/2 points)*

  The PMS identifies future projects and activities as well as project histories.

-Requirement OM-07.3: Set Goals and Monitor Progress
2/2 points

ADOT sets quantifiable goals for pavement condition and has monitored progress toward these goals for several years.

-Requirement OM-07.4: Leverage Data to Demonstrate Sustainable Outcomes
7/7 points

- *Requirement OM-07.4a: Leverage PMS Data to Prioritize Projects (2/2 points)*

  ADOT leverages PMS data and traffic counts to prioritize projects.

- *Requirement OM-07.4b: Leverage Life Cycle Cost Analysis (LCCA) to Predict Costs (2/2 points)*

  ADOT performs LCCA to predict short- and long-term costs every year.

- *Requirement OM-07.4c: Include Pavement Preservation in Annual Plan (1/1 point)*

  ADOT's STIP includes lump sum pavement preservation needs.

- *Requirement OM-07.4b: Link Pavement Repair, Preservation and Maintenance to Projects (2/2 points)*

  Pavement preservation and maintenance activities are linked to capital projects.

-Requirement OM-07.5: Sustainable Specifications
2/2 points

ADOT's pavement team always considers sustainable pavements for its projects. The sustainable pavements are used when they are the best option available.

ADOT Transportation Defined: Pavement Design Life

Pavement design life is a term that engineers use when they're planning to build a new road or maintain an existing roadway. They'll also use a number of years to go along with it, for example: 10-year pavement design life, 20-year pavement design life, etc.

The phrase should not be taken to imply that a road is only being built to survive for a set number of years. What it does represent is the road's age at which some preventative maintenance or reconstruction will be considered so the road can continue to be durable and useful for the traffic it's serving.

For a typical highway, ADOT generally will design asphalt pavement for 20 years. A lot is taken into consideration, soil condition, location, expected traffic levels and the area's climate. All those conditions play a role in how the pavement is designed. Say, for example, the road's being built in an area that gets very cold weather. If that's the case, engineers will adjust the asphalt pavement mix to account for the temperature extremes.

ADOT Quiet Pavement Program

One the real standout programs at ADOT is the Quiet Pavement Program. Back in the early 2000s ADOT started to hear from drivers who said certain stretches of Valley freeways seemed quieter than others. ADOT and the Maricopa Association of Governments (MAG) noticed a difference, too. It seemed that areas paved with an asphalt rubber friction course (rubberized asphalt), which MAG funded through the Regional Transportation Plan, were less noisy than freeway surfaces with cement concrete pavement. ADOT set out to determine whether the rubberized asphalt really did make any difference when it comes to noise abatement. ADOT officials also wanted to know whether the perceived noise-reducing properties of the rubberized asphalt would last as the pavement aged.

After some initial studies showed promise, ADOT, in connection with the Federal Highway Administration, developed the Quiet Pavement Pilot Program in 2003.

A three-year, $34 million project to surface about 115 miles of Phoenix-area freeways with rubberized asphalt is working toward a smoother ride for motorists and quieter neighborhoods for those who live adjacent to the roads.

The first areas to receive the “quiet pavement” were on the Loop 101 Agua Fria Freeway from Union Hills Drive to 31st Avenue, and on the Loop 101 Pima Freeway from 21st Avenue to Tatum Boulevard and from Frank Lloyd Wright Boulevard to Mountain View Road. State Route 51 was resurfaced from Shea Boulevard to Bell Road. The entire Loop 101 and SR 51 freeways plus sections of Interstate 10, Interstate 17 and the Loop 202 Red Mountain and Santan freeways will also receive new rubberized asphalt surfaces.

What Is Rubberized Asphalt?

Rubberized asphalt has been used for more than 20 years to resurface highways and city streets in Arizona when pavement surfaces reach their normal life expectancy. While it helped reduce the disposal of used tires, it recently has been recognized for its reduction of traffic noise.

Description of Rubberized Asphalt

Rubberized asphalt consists of regular asphalt paving mixed with “crumb rubber" which is ground, used tires that would otherwise be discarded or take up space in landfills. Used tires are processed by separating the casings, fabric and steel. The extracted rubber then is pulverized to the consistency similar to that of ground coffee. Rubberized asphalt has the benefit of being smoother and quieter. Noise readings have shown the rubberized asphalt generally reduces tire noise by an average of 4 decibels.

Approximately 1,500 tires are used for every lane-mile of rubberized paving, which can put a major dent in the 2 million used tires that are generated annually in Maricopa County.

Rubberized Asphalt Is Temperature Sensitive

Rubberized asphalt cannot be applied during cold weather or very hot weather. The concrete pavement surface needs to be between 85 and 145 degrees Fahrenheit for the material to adhere properly. So rubberized asphalt can only be applied in the spring and fall in the Phoenix area, from March 15 to May 31 and from September 1 to November 15. Prior to application, contractors must repair pavement cracks, chips and joints and prepare the concrete surface for the rubberized asphalt overlay.

Financing

The Quiet Pavement Program was developed by ADOT in cooperation with MAG and area cities. The completion was over a three-year period and funded using $34 million from other regional projects.

Building a Freeway: Rubberized Asphalt
http://azdot.gov/media/blog/posts/2013/07/26/building-a-freeway-rubberized-asphalt

Rubberized asphalt reduces noise, helps environment
http://azdot.gov/media/blog/posts/2011/04/21/rubberized-asphalt-reduces-noise-helps-environment

ADOT sustainable application types

Treatment	Description	Economic	Social	Environmental
Crack Filling	Placement of adhesive material	Life : Low Cost: Low	Aesthetics/Roughness	Low
Crack Sealing	Placement of adhesive material	Life : Low Cost: Low	Aesthetics/Roughness	Low
Asphalt Patching	Localized structural distress	Life : Medium/Low Cost: Medium/Low	Aesthetics/Roughness	Low Variable
Fog/Seal Rejuvenators	Very light asphalt emulsion application	Life: Low Cost: Low	Improved Aesthetics	Medium Variable
Chip Seal	Sprayed application/subsequent chips	Life : Medium/Low Cost: Medium/Low	Improved Friction/Roughness	Medium High
Slurry Seal	Mix of well-graded aggregate/emulsion	Life : Medium/Low Cost: Medium/Low	Aesthetics/Improved Friction	Medium
Microsurfacing	Crushed, well graded aggregate/emulsion/multiple course	Life: Medium/High Cost: Medium	Aesthetics/Improved Friction	Medium Variable
Hot In-Place Recycling	Heat or mechanically loosening within top 2"	Life: Medium/High Cost: Medium/High	Aesthetics/Ride Quality/Friction	Medium High
Cold In-Place Recycling	Milling and sizing reclaimed asphalt pavement (RAP)	Life: Medium/High Cost: Medium	Aesthetics/Ride Quality/Friction	Medium Variable

End of life sustainable pavement applications decision making (replacing recycled applications)

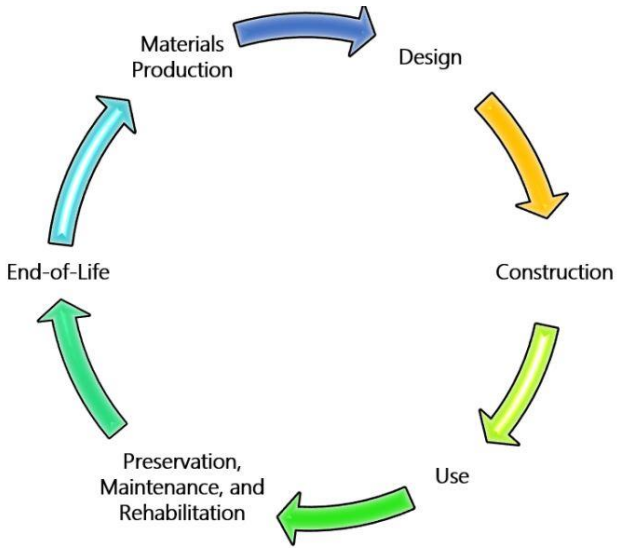
- If the pavement is extremely deteriorated and the residual asphalt content is too low then it is not a candidate for a second round of recycling with a rejuvenation agent. The only option is to Remove and Replace with newly produced AC pavement.

- If the pavement is deteriorated and the residual asphalt content is determined to be sufficient then it is a candidate for a second round of recycling with a rejuvenation agent.

FHWA Sustainable Pavements Tech Brief

In October 2014, FHWA issued a TechBrief on Pavement Sustainability (HIF-14-012)[3]. FHWA defines a sustainable pavements as one which "achieves its specific engineering goal" (i.e., meeting accepted performance standards) while meeting "basic human needs," using "resources effectively," and preserving/restoring ecosystems. FHWA notes that this is an aspirational goal to evolve toward, but is "not yet fully achievable".

Figure 2. Pavement Life-Cycle Phases (Source: FHWA)



Pavement sustainability, as defined by FHWA, is meant to involve every phase of the pavement life cycle, including 1) materials production, 2) pavement design, 3) construction, 4) use, 5) preservation, maintenance, and rehabilitation (the main emphasis of INVEST OM-07), and 6) end-of life.

FHWA notes that measuring pavement sustainability is often critical to the improvement of practices and achievement of objectives, and cites four main methods of measurement: 1) performance assessment (e.g., condition ratings, structural capacity, ride quality, etc.), 2) life-cycle cost analysis (evaluation of the "total cost of an investment over its entire life"), 3) life-cycle assessment (quantification of the environmental impacts of pavements over their life spans), and 4) rating systems, such as INVEST and Greenroads[4].

FHWA recognizes that most sustainable pavement investments will entail consideration of tradeoffs and suggests a decision-making framework that includes: 1) priorities and values of the organization or project, 2) performance ("the ability to serve an intended use"), 3) cost and benefit (focused on economic considerations), 4) impact magnitude and duration (of both positive and negative impacts), 5) risk (the degree to which the costs and/or impacts are uncertain), and 6) broad impacts in time and space (the extent to which decisions have impacts "beyond their immediate purpose").

Sustainability best practices suggested by FHWA involve "activities that result in life-cycle reductions in 1) the quantities of non-renewable resources consumed either as fuel or as direct materials, 2) the amount of greenhouse gas (GHG) emissions generated and 3) … ecological impacts." Suggested practices are organized into the following categories:

- **Materials.** Practices that aim to reduce energy and emissions while maintaining or enhancing performance. Generally, these practices a) reduce the use of virgin materials through the use of recycled, co-product, and waste materials, b) improve mix design to enhance longevity, and/or c) improve the efficiency of materials production to reduce impacts, including emissions.
- **Pavement Structural Design.** Practices include a) considering life cycle implications in decision-making, b) applying innovative pavement types and materials, and/or 3) improving structural

[3] http://www.fhwa.dot.gov/pavement/sustainability/hif14012.pdf
[4] https://www.greenroads.org/

design (leading to improvements in performance and longevity) through the application of new tools and techniques.

- **Construction Considerations to Improve Pavement Sustainability.** Practices generally focus on pavement quality, which impacts the performance and longevity across the pavement life cycle. Suggested best practices include a) allowing the use of sustainability best practices, as appropriate, b) reducing fuel consumption, energy use, and GHGs involved in construction, and/or c) improving construction quality.
- **Maintenance and Preservation Practices.** Includes practices that result in a) keeping pavements smoother for longer durations, which enables better fuel efficiency for roadway users, and b) extending the service life of pavements, resulting in material reductions over time.
- **End-of Life Considerations.** Practices that a) delay the need to repave or reconstruct (extending the usable life of pavements) and/or b) involve pavement recycling or reuse.

Next Steps for Arizona DOT

FHWA's reference document, entitled *Toward Sustainable Pavement Systems* (January 2015), elaborates and expands on these concepts and practices[5]. Although ADOT received all points available in the INVEST OM-07 scoring process, the agency recognizes that further sustainability gains can be achieved, particularly by leveraging recent FHWA research and resources. ADOT hopes to partner with FHWA to pilot a selection of suggested sustainable practices and to further recognize sustainable pavement innovations and applications by ADOT staff. The ADOT Pavement Group would like to try an Ultra-Thin Bonded Overlay (UTBO) (1/2" to 5/8") as an alternative to a ½" Friction Course in areas that have high turning movements. A Friction Course has a tendency to scrub off quickly in urban conditions. A few UTBO projects were done 10± years ago and it's time to try again.

The 2016 goal also includes the launching of a sustainable pavement systems program.

[5] http://www.fhwa.dot.gov/pavement/sustainability/hif15002/hif15002.pdf

Appendix F - Roles & Responsibilities

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