Arizona Department of Transportation

Digital Delivery Program Implementation Plan

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Submitted by: HDR Inc.

ADOT

Foreword

The transportation industry is often seen as a system of physical infrastructure comprised of roads and bridges. At the Arizona Department of Transportation, we understand that to continue providing people of Arizona with the safest and most efficient transportation system, we must continue to advance our use of digital technology to design, deliver, construct, and maintain the physical transportation infrastructure.

We owe it to Arizonans to keep up with technologies that can potentially help address some of the significant project delivery challenges, including unforeseen risks that can create costly delays and uncertainty. For example, with today's digital technologies, transportation engineers can create visualizations that will foster collaboration and coordination with stakeholders well before groundbreaking. That can save time and increase efficiencies that were previously unavailable.

In 2022, ADOT developed a Digital Delivery Roadmap with a goal of using 2D and 3D modeling technology and digital delivery documentation on construction projects as soon as 2026. This Digital Delivery Program Implementation Plan further defines how ADOT plans to make that goal a reality.

This effort requires collaboration amongst ADOT people and programs, as well as partnership with a variety of stakeholders including the contractors and consultants who work with ADOT every day to deliver for Arizonans. We look forward to engaging with the many interested groups to fully realize the promise of digital delivery for Arizona's transportation system.

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Acronyms

2D	2-Dimension
3D	3-Dimension
ACEC	American Council of Engineering Companies
ADOT	Arizona Department of Transportation
AGC	Associated General Contractors
AMG	Automated Machine Guidance
ASCE	American Society of Civil Engineers
BIM	Building Information Management
bSI	buildingSMART International
CAD	Computer Aided Drafting
CDE	Common Data Environment
CMAR	Construction Management at Risk
COTS	Commercial Off-The-Shelf
CRS	Coordinate Reference System
DDDGS	Digital Delivery Design Guidelines & Specifications
DDEP	Digital Delivery Execution Plan
DDGC	Digital Delivery Governance Committee
DDP	Digital Delivery Program
DDSC	Digital Delivery Steering Committee
DDR	Digital Delivery Roadmap
DDTC	Digital Delivery Technical Committee
DOT	Department of Transportation
FAST	Field Office Automation System
FHWA	Federal Highway Administration
FIO	For Information Only
FIS	Feature Inventory Systems

FTE	Full Time Equivalent
GIS	Geographic Information System
GNSS	Global Navigational Satellite Systems
ITG	Information Technology Group
LDPS	Low Distortion Projection System
LOD	Level of Development
LOIN	Level of Information Need
MALD	Models As Legal Documents
MEBS	Model Element Breakdown Structure
NIBS	National Institute of Building Sciences
ORD	OpenRoads Designer
OBD	OpenBridge Designer
PDF	Portable Document Format
PeCoS	Performance Control System
ROW	Right of Way
SME	Subject Matter Expert
SUE	Subsurface Utility Engineering
TSMO	Transportation Systems Management and Operations
UAS	Unmanned Aerial Systems

Introduction

What is Digital Delivery

Digital Delivery refers to a modernized process for the design and delivery of digital data such as 3D models to enhance design, construction, and asset management. For years, transportation agencies have relied heavily on printed 2D plans for roadway and bridge projects. However, an ongoing shift towards digital delivery is changing the way projects are delivered and constructed, leaving 2D plans behind. Overall, digital delivery is becoming increasingly essential for transportation agencies as it offers a more efficient, accurate, and cost-effective way of delivering construction projects.

A Digital Transformation

The Arizona Department of Transportation (ADOT) is implementing digital delivery, which is about sharing asset information, such as design data, and feature attributes using digital workflows.

Today, people associate the word "digital" with paperless. But in reality, there are two separate terms with different connotations:

Electronic Workflows

are paperless, but document-based deliverables for people.

Digital Workflows

are a sequence of activities, that leverage data-based exchanges resulting in deliverables that can be consumed by computer systems, software, and automated equipment.

Overview

The adoption of digital delivery in the transportation construction industry has been steadily increasing. As advancements in digital technology continue to progress at a rapid pace, ADOT is working towards the adoption and implementation of a phased systematic approach to digital delivery statewide. This paperless delivery system has quickly become a "must-have" as it offers numerous advantages over traditional paper-based delivery methods.

The Digital Delivery Program (DDP) establishes objectives and guidelines to help ADOT achieve its goals while continually adapting to this evolving technology. The DDP will streamline the processes from inception through project delivery. The value of digital delivery lies in its ability to improve collaboration, increase efficiency and sustainability, and enhance visualization allowing projects to be completed on time, within budget, and to the highest level of quality.

ADOT Digital Delivery Program

A Department initiative to leverage advancements in digital technology to design, deliver, construct, and maintain the Arizona Transportation Management System.

Vision and Mission

ADOT'S VISION: By December 31, 2025, construction projects will be designed and bid using 2D and 3D modeling technology with digital delivery of design documentation, and no longer deliver projects in a traditional construction plan format.

THE MISSION of the DDP is to enable continued modernization of the project delivery process to improve design quality, reduce risk, improve design and construction efficiencies, while managing data integrity of signed and sealed digital deliverables. A secondary desired outcome is to enhance the management of asset information post construction.

Objectives

DEVELOP STANDARDIZED AND ACCESSIBLE digital delivery standards and processes, guidance documents, training, and tools to support all project development functions by all stakeholders.

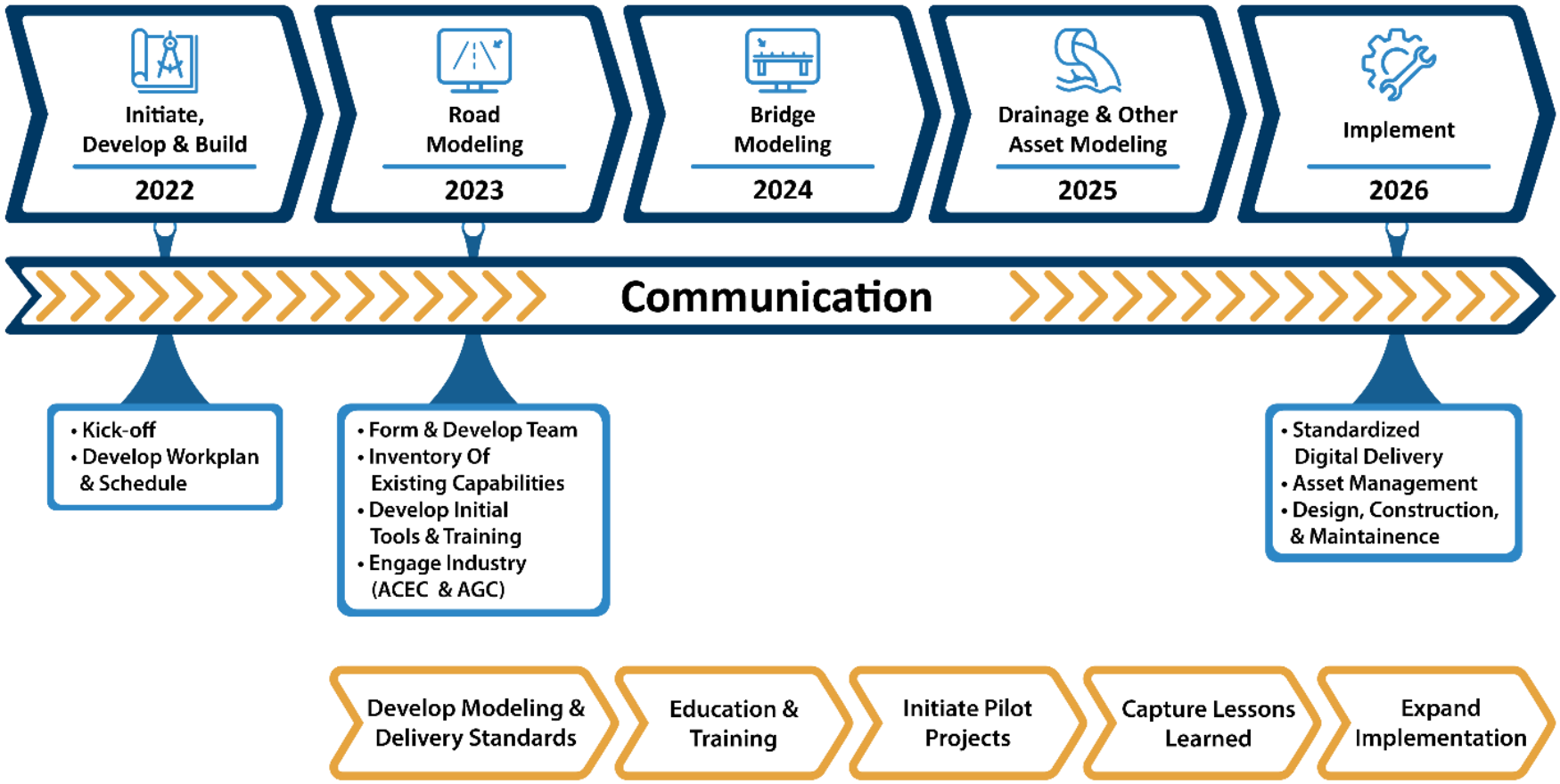
USE 2D AND 3D DIGITAL TECHNOLOGIES to create high quality, data-rich models of projects and systems, by capturing historical, present, and future data through project deliverables.

DEVELOP AND IMPLEMENT new information management processes that capture asset information from projects and use it to improve construction inspections and asset management capabilities.

Multi-Year Roadmap

The DDP is guided by a Digital Delivery Roadmap (DDR), illustrated in Figure 1, that includes a series of activities set for completion by the end of 2025 and, long-term recommendations to sustain the program into the future. The first step was to assemble a team to oversee the program that will ultimately launch ADOT further into the future as digital delivery becomes a primary business practice. It is expected that ADOT will be positioned for implementation by calendar year 2026 and will begin working on a framework for the collection of digital as-built records to support operations and maintenance activities.

Figure 1. Multi-Year Roadmap



Alignment with Key Initiatives

ADOT has five teams working on key initiatives that share similar goals and objectives to leverage modern technology and digital workflows as the DDP. The DDP team will work with technical leads from these initiatives to align objectives and avoid duplication of efforts and/or gaps in data management.

Bentley OpenX Software Deployment: ADOT is in the process of upgrading from legacy Microstation computer aided drafting (CAD) and InRoads engineering design software to the suite of OpenX products, including OpenRoads Designer (ORD), OpenBridge Designer (OBD), and exploring the use of OpenGround as a geotechnical database.

Implementation of Low Distortion Projection Zones: ADOT is working on defining a low distortion projection system (LDPS) that will replace the current State Plane system. A pre-defined LDPS will minimize the linear distortion of the topographic surface over large areas. A LDPS will also increase data transferability between design and GIS systems.

Field Office Automation System (FAST) Replacement: ADOT is in the process of evaluating a replacement for FAST, which is ADOT's legacy construction administration and management system. The initiative includes preparing a software replacement strategy and roadmap, followed by procuring a new construction management system.

Performance Control System (PeCoS) Database Replacement: ADOT is currently evaluating a replacement for PeCoS, which is ADOT's Maintenance Management System. The initiative includes preparing a software replacement strategy and roadmap.

ArcGIS Pro Implementation: ADOT is in the process of migrating from the ArcGIS to the ArcGIS Pro platform. The Geographic Information Systems (GIS) group is working with various business groups to identify data that can be displayed through a GIS interface.

Organizational Structure

The ADOT DDP is an initiative that will require a large team to oversee, manage and execute activities necessary to achieve the vision of the program and sustain it long-term. The DDP currently has a small executive team composed of one Deputy Director and two Deputy State Engineers including the DDP Executive Champion that will provide leadership support.

The DDP Champion will work directly with the DDP Leads who are responsible for the project management and coordination of work, activities, and schedule to successfully develop and setup the program.

The DDP Leads will work with three separate committees to execute this implementation plan and help transition the initiative to a long-term program. The DDP Leads will also work with the consultant team assisting ADOT with the development and execution of the implementation plan.

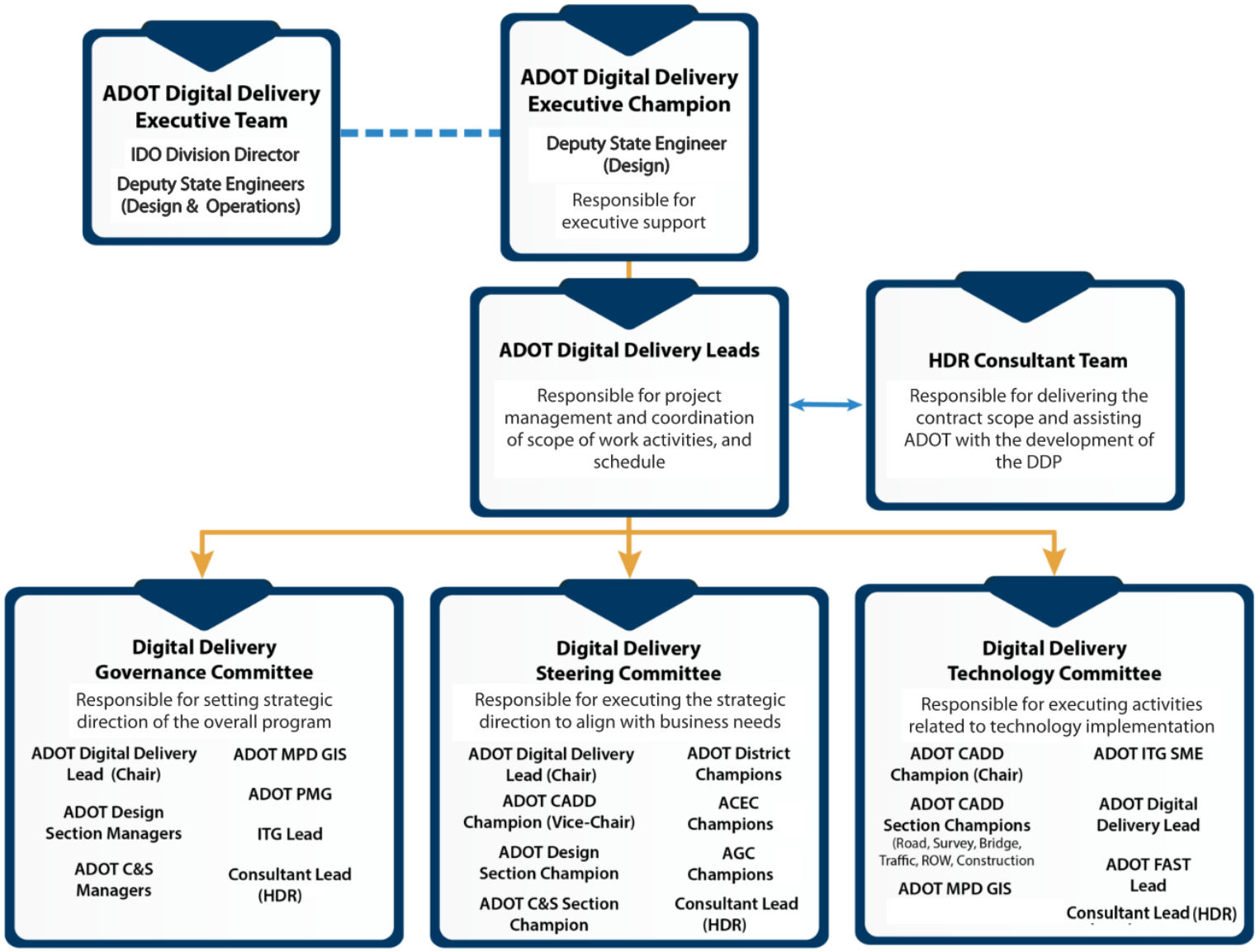
The three DDP committees that will work with the DDP Leads include:

- The **Digital Delivery Governance Committee** (DDGC) is responsible for setting strategic direction for the overall program.
- The **Digital Delivery Steering Committee** (DDSC) is responsible for executing the strategic direction to align with business needs.
- The **Digital Delivery Technical Committee** (DDTC) is responsible for executing activities related to technology implementation.

Each committee will have a chair and a vice-chair that will work with their committee members representing their areas of expertise to execute the initial activities in this plan and establish strategies for long-term maintenance.

The current ADOT DDP organizational structure is illustrated in Figure 2. Appendix A provides recommendations to establish a permanent organizational structure for digital delivery.

Figure 2. DDP Organizational Structure



Readiness Assessment and Focus Areas

A readiness assessment was conducted utilizing data collected from a variety of methods including a cursory review of manuals and documents, Project Delivery Academy videos, communication between stakeholders, software documentation, and interviews with ADOT subject matter experts (SMEs). The readiness assessment revealed six focus areas: strategy, people, digital delivery use, process, data, and technology.

Strategy

Continue executive leadership support to achieve the ADOT DDP vision and objectives. Specifically,

- **Vision & Objectives:** ADOT will review and update its DDP vision and objectives throughout the implementation period to align with ADOT's mission, strategy, and culture.
- **DD Champion(s):** ADOT will consider re-organizing and structuring an interim DD organizational structure.
- **Management Support:** ADOT has essential management support and will continue to explore options to add resources to establish a permanent (long-term) program with a dedicated organizational structure.
- **DD Committees:** ADOT will review the proposed membership of DD committees to include representation from all disciplines.

People

Keep stakeholders informed and engaged, dedicate staff to assist with the deployment of digital delivery activities, and provide training that is specific to job tasks. Specifically,

- **New Roles and Responsibilities:** ADOT will consider proposed roles and responsibilities and add key positions to support digital delivery (Appendix A) as part of this implementation plan.
- **Organizational Hierarchy:** ADOT will consider establishing a permanent organizational hierarchy to oversee development and execution of the program long-term similar to Appendix A.
- **Education:** ADOT will need a strong communication and engagement plan to educate all stakeholders. The communication and engagement plan outline (Appendix B) will be expanded into a full plan.
- **Training:** ADOT will need specific training to implement new methods, procedures, and technology by functional task. The training plan (Appendix C) will be used as the guide for the development of digital delivery training under this implementation plan.
- **Industry Receptiveness:** ADOT will collaborate with industry to find solutions to challenges and leverage the best opportunities for improvement. An industry survey was conducted to capture initial industry input. Survey responses are available in Appendix D.

- **Change Readiness:** ADOT will need to implement a strong change management strategy and continue encouraging a culture of innovation and acceptance to change. A change management strategic plan is one of the activities within this implementation plan.

Define and prioritize how digital delivery will be implemented on construction projects as defined guidance. Given ADOT's highest priority is to deliver models as legal documents (MALD), the following use cases will be undertaken first:

- **Existing Condition Modeling:** The process of documenting existing conditions for a project to form the basis of design and construction. Existing condition models may include digital terrain models or surfaces, surface features such as edges of pavements, utility features and structures, subsurface features such as existing pavement layers and geotechnical characteristics, and discrete elements, such as signs and fences. The existing conditions may be captured using a variety of technologies to produce 2D and 3D elements, such as traditional photogrammetry, robotic total stations, global navigational satellite systems (GNSS), unmanned aerial systems (UAS), and lidar scanning. The digital data products may include CAD files, GIS and raster files, and reports.
- **Design Authoring:** The process of developing a digital model to define and document the design. The model may contain 2D and 3D geometry depending on the modeling requirements. Typically, individual disciplines (e.g., roadway, structures, drainage, etc.) develop a discipline model using a common coordinate reference frame. The individual discipline models are then referenced together into a single, federated model. ***This is an essential model use case that supports many downstream uses.*** The digital data products may include CAD files, spreadsheets, raster files, and reports. An important and critical step to enable this use case to deliver the model as the legal document (MALD) files is to determine the process of gaining legal approval through the state by allowing digital sign and seals of models, files, and other data by a registered professional (e.g., engineer, surveyor, landscape architect).
- **Contract Documents:** The process of documenting the existing conditions, proposed design, construction specifications, and engineer's cost estimate for the purposes of bidding and construction. Currently, the process uses documents such as plans, specifications, and other documents. With digital delivery, plans could be replaced with digital data which may be comprised of 2D and 3D geometry, tabular data, and documents. The digital data products may include CAD files, spreadsheets, and reports. For this use case to be successful, ADOT will need to standardize the expectations and deliverable requirements for documents, files, models, and other digital data for each type of project.
- **Visualization:** The process of creating visual representations of the project to communicate with technical and non-technical stakeholders throughout the project lifecycle. The digital data products may include CAD files, other types of 3D models, raster files, and videos.

- **Clash Detection and 3D Coordination:** The process of using software to analyze a federated model of design models using rule sets to identify conflicts between design elements. 3D coordination also includes performing a visual analysis to identify potential spatial design issues. 3D coordination may also refer to referencing discipline models into a federated design model to exchange design information between disciplines. The digital data products may include CAD and GIS files, spreadsheets, and documents (i.e., conflict reports).
- **Engineer's Cost Estimate:** The process of calculating quantities from the design according to a schedule of bid items and estimating a price for each bid item to estimate the construction cost. The digital data products may include CAD files, spreadsheets, and documents, such as a database of historic bid prices that can be queried by location and pay item number.
- **Construction Inspection (Verification, Documentation & Acceptance):** The process in which a construction inspector accesses the design information in the contract models to verify that the project is constructed per plan and in accordance with the pay item quantities and specifications. Acceptance includes accessing material testing results and comparing them to the specifications. If there are deviations to plan, quantities, and/or specification, then the inspector initiates the appropriate remedy, which may include creating a record of the as-built condition. The digital data products may include CAD files, spreadsheets, and documents.
- **Record As-Built Model:** The process of documenting any changes to the contract models, specifications, and quantities in a comprehensive record of the as-built condition. Capturing digital as-built records will include updates to the design models and shop models to reflect the as-built condition, including location and attributes about the constructed asset. The digital data products may include CAD and GIS files, spreadsheets, and documents (e.g., inspection forms, certification materials, warranties, etc.).

Note: Use cases for operational and maintenance activities will be deferred to future years.

Processes

Document processes that enable workflow efficiencies and serve as instructions for project teams piloting the project delivery use cases. Specifically, creating procedures for setting up projects, managing files, modeling specific design aspects, performing design and quality management reviews, preparing files for milestone submittals, and setting up bidding and construction management systems with digital models.

Document organizational digital workflows that will be deferred to a future initiative. This may include enterprise data governance and management of digital data and workflows to connect the various systems.

Data

Create data standards to produce, manage and exchange digital information for project development and delivery use cases. Specifically:

- **Model Element Breakdown Structure:** ADOT will adopt a Model Element Breakdown Structure (MEBS) to organize model objects based on the IFC schema as a foundation. This will enable ADOT to pilot the use of proprietary digital models in the near future, but also to be well positioned to adopt open data standards to transfer non-proprietary file format between the Bentley software and the contractor software of choice.
- **Level of Development:** ADOT will evaluate industry, AASHTO, and other peer State DOTs level of development (LOD) guidelines as a starting point for its modeling standards. The LOD to be defined for each milestone submittal will be an important element to implement digital delivery for project development and construction.
- **Level of Information:** ADOT will evaluate buildingSMART International (bSI) Level of Information Need (LOIN) specifications for applicability to ADOT digital delivery priority use cases. A similar approach in defining LOD applies for LOIN. LOIN should align with the information needs supporting priority use cases and stakeholder needs. ADOT will establish information requirements to support the project development use cases. Information requirements for operations and maintenance use cases will be established in the future.

Technology

Optimize current software and hardware and explore new tools within ADOT's technology portfolio. Specifically:

- **Software:** ADOT will explore and evaluate technology available through ADOT's current contracts with Bentley and Trimble. Digital Delivery Leads will coordinate closely with ADOT's Information Technology Group (ITG) to assess opportunities to leverage contract credits for setup and configuration of the various Bentley products or to assist ADOT with the development of training material. Also, ADOT will determine any additional cost to access more licenses or different products available to ADOT, not currently budgeted.
- **Hardware:** ADOT will consider assessing current hardware against industry trends and other State DOT's or industry partners to establish recommendations to procure computers to support specific needs. For example, survey staff processes big data sets that may need a computer that has more power and higher visualization cards to enable efficient workflows to produce files for their customers. Hardware also includes the IT infrastructure such as bandwidth and storage capacity on the network or common data environment for project work. Specifically, ADOT will explore the use of ProjectWise Connect, ProjectWise Design Review, and Bentley Synchro.

Implementation Approach

This implementation plan has been designed to bridge the gaps identified during the gap assessment for successful implementation of digital delivery. The proposed tasks and associated activities within this implementation plan fall under the following categories:

- **Task 1 - Communication and Engagement:** This task includes two subtasks:
  - *Subtask 1.1* - Developing a detailed communication and engagement plan (Appendix B) and will be a continuous activity during and after the DDP implementation.
  - *Subtask 1.2* - Engaging with the Arizona Board of Technical Registration to determine how the signing and sealing process will need to change to enable digital deliverables.
- **Task 2 - Assessment and Development of Bentley Products:** This task includes three subtasks:
  - *Subtask 2.1* - Assessing all the Bentley products needed for digital delivery to identify gaps that need to be addressed to enable production of digital deliverables for every discipline design that is typically included in the contract plans.
  - *Subtask 2.2* - Setting up and developing the necessary components within the software to enable model-based design for every discipline that is typically included in the contract plans.
  - *Subtask 2.3* - Evaluating and setting up Bentley ProjectWise Connect (model/file management system), Bentley ProjectWise Design Review (program for reviewing model-based design), and Bentley Synchro (program for construction engineering and inspection using model-based deliverables).
- **Task 3 - Development of Digital Delivery Standards and Procedures:** This task includes three subtasks, which will be conducted using a phased-approach to facilitate the delivery of pilot projects:
  - *Subtask 3.1 - Updating the Engineering Survey Specifications and Practices Manual*, will include developing specifications for levels of accuracy, point density and resolution, as well as procedures for validating the standards have been met.
  - *Subtask 3.2 - Developing Digital Delivery Design Guidelines & Specifications*, which will include topics such as model development concepts and terminology, modeling requirements by milestone deliverables specific to each discipline (such as LOD and LOIN requirements) and quality management strategies and procedures to review digital deliverables.
  - *Subtask 3.3 - Developing Digital Delivery Construction Engineering & Inspection (CE&I) Guidelines & Specifications,* which will include topics such as an overview of digital deliverables and file management protocols, guidance on accessing project information within the contract model, including, but not limited to geometry, terrain, and location information (e.g., station/offsets), elevations, pay items and quantities. The document will also include procedures for transferring information to and from field devices, addressing updates to the model during construction, and measuring pay item quantities.
- **Task 4 - Development and Delivery of Training:** This task includes two subtasks:
  - *Subtask 4.1* - Developing training material identified in the Training and Tool Development Plan (Appendix C). Some of the content developed during Task 3 may be used as training material or to augment any training material developed as part of Task 4.

  - *Subtask 4.2* - Delivering "just-in-time" training to project teams engaged in pilot projects.
- **Task 5 - Pilot Projects:** This task includes a series of subtasks necessary to support project teams engaged in pilot projects. All of the content developed in previous tasks will be used to assist project teams that will produce model-based deliverables. Subtasks for Task 5 will be specified in the future based on each pilot selected for digital delivery.
- **Task 6 - Digital Asset Management Implementation:** This task includes three subtasks:
  - Subtask 6.1 - Developing information requirements for digital as-built surveys to be added to the Engineering Survey Specifications and Practices Manual.
  - Subtask 6.2 - Developing technology and processes to collect model-based digital as-builts.
  - Subtask 6.3 - Developing and implementing a data governance and management plan for digital workflows to facilitate asset management decisions.

The tasks will be carried out using a phased approach with many of the subtasks happening concurrently to reach the target goal of digital delivery implementation by 2026. Figure 3 illustrates a high-level schedule for each task listed above.

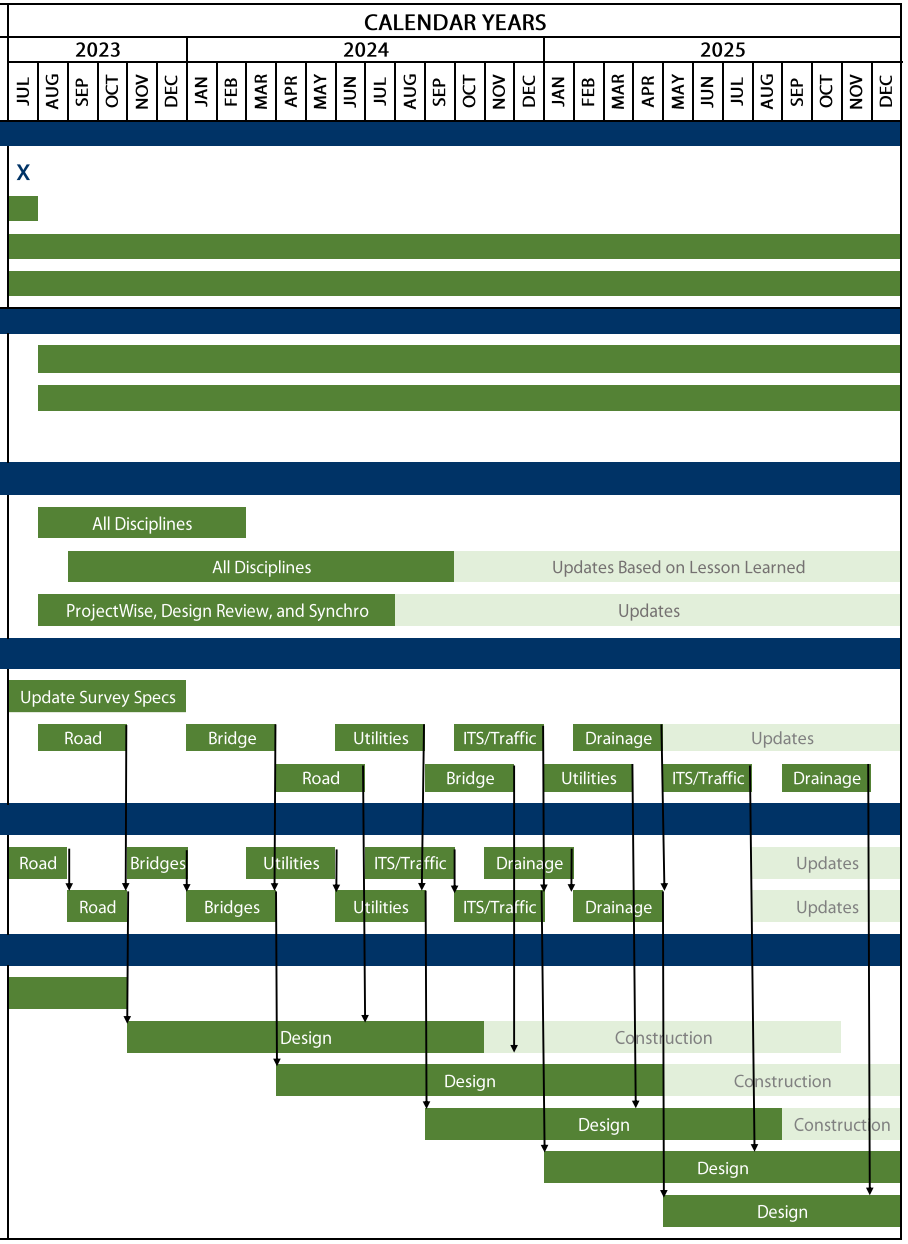
Schedule Assumptions

- This implementation plan includes activities to achieve ADOT goals within calendar years 2023-2025. Tasks 6.2 and 6.3 are listed in the schedule but go beyond the scope of this primary initiative.
- Resources will be available to concentrate on their respective activities.
- Timeline is based on ADOT full-time equivalent (FTE) resources, consultant team(s), and Bentley staff to assist with:
  - The assessment, development, and updates to Bentley products.
  - The development digital delivery standards and procedures.
  - The development and delivery of training material.
- Multiple teams will be working concurrently on all tasks.
- The implementation team will:
  - Leverage modeling standards and digital delivery guidelines from other State DOTs, and Bentley online training material as a starting point for training pilot project teams.
  - Conduct tasks and activities using numerous iterations and incremental steps, which will prioritize on workspace development, standards, best practices, and training specific to each pilot project.
  - Make continuous updates to the DD standards and procedures documents throughout the duration of the initiative.
- Technical Committee will have the authority to make day-to-day decisions regarding the task activities to meet the schedule.
- Design phase for each pilot project will last no more than 12 months and will be finished before 2025.
- Construction phase for each pilot project is assumed to last 12 months, bue it may extend beyond 2025.

Schedule of Activities

Figure 3. Proposed High Level Schedule for ADOT's DPD Implementation Plan for Tasks 1-5 (2023-2025)

TASKS AND ACTIVITIES	START	END
Task 0. Digital Delivery Project Management		
Project Kickoff	Aug-23	N/A
Develop Working Groups	Jul-23	Jul-23
Monthly Progress Reports (throughout initiative)	Jul-23	Dec-25
Committee Meetings (TBD, throughout initiative)	Jul-23	Dec-25
Task 1. Communication and Engagement		
Subtask 1.1. Prepare and Execute Communication and Engagement Plan	Aug-23	Dec-25
Task 1.2. Evaluate and Establish the Rules, Processes and Technologies for Signing and Sealing Contract Digital Deliverables	Aug-23	Dec-25
Task 2. Assessment, Development and Updates to Bentley Products		
Task 2.1 Assessment of Current ADOT Bentley Workspaces	Aug-23	Feb-24
Task 2.2 Develop/Update ADOT Bentley Workspaces per Assessment	Sep-23	Sep-24
Task 2.3 Evaluate and Setup Additional Bentley Products to Support DPD	Aug-23	Jul-24
Task 3. Development of Digital Delivery Standards and Procedures		
Task 3.1 Update Engineering Survey Specifications and Practices Manual	Aug-23	Dec-23
Task 3. 2. Develop Digital Delivery Design Guidelines and Specifications	Sep-23	Apr-25
Task 3. 3 Develop Digtial Delivery CE&I Guidelines and Specifications	Apr-23	Nov-25
Task 4. Develop Training Materials		
Task 4. 1 Develop Training Materials for Knowledge Base Courses	Jul-23	Jan-25
Task 4. 2 Develop Training Materials for Modeling Software & Skill Set Courses	Sep-23	Apr-25
Task 5. Conduct Pilot Projects		
Selection of Pilot Projects	Jul-23	Oct-23
Pilot #1. Alignment, Pavement and Earthwork Features (MALD)	Nov-23	Oct-24
Pilot #2. Bridge Fetures MALD	Apr-24	Mar-26
Pilot #3. Utility Features MALD	Sep-24	Dec-26
Pilot #4. ITS and Traffic Featues MALD	Jan-25	Dec-26
Pilot #5. Hydraulics and Drainage Features MALD	May-25	Dec-26



Key Success Factors

Strong Leadership and Executive Support: Implementing digital delivery at the enterprise level is not an easy task and requires reassurance that it is of utmost importance for ADOT. The DDP leadership will provide frequent communications about the progress of the initiative and opportunities for active involvement from all stakeholders.

Managing the Pace of Change: People are at the center of the digital delivery initiative, as they will be the ones learning new technologies and methodologies to perform their current functions. Activities within this implementation plan consider a phased approach to manage the pace of change. If the initiative moves too quickly, people may feel overwhelmed and frustrated because it is difficult to follow along. However, if the initiative moves too slowly, people may lose interest and feel frustrated because they are not seeing results.

Empower Pilot Project Teams: Creating a safe environment for innovation empowers staff to try different technologies and find opportunities for process improvements. While executive and management support is essential for success, allowing people to make decisions at the lowest levels of the implementation through the pilot projects will create a sense of ownership and accountability.

Partner with Industry: As the saying goes "it takes a village", and this is certainly true for digital delivery. Industry partners, such as consultants and contractors working on ADOT projects can provide support and assistance to ADOT through the initial digital delivery implementation and make improvements as the program matures over time.

Coordination and Communication: Implementing the activities set in this plan will require extensive coordination and communication with ADOT staff, government agencies, and business partners. The communication and engagement plan will serve as the guide for these activities.

Measuring Progress

The DDP leadership should establish a communication strategy and transparent processes to report progress. The following have been identified as the primary metrics for the DDP:

- Level of investment (e.g., resources, time, technology and/or funds) to establish, grow and sustain the ADOT DDP.
- Number of pilot projects (both in-house and consultant projects).
- Number of use cases being piloted.
- Number of ADOT guidance documents, and other publications being developed or updated.
- Time to access and set up software.
- Cost of new software licenses
- Number of software packages and technologies being explored and piloted.
- Number of meetings with various stakeholders.
- Number of training sessions and people being trained.
- Number of presentations (internal to ADOT or with external stakeholders and partners).
- Time to deliver a project should be considered as a metric in the future once staff has become proficient in modeling techniques.

Lastly, ADOT should consider reassessing the digital readiness score as another measure of progress.

Digital Project Delivery Implementation Phase

Figure 3 illustrates the high-level implementation tasks schedule (Tasks 1 through 6) that are required for ADOTs Digital Delivery Program Implementation 2023 through 2025. As such, Tasks 2 through 4 form the core components of the Digital Project Delivery Development Phase. Therefore, Figure 4 provides a more in-depth schedule for Tasks 2 through 4. This schedule provides a structured roadmap that outlines the tasks and their respective timelines. These tasks are crucial as they develop the foundation of the implementation and ensure that ADOT and their consultants and contractors have the necessary guidance and training that is required.

This section also delves into each task and subtask in more detail, providing a description of the work to be accomplished, importance and impact to the schedule, task goals and objectives, level of effort, resources needed, prerequisites, outcomes, and task schedules.

Considerations for Implementation

Change Management Strategy

Implementation of digital delivery is a complex task and a new methodology that brings much uncertainty to stakeholders affected by this digital transformation. ADOT DDP Leads will work with the steering and technical committees to implement change management strategies guided by the communication and engagement plan, as well as a phased approach for training staff and conducting pilot projects as described in this implementation plan. The ADOT DDP Leads will oversee the implementation plan in the short term and will work with ADOT leadership to identify and establish key positions to assist with change management strategies. Also, ADOT will explore establishing a permanent organizational structure to manage the DDP implementation and long-term governance of the program.

Technology Management

ADOT has an extensive portfolio of modern data collection tools for surveying applications, and a variety of software to support multiple use cases for digital delivery. ADOT DDP Leads, and the Technology Committee will work together to identify and assess products currently being underutilized, and coordinate with ADOT's ITG to explore and assess new products. Specifically,

- ProjectWise Connect will be evaluated as a potential Common Data Environment (CDE) for managing work in progress project files and as a platform for collaboration.
- ProjectWise Design Review will be evaluated as a real-time collaboration review tool in which reviewers may navigate the project federated model in a read-only mode, make comments, assign comments for resolution, and document the quality management review.
- Bentley Synchro platform will also be evaluated for model-based construction inspection. Synchro is a cloud-based application that enables construction teams (contractors and construction inspectors) access to the 3D models and other project files in a read-only viewing environment either through a web browser or a mobile application.

The ADOT DDP Leads will work closely with other ADOT teams working on Department initiatives looking at digital technologies and solutions related to project development and delivery of

construction projects. Specifically, the DDP Leads will work with the teams evaluating the replacement of the FAST and PeCoS systems, and the migration to ArcGIS Pro.

Digital Delivery Use Cases

A model use case determines what the project model(s) must be used for and thus defines the level at which the model or collection of models must be capable of performing. For example, if a model use case of design quantities is specified, then the model must contain ample information and detail to provide the correct quantification for each pay item. Each specific model use case is selected based on the goals of the project and may be used over multiple phases of a project. ADOT and its consultants may require different model use cases other than construction due to each entity having different objectives. Not all use cases may be used on a project. Definitions of model use cases can be found in Appendix E.

Pilot Project Guidance and Technical Support

ADOT will focus on high priority use cases for digital delivery. The ADOT DDP Leads will work with the steering and technology committees and other SMEs to focus on the development of training materials and procedural guidance and identify resources that provide continued technical support for pilot project teams prior to starting the pilot projects.

Lessons learned from other State DOTs that should be considered for ADOT's pilot project deployment:

- It is helpful to develop training materials and procedures ahead of beginning pilot projects. Project teams appreciate having "how-to" instructions as a reference for unfamiliar digital delivery workflows and best practices.
- Pilot project teams may benefit from weekly technical meetings in which the design team works through technical issues with an expert in modeling software and best practices for their discipline.
- It is important for an expert modeler familiar with ADOT's contract plans and modeling requirements to perform an independent model integrity review for each product being delivered by the pilot project teams. ADOT should consider additional project funding to allow design staff to spend more hours creating more detail models that will meet the expectations of the contractors. Also, additional staff time should be consider to perform independent model integrity reviews that will provide the right products for contractors.

Risk Management

Managing risk is a big component for transforming an organization from analog to digital workflows. A risk management strategy that documents potential risks, assesses impacts of risks, and identifies strategies for responding to each risk, using a risk registry, should be considered at the start of the implementation. The risk registry should be reviewed on a quarterly or semi-annual basis during the initiative to update or retire risks as work is completed.

Project Delivery Implementation Task Descriptions and Schedules

Introduction

The activities listed in this section are in sequential order as shown in the implementation schedule. Each of the tasks listed include:

- General description of the activities to complete, and importance in terms of criticality and impact to the success of the program if the activity is not finished within the sequence in the schedule.
- Goals and objectives of the ADOT DDP and focus areas identified to achieve ADOT's target digital maturity by the beginning of 2026.
- Desired outcomes describing the products that should be delivered at the end of the task.
- General level of effort in terms of resources and cost needed for completing the task, as well as the anticipated duration based on the complexity of the task.
- Types of resources needed in terms of skill sets required for completing the task. Resources may be in-house ADOT staff or consultants.
- Pre-requisites needed for performing the task.
- A task schedule to accomplish the work.

While not specifically indicated in each of the tasks, funding sources may come from the state budget or federal grants. It is important to recognize that the scope of work in this implementation plan is ambitious and has been prepared to meet the target goal of digital delivery implementation by 2026. ADOT will require a large team with diverse knowledge and technical expertise to oversee and execute the various tasks concurrently. For example, one team of SMEs may be working on the assessment and configuration of the software while another group of SMEs prepares training materials and assists the project teams in setting up each of the pilot projects. The DD Leads and Committees will need to establish strong communication and collaboration protocols to avoid duplication of work and verify that SMEs are prioritizing the development and delivery of standards, procedures, and guidelines to support pilot project teams.

Lastly, this implementation plan also assumes that ADOT will utilize other State DOTs or national standards, specifications, and training material, as well as applicable technology configuration as starting base for the ADOT DDP.

Task 1. Communication and Engagement

Task 1.1 - Prepare and Execute Communication and Engagement Plan

Description: The Communication and Engagement Plan identifies a list of stakeholders to engage during the implementation of the DDP. An annotated outline (Appendix B) describes the contents desired in the plan. The plan includes engagement strategies; methods, types, and frequency of communications; updates on implementation plan activities; strategies for requesting input; and mechanisms for identifying and resolving issues throughout the initiative.

Importance and Impact to Schedule: While the communication and engagement plan does not impact the pilot projects directly, it is an important activity to start as soon as possible. This activity is considered important for change management and will assist ADOT in keeping the momentum of the initiative going. Change management was identified as one of the success factors for implementation of digital delivery by peer State DOTs.

Table 1. Task 1.1 - Prepare and Execute Detailed Communication and Engagement Plan

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop and implement new information management processes	**People** - Education, Change Readiness, and Industry Receptiveness	Stakeholder communication and engagement plan that includes key messages, tools, and tactics. Visual Identity for DDP (Colors, Messaging, Google Products, Graphics, etc.) Infographic summarizing high level roadmap, goals, and key activities.
Level of Effort	**Resources Needed**	**Pre-Requisites**
Low level of effort **Low cost** **Short duration**	Strategic communication professionals (in-house or consultant staff). Funding for developing the plan if using a consultant. ADOT DDP team to review and approve plan	None

Task 1.2 - Evaluate, and Establish the Rules, Processes and Technologies for Signing and Sealing Contract Digital Deliverables

Description: One important engagement activity is to work with the Arizona Board of Technical Registration, industry, and SMEs to propose rule changes to the Arizona Administrative Code related to signing and sealing of digital deliverables by professional engineers, registered land surveyors, landscape architects.

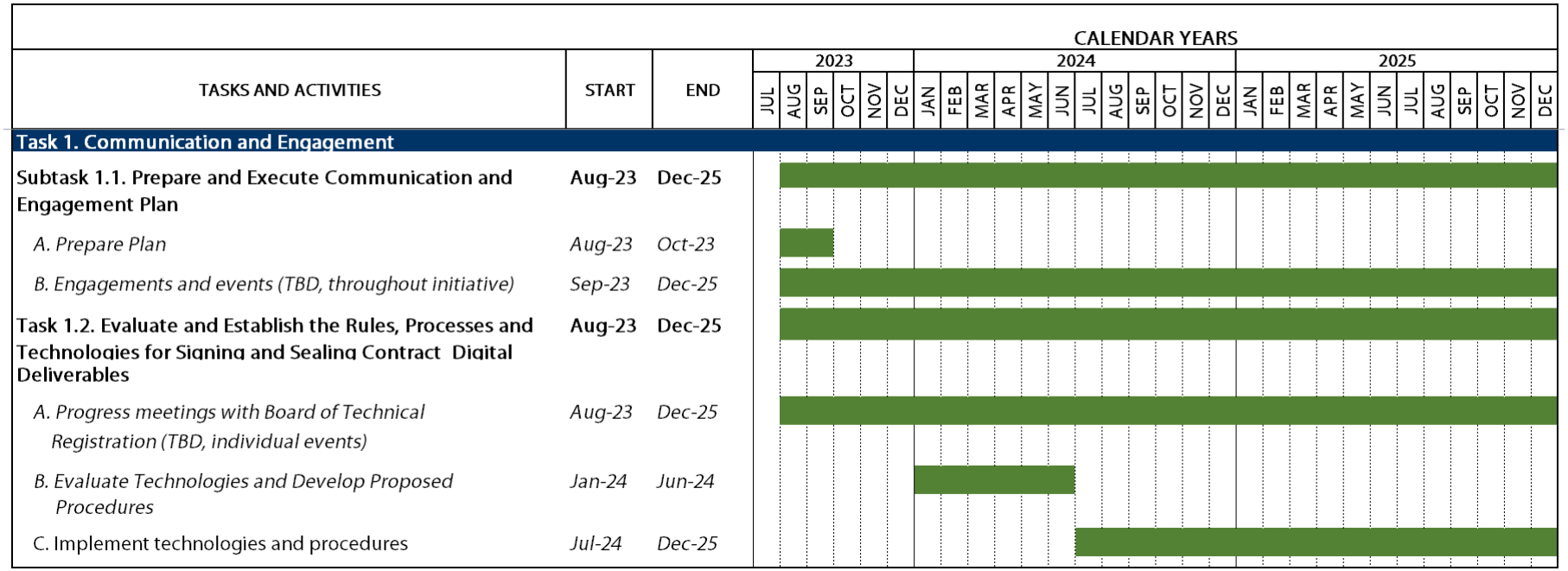
Importance and Impact to Schedule: This is an activity within the critical path for successfully implementing the ADOT DDP. A final rule change may not be needed to start the pilot projects, if it is allowed to use a temporary solution for documenting the contractual deliverables using a manifest that includes a list of files with date stamps and secure location details. The manifest is the document that the engineer, surveyor, or land architect would sign and seal. This is, however, a temporary solution that cannot be sustained long-term. So, it is essential, ADOT starts the process of working with the AZ Board of Technical Registration and Industry to evaluate technologies and best practices that are acceptable. The process for changing rules to the Arizona Administrative Code may also take as long as 2 years, so it is essential that this activity starts right away to establish the new rules, process, and technologies by January 2026.

This task is a pre-requisite for institutionalizing digital delivery by 2026.

Table 2. Task 1.2 - Evaluate and Establish Rules, Processes, and Technologies for Signing and Sealing Digital Contract Deliverables

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop consistent and accessible standards, processes, and tools	**People** - Education, Change Readiness, and Industry Receptiveness **Processes** – Documentation to support existing conditions use case	A document with recommendations for proposed rule changes.
Level of Effort	**Resources Needed**	**Pre-Requisites**
Low level of effort **Low cost** **Medium-to-Long duration**	SMEs working group (ADOT and ACEC) ADOT legal council representative Arizona Board of Technical Registration representative Cost associated with ADOT staff time	None

Figure 4. Task 1 - Proposed Schedule



TASKS AND ACTIVITIES	START	END
Task 1. Communication and Engagement		
Subtask 1.1. Prepare and Execute Communication and Engagement Plan	**Aug-23**	**Dec-25**
A. Prepare Plan	*Aug-23*	*Oct-23*
B. Engagements and events (TBD, throughout initiative)	*Sep-23*	*Dec-25*
Task 1.2. Evaluate and Establish the Rules, Processes and Technologies for Signing and Sealing Contract Digital Deliverables	**Aug-23**	**Dec-25**
A. Progress meetings with Board of Technical Registration (TBD, individual events)	*Aug-23*	*Dec-25*
B. Evaluate Technologies and Develop Proposed Procedures	*Jan-24*	*Jun-24*
C. Implement technologies and procedures	*Jul-24*	*Dec-25*

Task 2. Assessment, Development and Updates to Bentley Products

Subtasks under Task 2 activities will be conducted using a phased approach with the highest priorities to support the pilot project teams. Specifically,

1. **Priority #1.** ORD Assessment, development and updates to the workspace portion related to survey modeling, and roadway corridors, The development should focus on creating the necessary libraries (levels, cells, element templates, feature definitions, etc.) needed to deliver:
    a. Existing ground models with accuracy confidence to support digital delivery.
    b. Paving and earthwork MALD pilot projects.

    Note: It is anticipated that the ORD workspace libraries to support the modeling of roadway corridors have already been set up and are sufficiently advanced to start pilot projects at any time. Any updates related to roadway modeling libraries may occur as part of the setup for pilot projects.

2. **Priority #2.** ORD Assessment, development and updates to the workspace portion related to other discipline libraries, including, but not limited to ITS, traffic and safety assets (e.g., signing, lighting, striping, signals, main trunk line, ITS elements, conduit, fiber and conductors).

3. **Priority #3.** OBD Assessment, development, and updates specific to bridge modeling and all necessary libraries (levels, cells, element templates, feature definitions, etc.) needed to deliver the bridge MALD pilot projects. The development of the OBD workspace should also include the framework to support parametric functional components for custom bridge elements.

4. **Priority #4.** ORD Assessment, development, and updates specific to drainage and utility modeling and all necessary libraries (libraries, cells, element templates, feature definitions, etc.) needed to deliver MALD pilot projects that include drainage and culvert elements as part of a roadway project.

5. **Priority #5.** ORD Development of Bentley Item Types to support automated quantity takeoffs, and digital as-built attributes. Item Types may be developed incrementally as part of previous priorities, or all at once. This activity may serve as an opportunity to evaluate which Item Types are still needed and create a prioritized list for development.

Task 2.1 - Assessment of Current ADOT Bentley Workspaces

Description: Review current ADOT Bentley workspace gaps or needs for ORD, OBD, Drainage & Utilities, and Survey configuration, and provide a list of recommendations for further development of the workspace to support all digital delivery project use cases. The summary will provide a list of items to be developed or modified for the current configuration libraries, including but not limited to existing levels, cells (2D and 3D), and element templates, feature definitions and symbologies, templates, design tables and standards, and Item Types that are currently within the existing workspace.

Importance and Impact to Schedule: It is difficult to prioritize which part of the software needs to be improved first without a proper assessment of the current status. ADOT implemented ORD in 2022, and the software has been configured to replicate the traditional plan development process. The assessment will be conducted to evaluate the items that either need to be updated or developed to enable streamlined production of model-based deliverables. This phased approach will enable SMEs to immediately update the specific portions of the configuration to support the needs of each pilot project. The assessment may be performed by Bentley SMEs using ADOT contract agreement credits, or by a consultant team.

This task is a pre-requisite for Task 2.2.

Table 3. Task 2.1 - Assessment of Current ADOT Bentley Workspaces

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop consistent and accessible standards, processes, and tools **Use 2D and 3D digital technologies**	**Use Cases** – Enabling design authoring for all disciplines **Data** – Creating modeling standards within the software to meet MEBS, LOD and LOIN **Technology** – Advancing digital delivery software systems	List of levels, 2D and 3D cells, element templates, feature definition and symbologies, and design settings and standards, and Item Types to be added or modified
Level of Effort	**Resources Needed**	**Pre-Requisites**
Low level of effort **Low cost** **Short duration**	Bentley software configuration SMEs Bentley credits may be used for this activity with the support of a digital delivery SME ADOT DDP team to review and approve recommendations	Software installed and access to current workspace Coordination with ITG, ADOT users, consultants, and contractors

Task 2.2 - Develop or Update Current ADOT Bentley Workspaces per Assessment Recommendations

Description: Develop and/or update ADOT Bentley workspace for ORD (roadway, drainage, utilities, and ITS), OBD, and Survey configuration per recommendations provided in Activity #2.1.

Importance and Impact to Schedule: Having a complete set of modeling tools for each discipline is important to successfully implement digital delivery. Setting up the modeling software to make it as easy as possible for the user to start modeling has been proven beneficial in other states. Digital delivery processes and techniques are supposed to provide easier and more efficient ways of delivering work, so it is important to configure the modeling software to optimize the user experience. The easier it is for the user to comply with the modeling requirements and standards, the faster it will be to gain buy-in and institutionalize digital delivery.

This task is a pre-requisite for delivering training and initiating pilot projects.

Table 4. Task 2.2 - Develop or Update ADOT Bentley Workspaces

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Use Cases** – Enabling design authoring for all disciplines **Data** – Creating modeling standards within the software to meet MEBS, LOD and LOIN **Technology** – Advancing digital delivery software systems	Updated libraries (dgnlibs and cell libraries, pay items) specific to ORD, OBD and Drainage and Utilities Bentley software, including, but not limited to levels, 2D and 3D cells, element templates, feature definition and symbologies, and design settings and standards
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium-to-high level of effort **Medium-to-high cost** **Medium-to-long duration**	Bentley software configuration SMEs Bentley credits may be used for this activity ADOT DDP team to review and approve recommendations	Software installed and access to current workspace Coordination with ITG, ADOT users, consultants, and contractors

Task 2.3 - Evaluate and Setup Additional Bentley Products to Support Digital Delivery

Description: Evaluating and setting up Bentley ProjectWise Connect (model/file management system), Bentley ProjectWise Design Review (program for reviewing model-based design), and Bentley Synchro (program for construction engineering and inspection using model-based deliverables).

Importance and Impact to Schedule: The digital delivery process introduces new types of deliverables and ways of exchanging those deliverables that require software and systems currently not being utilized at ADOT. Specifically, there are critical functions being introduced by digital delivery that require specialized software, which include:

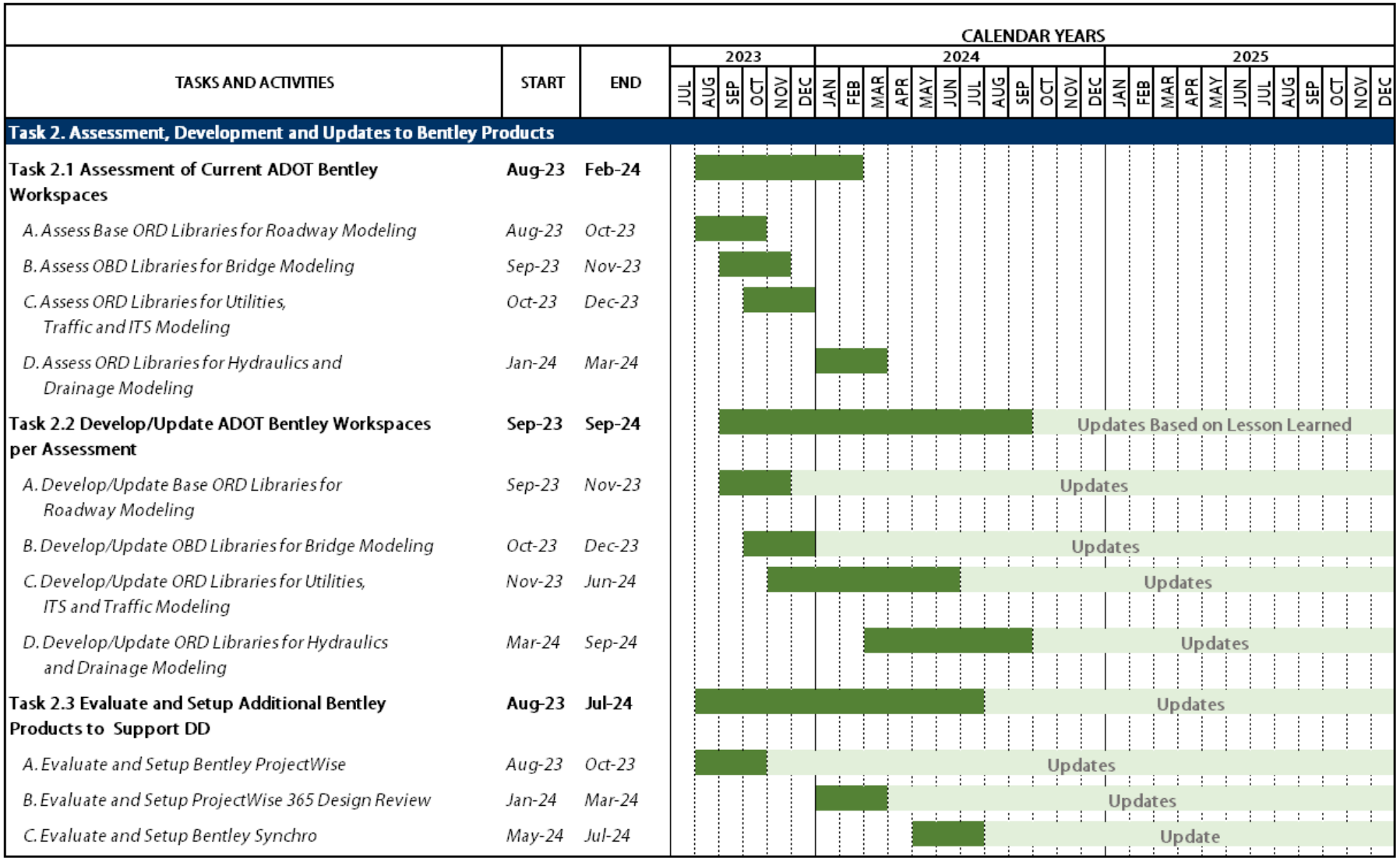
- **A shared repository**, a common data environment (CDE) that serves as the collaboration portal for the project during the design phase. **ProjectWise** is a product within the ADOT technology portfolio that has not been utilized to-date and provides the functionality needed for managing files during design, but also in other phases of the project development and delivery process. It is highly encouraged that ProjectWise is set up for each pilot project to test the digital delivery environment that will be institutionalized at ADOT. Most state DOTs have standardized their processes using ProjectWise. While not the only solution on the market, it is currently available to ADOT, and could be implemented with the pilot projects fairly quickly and easily to meet the DDP schedule.
- **A real-time collaboration portal for reviewing model-based design files,** a system that enables reviewers (e.g., project manager, section managers, and other non-CAD users) to interrogate the model to check information about the project has been produced according to design criteria and other engineering standards. ADOT currently uses WorkFront for this purpose, and it is a great solution for the exchange of PDF deliverables. However, it is inadequate for providing the same functionality of 3D model files. **ProjectWise 365 Design Review** is a product within ADOT technology portfolio that has not been utilized to-date and provides the functionality needed for performing design reviews by those not familiar with CAD products. The system is set up with the pertinent files and information for each milestone deliverable and it is secured in a "read-only" environment very similar to how WorkFront works. The activities for pilot projects within this implementation plan are designed to use this product and should be made available as soon as possible. ProjectWise 365 Design Review is the most advanced product on the market to enable roadway and bridge project design reviews. Other systems exist, but they do not support alignment-based information, plan, profile, and cross section views as they have been designed specifically for vertical construction.
- **A 3D model viewer**, a tool that will enable construction management and inspection staff access the information that has traditionally been transmitted through contract plans in PDF format. **Bentley Synchro** is a product within ADOT technology portfolio that has not been utilized to-date and provides the functionality needed for construction inspection staff access contract plan information, such as plan and profile view elements, feature locations and elevations, notes, and pay items.

ADOT. ProjectWise 365 is a pre-requisite to implement Design Review and Synchro. Thus, ProjectWise 365 should be installed and configured as soon as possible. This task is a pre-requisite for delivering training and initiating pilot projects.

Table 5. Task 2.3 - Evaluate and Setup Additional Bentley Products to Support Digital Delivery

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Technology** – Advancing digital delivery software systems	Setup ORD and OBD managed workspace for ProjectWise Instructions for setting up ProjectWise System Instructions for setting up and using ProjectWise 365 Design Review Instructions for setting up Synchro
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium-to-high level of effort **Medium-to-high cost** **Medium-to-long duration**	Bentley software configuration SMEs Bentley credits may be used for this activity ADOT DDP team to review and approve recommendations	Licenses secured and software installed prior to starting pilot projects Coordination with ITG, ADOT users, consultants, and contractors working on pilot projects

Figure 5. Task 2 - Proposed Schedule



TASKS AND ACTIVITIES	START	END
Task 2. Assessment, Development and Updates to Bentley Products		
Task 2.1 Assessment of Current ADOT Bentley Workspaces	**Aug-23**	**Feb-24**
A. Assess Base ORD Libraries for Roadway Modeling	*Aug-23*	*Oct-23*
B. Assess OBD Libraries for Bridge Modeling	*Sep-23*	*Nov-23*
C. Assess ORD Libraries for Utilities, Traffic and ITS Modeling	*Oct-23*	*Dec-23*
D. Assess ORD Libraries for Hydraulics and Drainage Modeling	*Jan-24*	*Mar-24*
Task 2.2 Develop/Update ADOT Bentley Workspaces per Assessment	**Sep-23**	**Sep-24**
A. Develop/Update Base ORD Libraries for Roadway Modeling	*Sep-23*	*Nov-23*
B. Develop/Update OBD Libraries for Bridge Modeling	*Oct-23*	*Dec-23*
C. Develop/Update ORD Libraries for Utilities, ITS and Traffic Modeling	*Nov-23*	*Jun-24*
D. Develop/Update ORD Libraries for Hydraulics and Drainage Modeling	*Mar-24*	*Sep-24*
Task 2.3 Evaluate and Setup Additional Bentley Products to Support DD	**Aug-23**	**Jul-24**
A. Evaluate and Setup Bentley ProjectWise	*Aug-23*	*Oct-23*
B. Evaluate and Setup ProjectWise 365 Design Review	*Jan-24*	*Mar-24*
C. Evaluate and Setup Bentley Synchro	*May-24*	*Jul-24*

Task 3. Development of Digital Delivery Standards and Procedures

Task 3.1 - Update Engineering Survey Specifications and Practices Manuals.

Description: A thorough review of the ADOT Survey Specifications and Practices Manuals is necessary to identify content to be added or updated to assist survey staff making decisions about choosing data collection methods and technologies that provide the accuracies, point density and data resolution to support digital delivery and models as legal documents. Make updates identified during the review.

Importance and Impact to Schedule: Having the Engineering Survey Specifications and Practices Manual entirely completed is not a pre-requisite for pilot projects. However, the Engineering Survey and Specifications and Practices Manual is a pre-requisite for institutionalizing digital delivery by 2026.

Establishing specifications for levels of accuracy, point density and resolution is a pre-requisite for initiating pilot projects.

Table 6. Task 3.1 - Update Engineering Survey Specifications and Practices Manual

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Processes** – Documentation to support existing conditions use case **Data** – LOD and LOIN **People** – Training, Change Readiness, and Industry Receptiveness	Tech memo: Recommendations for Survey Specifications and Practices Manual Updates Updated Survey Specifications and Practices Manuals
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium level of effort **Medium cost** **Medium duration**	Geomatics subject matter expert (in-house or consultant support) Internal survey staff to lead the review, update, and development of the ADOT Survey Specifications and Practices Manuals Consider industry participation	None

Task 3.2 - Develop Digital Delivery Design Guidelines & Specifications.

Description: The Digital Delivery Design Guidelines & Specifications (DDDGS) will provide guidance for digital delivery workflows and modeling requirements, such as LOD and LOIN standards for each discipline producing contract plans. Also, the document will include data and quality management procedures and best practices, and execution plans, among other topics, that are critical for successfully delivering all elements of a project in a digital format.

Importance and Impact to Schedule: This task will be conducted using a phased approach focusing first on the content needed to support pilot project teams. The DDDGS will be a living document that should be updated every quarter to incorporate new content being developed as well as lessons learned from pilot project teams. This phased approach will enable ADOT to start pilot projects before the entire set of standards and guidelines are completed in their entirety.

The portion of the DD Design Guidelines & Specifications document related to the delivery of pilot projects is a pre-requisite for delivering training and pilot projects.

Table 7. Task 3.2 - Develop Digital Delivery Design Guidelines & Specifications

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Processes** – Documentation to support multiple use cases **Data** – LOD and LOIN **People** – Training, Change Readiness, and Industry Receptiveness	Digital Delivery Design Guidelines & Specifications including: • Model Element Breakdown Structure Spreadsheet • Modeling Standards for LOD and LOIN • Process Maps of Digital Exchanges • Quality Management Procedures
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium level of effort **Medium cost** **Medium duration**	Digital delivery SMEs (in-house or consultant staff). Funding if using a consultant. ADOT staff to provide support, review, and approval of new document	Develop/Update current ADOT Bentley Workspaces Sufficient content to deliver just-in-time training to project teams working on pilot projects

Task 3.3 - Develop Digital Delivery CE&I Guidelines & Specifications.

Description: The Digital Delivery CE&I Guidelines & Specifications will provide guidance for digital delivery workflows related to working with digital deliverables during construction, including procedures for project set up and file management, accessing project information within the contact model, such as geometry, terrain, and location information (e.g., station/offsets), elevations, pay items and quantities. The document will also include procedures for transferring information to and from field devices, addressing updates to the model during construction, and measuring pay item quantities.

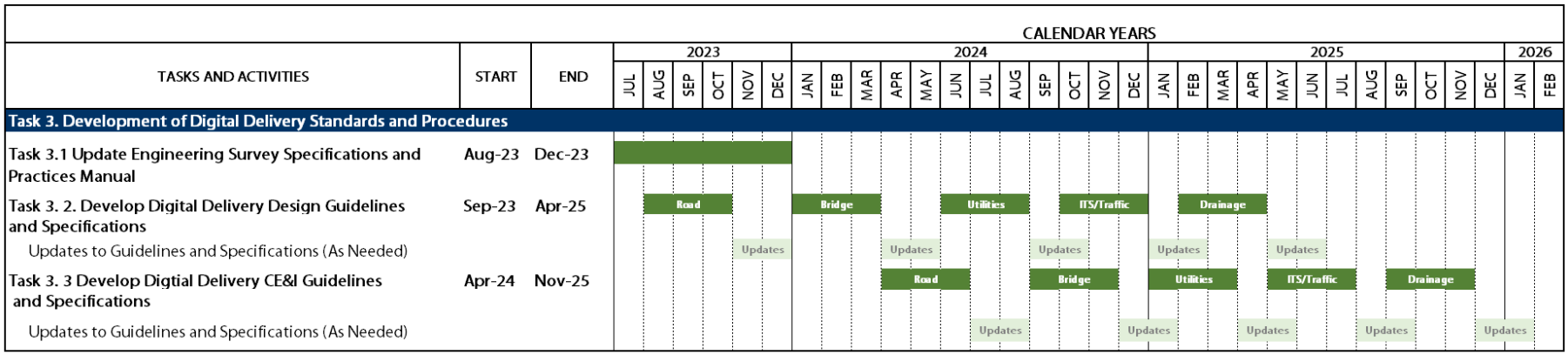
Importance and Impact to Schedule: This task will be conducted using a phased approach focusing first on the content needed to support pilot project teams. This document will be a living document that should be updated every quarter to incorporate new content being developed as well as lessons learned from pilot project teams. This phased approach will enable ADOT to start pilot projects before the entire set of standards and guidelines are completed in their entirety.

The portion of the DD CE&I Guidelines & Specifications document related to the delivery of pilot projects is a pre-requisite for delivering training and pilot projects.

Table 8. Task 3.3 - Develop Digital Delivery CE&I Guidelines & Specifications

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Processes** – Documentation to support multiple use cases **Data** – LOD and LOIN **People** – Training, Change Readiness, and Industry Receptiveness	Digital Delivery CE&I Guidelines & Specifications including: • Standards and specifications for digital construction methods • Procedures for verification and documentation of construction outcomes using digital means • Protocols for addressing model changes during construction
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium level of effort **Medium cost** **Medium duration**	Digital delivery SMEs (in-house or consultant staff). Funding if using a consultant. ADOT staff to provide support, review, and approval of new document	Develop/Update current ADOT Bentley Workspaces Sufficient content to deliver just-in-time training to project teams working on pilot projects

Figure 6. Task 3 - Proposed Schedule



Note: Updates will be made to all standards and specification as each pilot project is completed.

Task 4. Development of Training Material

Task 4.1 - Develop Training Material for Digital Delivery Methodology and Process Knowledge Base Courses.

Description: Develop fundamental competency level courses that will serve as the pre-requisites for more advanced topics specific to each discipline as described in Appendix C.

Importance and Impact to Schedule: This task will be conducted using a phased approach focusing first on the content needed to support pilot project teams. The content developed under Task 4.2 and 4.3 will be used as part of the training material for the courses under the category of Digital Delivery Methodology and Process Knowledge Base.

The portion of the training material related to the delivery of pilot projects is a pre-requisite for delivering training and pilot projects.

Table 9. Task 4.1 - Develop Training Material for Digital Delivery Methodology and Process Knowledge Base Courses

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Processes** – Documentation to support existing conditions use case **Data** – LOD and LOIN **People** – Training, Change Readiness, and Industry Receptiveness	The following training modules/courses • Digital Delivery Overview • Project Development Data Management Concepts • Modeling Standards • Quality Management • Project Development Milestone Submittals • Overview of Digital Workflows for Contracts & Specifications Tasks
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium-to-high level of effort **Medium-to-high cost** **Medium-to-long duration**	Digital delivery and discipline SMEs in-house or consultant staff). Funding if using a consultant. ADOT staff to provide support, review, and approval of new document	Engineering Survey Specifications and Practices Manual Digital Delivery Design Guidelines & Specifications

Task 4.2 - Develop Training Material for Modeling Software and Skill Set Development Courses.

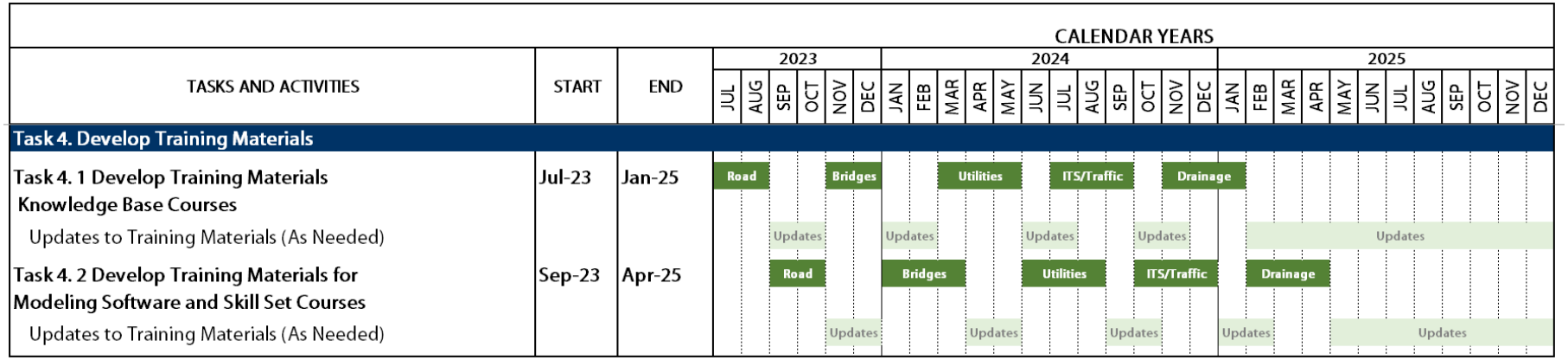
Description: Develop training for the use of software specific to tasks performed by each discipline, focusing on general concepts, techniques, and best practices for using the software as described in Appendix C.

The portion of the training material related to the delivery of pilot projects is a pre-requisite for delivering training and pilot projects.

Table 10. Task 4.2 - Develop Training Material for Modeling Software and Skill Set Development Courses

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Processes** – Documentation to support existing conditions use case **Data** – LOD and LOIN **People** – Training, Change Readiness, and Industry Receptiveness **Technology** – Advancing digital delivery software systems	The following training modules/courses: • Overview of ORD Modeling & Plan Production • ORD for Survey • ORD for Roadway Modeling Part 1 • ORD for Roadway Modeling Part 2 • OBD for Bridge Modeling Part 1 • OBD for Bridge Modeling Part 2 • ORD for Drainage • ORD for Utilities • Construction Engineering & Inspection for Digital Delivery • Collection & Submittal of Digital Record Drawings
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium-to-high level of effort **Medium-to-high cost** **Medium-to-long duration**	Digital delivery SMEs Software subject matter expert Funding for developing training material (portion of this task may be funded through Bentley credits) ADOT staff to provide support, review, and approval of new document	ORD, OBD and Drainage & Utilities Updated Workspace

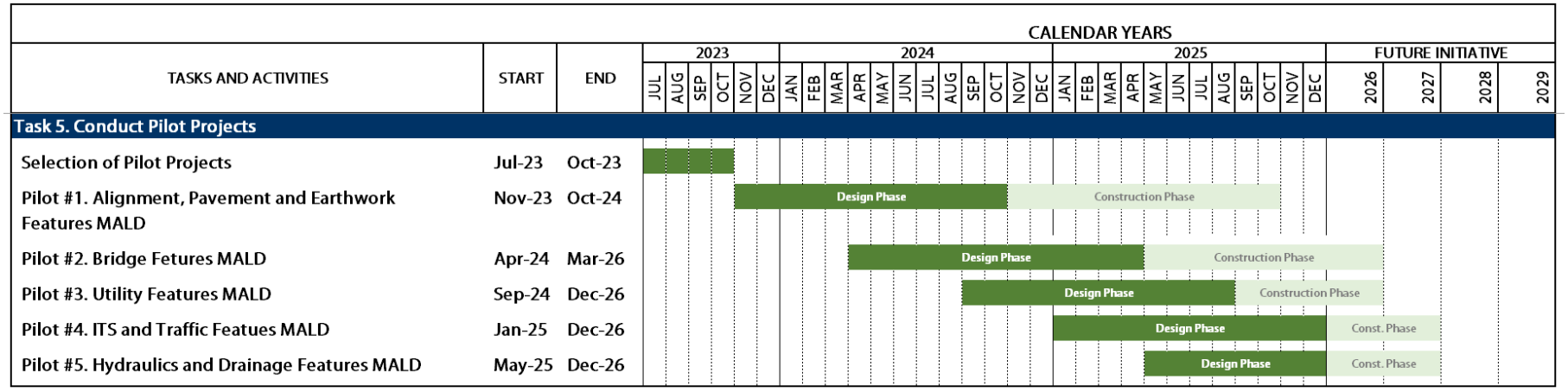
Figure 7. Task 4 - Proposed Schedule



Task 5. Conduct Pilot Projects

This task includes the technical approach for implementing digital delivery through pilot project initiatives, and it is further discussed in the "Digital Delivery Pilot Projects Deployment" of this implementation plan.

Figure 8. Task 5 - Proposed Schedule



Task 6. Development of Information Requirements and Tools

The scope of the ADOT DDP does not include the implementation of digital asset management. *Task 6 - Development of Information Requirements and Tools* are associated with operations and maintenance use cases to support digital asset management, and include:

- *Subtask 6.1 – Develop Information Requirements for Digital As-Built Surveys*, which is the only subtask in this section included in the 2023-2025 schedule of the ADOT DDP initiative.
- *Subtask 6.2 – Develop CAD to GIS Process and Prototype Tools*. This subtask requires software development to enable the transfer of information from 3D objects and attributes from CAD to GIS platforms. The technology to enable this type of data exchange is not ready for prime time production, and so, it would require ADOT to develop a custom process and prototype tool.
- *Subtask 6.3 - Develop Data Governance Plan for ADOT's Critical Data*. This subtask requires the development of a formal structure regarding definition, creation, and use of data to improve quality and usability of enterprise information. Thus, it is recommended for ADOT to consider creating a data governance plan, which would include the business competency that engagers the ADOT's workforce at the executive, strategic, tactical, and operational level. This engagement will help to create, implement, and maintain data standards for making better decisions across the asset management lifecycle.

As the amount of data that is collected and created increases through the use of LiDAR, BIM, Internet of Things, and other means, data governance also increases in importance alongside the collected transportation data.

A good data governance framework can help ADOT in multiple ways, including:

- Obtaining consistent answers to questions in a timely manner.
- Verifying a consistent understanding of data use and needs throughout the agency.
- Providing the ability to rely on (trust) data for better decision-making.
- Addressing data quality issues, including defining purpose, reliability and accuracy for its intended uses.

A typical data governance planning path to establish data definitions includes:

- Accepting data governance as a core topic.
- Defining data governance and information management.
- Establishing data definitions and sources.

Task 6.1 - Develop Information Requirements for Digital As-Built Surveys

Description: Develop information delivery requirements that align with the Feature Inventory Systems (FIS) Manual and capture information needs for digital as-built records using surveying data collection methods. This activity has been identified as a low hanging fruit given that the FIS Manual is very comprehensive for specific asset classes, and there are examples of other states collecting digital as-built information leveraging modern surveying data collection methods through contract line items.

This task will be conducted as a component of each pilot project as defined in the implementation phase.

Table 11. Task 6.1 - Develop Information Requirements for Digital As-Built Surveys

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Develop and implement new information management processes**	**Processes** – Documentation to support collection of digital as-built records **Data** – LOD and LOIN **People** – Training, Change Readiness, and Industry Receptiveness	A list of prioritized asset classes to include in the Transportation Asset Management Plan and other ADOT needs A list of minimum information needed to make decisions for proactive asset management
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium-to-high level of effort **Medium-to-high cost** **Medium-to-long duration**	Digital delivery SMEs Data stewards and data domain trustees for each asset class Coordination with the ArcGIS Pro Implementation Initiative Team Funding for developing information requirements for digital as-builts if using a consultant ADOT staff to provide support, review, and approval of new document	Access to FIS Manual Coordination with the ArcGIS Pro Implementation Initiative

Task 6.2 - Develop CAD to GIS Process and Prototype Tools

Description: Configure the CAD software to include attributes for the information requirements established in activity 6.2. Also, develop a data collection tool and mechanism to use CAD information for GIS applications.

This activity should be deferred to a future initiative, starting in 2026.

Table 12. Task 6.2 - Develop CAD to GIS Process and Prototype Tools

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Use 2D and 3D digital technologies** **Develop and implement new information management processes**	**Processes** – Documentation to support collection of digital as-built records **Data** – LOD and LOIN **People** – Training, Change Readiness, and Industry Receptiveness	Item Types configuration related to as-built record models information requirements Procedures to prepare CAD data for data collection handoff List of deliverables from design to construction for the data collection of as-built record models Prototype data collection tool that can consume design CAD data for the purpose of verifying and updating information for as-built records.
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium-to-high level of effort **Medium-to-high cost** **Medium-to-long duration**	Digital delivery SMEs and GIS specialists Data stewards and data domain trustees for each asset class Funding for configuration of the Item Types in ORD (Bentley credits may be used for this task) Funding for preparing procedures to prepare CAD data Funding for developing and testing the prototype data collection tool ADOT staff to provide support, review, testing, and approval of deliverables	Information Delivery Requirements for Digital As-Builts

Task 6.3 - Develop and Implement Data Governance Plan for ADOT's Critical Data

Description:

Develop a data governance implementation plan for ADOT. A plan that establishes the rules for managing critical asset data will guide all the involved parties to use consistent data language, and standardize its use to make data-driven decisions.

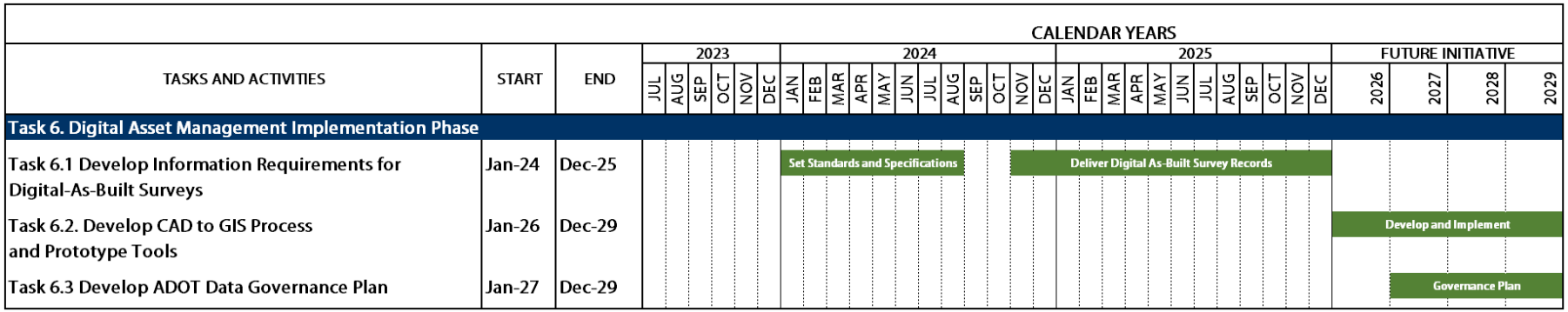
Data governance in an organization like ADOT is a complex activity, with a large variety of data and equally large number of stakeholders (both internal and external). Successful data governance starts with an implementation plan that identifies the current state, defines a vision and target state, and a roadmap to achieve the target state. A detailed roadmap will allow ADOT to properly plan for the resources required, timeline and budget to undertake this initiative, and connect all involved stakeholders (which is the most critical component in successful data governance initiatives).

This task should be deferred to a future initiative, starting in 2026.

Table 13. Task 6.3 - Develop and Implement Data Governance Plan for ADOT's Critical Data

Goals and Objectives Alignment	Focus Areas	Desired Outcomes (Products)
Develop standardized and accessible standards, processes, and tools **Develop and implement new information management processes**	**People** - Education, Change Readiness, and Industry Receptiveness **Processes** – Documentation to support operations and maintenance use cases **Data** – Creating organizational standards for collection, management, and validation of asset data **Technology** – Advancing software systems related to the collection, management, and validation of data	Data governance implementation plan that includes: • Business Drivers • Current State • Target State and Vision • Roadmap to implement a data governance framework, including priorities and phasing, resource requirements, schedule, and budget requirements.
Level of Effort	**Resources Needed**	**Pre-Requisites**
Medium level of effort **Medium cost** **Medium duration**	Business and data governance SMEs IT Experts (including data governance lead(s) from IT) Data stewards and data domain trustees for each asset class Funding for developing the data governance plan (if consultant being used) ADOT staff to oversee the development of the plan	• Identify key stakeholders and business functions • Document existing data governance and related policies and processes • Define roadmaps for major software changes/updates in motion (e.g., FAST replacement, PeCoS replacement)

Figure 9. Task 6 - Proposed Schedule



Digital Project Delivery Pilot Projects Deployment

Pilot Projects Deployment Overview

This section of the Implementation Plan covers the selection, execution, and evaluation of digital delivery projects. Following the adoption of digital delivery products, such as OpenX modeling platforms, ADOT will solicit and identify pilot project opportunities that meet the goals of the DDP based on the anticipated timeline for implementation of most DDP target goals by January 1, 2026.

During this phase of project selection for pilots, consideration should be given to synchronizing with the development of DDP products from the previous section. For example, if the goal of the DDP is to pilot earthwork/pavement modeling and AMG first, development of ORD should take precedence over other modeling elements (bridge, drainage, utilities, ITS, etc.).

Furthermore, it is more beneficial to those involved in the pilots to receive "just-in-time" training for the transition to a digital deliverable. Identifying and coordinating this section of the Implementation Plan with the Training Plan will be critical for success.

Lastly, it is highly recommended to find opportunities to work closely with the contractor on the selected pilot projects. The following strategies should be considered:

- Using the Construction Management at Risk (CMAR) delivery method may be the best option for projects being selected for pilot projects. Lessons learned from other states indicate that engaging the contractor and the CE&I team early on in the process is beneficial for design teams preparing model-based deliverables that are most useful for construction.
- Using formal construction partnering as part of Design-Bid-Build (D-D-B) delivery method as a way to collaborate with the construction team using workshops and regular meetings to proactively manage the risk of using MALD deliverables.
- Engaging with industry as part of a programmatic collaboration working group, in which consultants, contractors and ADOT staff come together to find solutions to successfully implement digital delivery and MALD.
- Adding a contract line item to the project construction budget to retain a designer for answering questions and being involved during the construction phase.

Pilot Projects Approach

During the design and construction of the project, various technologies, roles and responsibilities, and information exchanges should be evaluated based on pre-set criteria for each type of digital delivery activity. Digital delivery is an ever-evolving process, which requires the periodic update of the evaluation matrix and the status of the overall program. Using post-construction review meetings, contractor partnering, bid tabs, and in-field evaluation of new technology, ADOT should be able to periodically update the pilot project selection process to align project goals with the evolution of the DDP.

Selection of Pilot Projects

Goals and objectives for each pilot project should be established ahead of selection. It is important to clearly define the specific desired outcomes for each pilot project. This section provides recommendations for implementing a phased approach that considers piloting only certain portions of a design (or use cases) rather than modeling all aspects of a project.

Each pilot project is designed to test software readiness, standards and procedures for design and construction activities. An optional item for inclusion in pilot projects is the data collection of digital as-built records to support asset management using information requirements established in the FIS Manual and a contract line item for construction surveys.

Use Cases for Pilot Projects

Appendix E summarizes the national definitions for use cases. Within the context of the ADOT Implementation Plan Approach, a use case is defined as the task or process for which a digital delivery model is created. In other words, a use case defines the reason for developing model-based deliverables, and it is vital to determine the desired use case ahead of each pilot project for successful outcomes.

This section provides of the implementation plan provides recommendations for several pilot projects based on specific use cases. There are some use cases that apply to each pilot project listed in the recommendations and should not be conducted in isolation. The pilot projects approach described in this plan considers those use cases to be included in each of the pilot projects, and general requirements are provided in this section. The three use cases that apply to each of the pilot projects include:

- *Engineer's Cost Estimate and Contract Administration* with MALD Deliverables.
- *Construction Engineering and Inspection* with MALD Deliverables.
- *Digital As-Built Surveys* of the as-built model elements being tested.

Engineer's Cost Estimate and Contract Administration (Contractual)

This process leverages digital design information for automated quantity harvesting for the development of engineer's estimate and bid tabs of pay items for the contract documents. It is assumed that the development of the CAD workspace to enable automated, model-based quantity takeoffs will be completed in "runs" that align with the model-based deliverables and their associated pay items quantity being piloted. An individual pilot initiative for testing engineer's cost estimates and

contract administration tasks is not necessary, but rather it should be included as a pre-requisite for each pilot project.

Pre-requisites:

- Categories of pay items to be paid per model quantities should be identified and established at the start of the pilot project, and fully defined in the project special provisions.
- Software is set up with appropriate 2D and 3D object libraries, standard naming conventions for levels, element templates and feature definitions.
- Configuration of Item Types for pay items applicable to the pilot project should be developed and ready to use at the start of the pilot project. For example, if a project is a bridge model pilot, and the model information is contractual, bridge pay items should be harvested from the design as opposed to ITS or drainage objects.
- Procedures, methods, and best practices to verify pay items against the model quantities, develop pay item schedules for inclusion in contract documents, prepare pay item quantity files to transfer data from the model to the contract administration system, are in place prior to the start of the pilot project milestones deliverables.

Construction Engineering and Inspection with MALD Deliverables

This process leverages digital design information for inspecting and managing the construction phase of a project in lieu of some or all traditional plan sheets (PDF). For this type of pilot project, ADOT procedures and technology should be available ahead of the project going to construction. Project teams should be trained close to the start of the project. The training should have two components:

- The use of 3D model viewer to test digital inspection workflows, such as logging issues and daily logs, or working in the same connected environment as the contractor to manage the RFI process.
- The use of model files and surveying equipment (GNSS or other technology) to verify measurement of actual quantities for acceptance and payment.

The phased approach recommended in this implementation plan will enable project teams to learn how to use models for construction inspection and management one discipline at a time without eliminating PDF plans completely. For example, when piloting earthwork and paving models, construction staff will have a hybrid environment with PDF plan set in which the cross-sections are replaced with an AMG model.

Lastly, leveraging a user-friendly application on ADOT standard mobile devices for construction is a key success factor.

Pre-requisites

For each pilot project, following items are pre-requisites for the project to move to construction:

- The tools for viewing 2D PDF plans, 3D models, and other contract documents have been set up and are available for construction teams.
- The survey equipment needed for verifying measurement of pay item quantities is easy to use and is available for construction teams.

- Training in using technology and procedures to access information in a model-based environment is delivered just-in-time for the start of construction.

Lastly, consider adding a pay item for construction partnering that includes a kickoff workshop to discuss roles and responsibilities, systems being used, and escalation issues related to digital delivery. ADOT should consider also adding a line item in the construction contract to allow project teams to meet on a regular basis with the digital delivery team and the designer who authored the models being used in construction. This has been a lesson learned shared by other State DOTs. The construction team (contractor and ADOT staff) should have access to the design team to answer questions regarding issues related to digital delivery and design intent of the model(s). At the end of the project, an evaluation workshop should be set up to capture challenges, opportunities and overall lessons learned.

Digital As-Built Surveys

This process provides the mechanism to collect the assets being piloted with digital delivery using modern surveying equipment with additional attributes and metadata for each feature being collected.

Pre-requisites:

The standards and data collection specifications should be established ahead of the pilot project.

The Engineering Survey Specifications and Practices Manual section defining the level of accuracy, point density and resolution for the data being collected should be completed ahead of the pilot project.

The DDP Leads should collaborate with GIS staff and the Engineering Section responsible for asset stewardship (bridge, TSMO, pavement, etc.) to finalize the specifications information requirements for location data collection, attributes, and metadata to be collected and delivered as a data file that can be imported into GIS. The FIS Manual should be used as a starting point for the conversation.

The following are some questions ADOT should consider when defining the special provisions for the pilot project:

- What is the classification of these assets (e.g., category, class type, etc.)?
- Who will be responsible for the collection and validation of the data?
- When will the data be collected, (i.e., during construction or post construction)?
- Is a system currently in place to handle the information exchange or does ADOT need to establish one?
- What constitutes an "as-built" model record, and how it will differ from the current ADOT record drawings? For example, if an item is installed within tolerance, does the information need to be collected again or transferred from the as-designed model? And what should be the deliverable for storing in the ADOT record drawing system?

Recommendations for Pilot Projects

Pilot Project #1: Alignments, Pavement and Earthwork Modeling (Contractual)

The focus for these types of pilot projects is the design and modeling of alignments, profiles, pavement, and earthwork features.

Use Case Description: This pilot scope of work should concentrate on producing MALD deliverables to facilitate:

- Estimation of pavement and earthwork quantities.
- Preparation of bid items for pavement and earthwork quantities.
- Construction layout using contractual digital data of alignments and profiles.
- Automated machine guidance for grading and paving using contractual surface models.
- Verification of locations (station/offsets) and elevations of construction pay items.
- Measurement and documentation of paving and earthwork quantities.
- Data collection of pavement as-built conditions, including location, elevations, and feature inventory and asset management attributes, such as material, smoothness, etc. (optional).

Objective:

- Establish the standards, procedures, and deliverables for producing, reviewing, bidding and constructing roadway corridors using digital data for alignments, profiles, and surfaces.
- Earn the trust from contractors that ADOT 3D models are of sufficient quality to permanently replace cross section sheets.
- Evaluate technologies and methods suitable for construction inspection and verification of earthwork and pavement quantities without the need for cross-sections.

Desired Outcomes (Products):

- Standards, specifications and procedures for data collection, post-processing and production of deliverables for existing ground survey data sets with the appropriate levels of accuracy, point density and resolution to support MALD for all pilot projects.
- LOD and LOIN standards and specifications for pavement and earthwork models appropriate for construction means and methods using AMG.
- Procedures for producing, reviewing, bidding and constructing roadway projects without the use of cross sections sheets.
- CE&I standards and specifications for verifying location and elevations for pavement structure and side slope conditions and measuring quantities for pavement and earthwork without the need for cross-section sheets.
- Digital as-built record model of roadway alignment, profiles, and pavement sections with correct attribution to support asset management (optional task).

Selection Criteria:

The most suitable projects for this type of pilot project are those in which it is anticipated the contractor will use AMG equipment for grading, milling or paving operations, such as roadway widening, realignment, or new alignment construction.

Pre-requisites:

- Procurement language that describes the order of controlling documents and special provisions related to digital delivery.
- Existing conditions survey data that has the level of accuracy, point density and resolution needed to minimize the risk of using contractual 3D data and instill confidence in the use of this data by contractors. It may be necessary to augment survey data collection.
- Training material and interim guidelines are available to assist design teams to develop, review and deliver quality 3D models for pavement and earthwork features.
- Software is set up with appropriate roadway templates, standard naming conventions for levels, template point names, and feature definitions, as well as Item Types to facilitate automation of quantity of pay items.
- FIS Manual has information requirements and procedures for collection of pavement information to support asset management.

Deliverables:

- MALD alignment files in LandXML format.
- MALD surface files representing the proposed finished grade surface in LandXML format.
- Digital roll plot PDF that contains 2D geometry for other elements in the project not being modeled.
- Reports (PDF) showing details not being modeled, and source digital files for tabular data and quantities (e.g., spreadsheets).
- Digital as-built survey files (optional).

Pilot Project #2. Bridge Modeling (Contractual)

The focus for these types of pilot projects is the design and modeling of bridges and other structural elements designed by the Bridge Section.

One important item to note for bridge MALD is for ADOT to consider the following options:

1. Model the entire bridge elements, and deliver the entire bridge model contractually
2. Model the entire bridge elements and deliver only the substructure model contractually and use the superstructure and reinforcement model elements to produce traditional bridge plans.

Use Case Description: This pilot scope of work should concentrate on producing MALD deliverables to facilitate:

- Estimation of bridge pay item quantities.
- Preparation of bid items for bridge quantities.
- Construction layout using contractual digital data of alignments and profiles.
- Construction layout of bridge elements.
- Verification of locations (station/offsets) and elevations of construction pay items.
- Initiation of fabrication of bridge elements (assumes these elements are modeled and delivered contractually).

Objective:

- Establish the standards, procedures, and deliverables for contractual digital data for bridge elements.
- Develop a 3D model of a bridge as complete as possible to reproduce sheet content.
- Evaluate Bentley software for functionality and completeness to deliver bridge models.
- Evaluate technologies and methods suitable for construction inspection and verification of bridge elements.
- Enable contractor use, earn trust, and document progress.

Desired Outcomes (Products):

- Standards, specifications and procedures for data collection, post-processing, and production of deliverables for existing ground survey data sets with the appropriate levels of accuracy, point density and resolution to support MALD for all pilot projects.
- LOD and LOIN standards and specifications for bridge models appropriate for construction and fabrication.
- Procedures for producing, reviewing, bidding, and constructing bridge projects using MALD deliverables.
- CE&I standards and specifications for verifying location and elevations of bridge elements without the use of traditional bridge plan sheets.

Selection Criteria:

The most suitable projects for this type of pilot project are full bridge replacements and new bridges with or without roadway work. Non-complex bridges should be considered as the first pilot project.

Pre-requisites:

- Procurement language that describe the order of controlling documents and special provisions related to digital delivery.
- Existing conditions survey data that has the level of accuracy, point density and resolution needed to minimize the risk of using contractual 3D data.
- Training material and interim guidelines are available to assist design teams to develop, review and deliver quality 3D models of bridge features.
- Software is set up with appropriate bridge templates, standard naming conventions for levels, template point names, and feature definitions, as well as Item Types to facilitate automation of quantity of pay items.

Deliverables:

- MALD alignment files in LandXML format.
- MALD surface files representing the proposed finished grade surface in LandXML format.
- MALD drawing files representing the bridge model elements being delivered contractually.
- Traditional bridge plans (PDF) for bridge elements not being delivered contractually, in which case the model is provided for information only.

- Digital roll plot PDF that contains 2D geometry for other elements in the project not being modeled.
- Reports (PDF) showing details not being modeled., and source digital files for tabular data and quantities (e.g., spreadsheets).
- Digital as-built survey files (optional).

Pilot Project #3: Utility Modeling (Contractual)

The focus for these types of pilot projects is the design and modeling of existing utilities by roadway designers, and proposed utilities by the utility owners. ADOT should consider requiring the delivery of utility models as a pre-requisite for issuing permits to install utilities within its right-of-way

Use Case Description: This pilot scope of work should concentrate on producing MALD deliverables to facilitate:

- Coordination of proposed utilities within the ADOT right-of-way.
- Clash detection of proposed features and existing features.
- Estimation of quantities for relocation of existing utilities within the ADOT right-of-way.
- Relocation of existing utilities within the ADOT right-of-way
- Installation of utilities within the ADOT right-of-way
- Verification of locations (station/offsets) and elevations of construction pay items related to the relocation and installation of utilities within the ADOT right-of-way.
- Data collection and delivery of digital as-builts for utilities within the ADOT right-of-way.

Objective:

- Use the 3D roadway corridor model as the base for developing utilities contract models.
- Establish the standards, procedures, and deliverables for contractual digital data for roadway models that include utility features.
- Evaluate the use of the 3D models to visualize placement of utilities and assess conflicts with other project elements.

Desired Outcome:

- Standards, specifications, and procedures for producing models that contain utility elements associated with the roadway or bridge model being delivered.
- LOD and LOIN standards and specifications for utility elements within the 3D roadway or bridge models appropriate for construction and documentation of digital as-builts.
- Procedures for producing, reviewing, bidding, and constructing roadway/bridge projects using MALD deliverables.
- CE&I standards and specifications for verification of installation and pay item documentation for I utility-related features.

Selection Criteria:

The most suitable projects for this type of pilot include those in which it is anticipated to relocate existing utilities for roadway widening, realignment or new alignment construction projects with or without a bridge structure.

Pre-requisites:

- Procurement language that describes the order of controlling documents and special provisions related to digital delivery.
- Existing conditions survey data that has the level of accuracy, point density and resolution to support the MALD deliverables.
- Roadway and/or bridge modeling has been completed or is being completed as part of the project.
- Training material and interim guidelines are available to assist design teams to develop, review and deliver quality 3D models that include utility features.
- Software is set up with appropriate 2D and 3D object libraries, standard naming conventions for levels, element templates and feature definitions specific to utility features.

Deliverables:

- MALD alignment files in LandXML format.
- MALD surface files representing the proposed finished grade surface in LandXML format.
- MALD drawing files representing objects being modeled in 3D (e.g., ORD files).
- Digital roll plot PDF that contains 2D geometry for other elements in the project not being modeled.
- Reports (PDF) showing details not being modeled, and source digital files for tabular data and quantities (e.g., spreadsheets).

Considerations for Utilities:

- ADOT should consider the use of the latest standards published by the American Society of Civil Engineers (ASCE) Standards 38-22 *Standard Guideline for Investigating and Documenting Existing Utilities*, and 75-22 *Standard Guideline for Recording and Exchanging Utility Infrastructure Data*. The 38-22 standards have been updated to provide better guidance on positional accuracies rather than subjective "quality levels". ADOT should continue to use the 38-22 standard for assisting with the processes for subsurface engineering utility (SUE) surveys. Accurate SUE surveys are a key factor in successfully using 3D models for clash detection.
- The 75-22 standard is completely new and provides guidance on the data content, data collection best practices and positional accuracy levels for documentation of as-built records, and a framework for data exchanges. The 75-22 guide also includes a comprehensive list of feature attributes that could be selected for documentation of as-built conditions to inform asset management systems. Lastly, the 75-22 guide provides recommendations on the types of deliverables for data exchanges.

- ADOT should engage with utility companies to reach consensus on developing and delivering 3D utility models. ADOT should also consider creating a utility database for storing and managing data related to utilities within ADOT's right-of-way.

Pilot Project #4: ITS and Traffic Features (Contractual)

The focus of this pilot project is to design and model ITS features, such as main fiber trunkline, foundations for CCTV, DMS, ramp meters, etc., In addition, ADOT should evaluate the modeling requirements for traffic elements such as signs, striping, etc., which may be modeled either in 2D or 3D. The development of 3D models for traffic features is dependent on whether visualization renderings will be used. In many cases, 2D elements are sufficient as long as they have intelligent attributes and metadata useful for asset management.

Use Case Description: This pilot scope of work should concentrate on producing MALD deliverables to facilitate:

- Estimation of quantities for ITS pay items.
- Verification of locations (station/offsets) and elevations of construction pay items.
- Installation of the assets including, main fiber trunkline and the placement of foundations for CCTV, DMES, ramp meters and detection.
- Coordination with other engineering disciplines and utility owners.
- Design optimal locations for ITS assets.
- Clash detection of proposed features and existing features.
- Documentation of element property attributes for ITS features.
- Data collection and delivery of digital as-builts for ITS assets.

Objective:

- Use the 3D roadway corridor model as the base for developing ITS contract models.
- Establish the standards, procedures, and deliverables for contractual digital data for roadway models that include ITS features.
- Optimize the design and placement of ITS features considering factors like accessibility, existing infrastructure, and potential obstacles.
- Evaluate the use of the 3D models to visualize placement of CCTV and determine optimum CCTV locations based on camera height, viewability and obstructions, and elevations of CCTV foundation.

Desired Outcome:

- Standards, specifications, and procedures for producing, reviewing, and constructing ITS features in a model-based environment for roadway or bridge projects.
- LOD and LOIN standards and specifications for ITS features appropriate for construction and documentation of digital as-builts.
- Procedures for producing, reviewing, bidding, and constructing roadway/bridge projects using MALD deliverables.

- CE&I standards and specifications for verification of installation and pay item documentation for ITS features.

Selection Criteria:

The most suitable projects for this type of pilot include those in which it is anticipated that the main fiber trunk line will be extended with roadway widening, realignment or new alignment construction with or without a bridge structure.

Pre-requisites:

- Procurement language that describes the order of controlling documents and special provisions related to digital delivery.
- Existing conditions survey data that has the level of accuracy, point density and resolution to support the MALD deliverables.
- Roadway and/or bridge modeling has been completed or is being completed as part of the project.
- Training material and interim guidelines are available to assist design teams to develop, review and deliver quality 3D models that include ITS and utility features.
- Interim guidelines to supplement the ADOT ITS Design Guide to assist design teams in preparing and reviewing milestone deliverables (e.g., 2D, 3D and digital tabular data).
- Software is set up with appropriate 2D and 3D object libraries, standard naming conventions for levels, element templates and feature definitions specific to ITS features.

Deliverables:

- MALD alignment files in LandXML format.
- MALD surface files representing the proposed finished grade surface in LandXML format.
- MALD drawing files representing objects being modeled in 3D (e.g., ORD files).
- Digital roll plot PDF that contains 2D geometry for other elements in the project not being modeled.
- Reports (PDF) showing details not being modeled, and source digital files for tabular data and quantities (e.g., spreadsheets).

Pilot Project #5: Hydraulic and Drainage Systems Modeling (Contractual)

The focus for these types of pilot projects is the design and modeling of drainage structures, such as storm sewer, cross drains, basins, and culverts.

Use Case Description: This pilot scope of work should concentrate on producing MALD deliverables to facilitate:

- Installation of new drainage structures.
- Estimation of quantities for drainage and storm sewer systems pay items.
- Verification of locations (station/offsets) and elevations of construction pay items.
- Installation of the drainage structures, storm sewer, cross drains, basis, and culverts.
- Design of optimal asset locations
- Clash detection of proposed features and existing features.
- Documentation of element property attributes for the delivery of digital as-builts for these drainage system assets.

Objective:

- Use the 3D roadway corridor model as the base for developing the drainage model deliverables.
- Establish the standards, procedures, and deliverables for contractual digital data for roadway models that include drainage features.
- Optimize the design and placement of drainage structures.

Desired Outcome:

- Standards, specifications, and procedures for producing, reviewing, bidding and constructing models that contain drainage features associated with the roadway or bridge model being delivered.
- LOD and LOIN standards and specifications for drainage systems within the roadway and/or bridge models appropriate for construction and documentation of digital as-builts.
- Procedures for producing, reviewing, bidding, and constructing roadway/bridge projects using MALD deliverables.
- CE&I standards and specifications for verification of installation and pay item documentation for drainage features.

Selection Criteria:

The most suitable projects for this type of pilot include those in which the scope of work includes the design of closed storm water networks.

Pre-requisites:

- Procurement language that describes the order of controlling documents and special provisions related to digital delivery.
- Existing conditions survey data that has the level of accuracy, point density and resolution to support the MALD deliverables.

- Roadway and/or bridge modeling has been completed or is being completed as part of the project.
- Training material and interim guidelines are available to assist design teams to develop, review and deliver quality 3D models that include drainage features.
- Software is set up with appropriate 2D and 3D object libraries, standard naming conventions for levels, element templates and feature definitions.

Deliverables:

- MALD alignment files in LandXML format.
- MALD surface files representing the proposed finished grade surface in LandXML format.
- MALD drawing files representing objects being modeled in 3D (e.g., ORD files).
- Digital roll plot PDF that contains 2D geometry for other elements in the project not being modeled.
- Reports (PDF) showing details not being modeled, and source digital files for tabular data and quantities (e.g., spreadsheets).

Pilot Project Teams: Training & Technical Support

This section covers the approach to provide training, guidance, and support for project teams through all phases of the pilot project. When finished, ADOT staff should have the skills and knowledge base to deliver a project in a digital format, per established ADOT delivery standards, for their specific role and responsibility.

Digital Delivery Execution Plan

As each pilot project is selected, each team should have a kickoff meeting in which the roles and responsibilities of each member of the team are established. A Digital Delivery Execution Plan (DDEP) should be drafted. This plan should:

- Communicate the project team's expectations for developing and delivering digital deliverables.
- Define the requirements for digital delivery, including compliance with modeling standards.
- Identify the workflows to be followed for each model use case.
- Define the data management and folder structure for all files.
- Specify the information exchanges and coordination between different stakeholders.
- Define roles and responsibilities for each project team member during the lifecycle of the project, inclusive of bidding and construction.
- Describe the tools and technologies, and versions of the software being used. Also, consider adding recommendations for managing updates to the software versions.
- Define quality checking and review procedures.

Pre-Requisites for Training

All project team members working on a pilot project should complete all modules listed under the Digital Delivery Methodology and Processes Knowledge Base section of Appendix C. Additional training will be determined based on project team members roles and responsibilities.

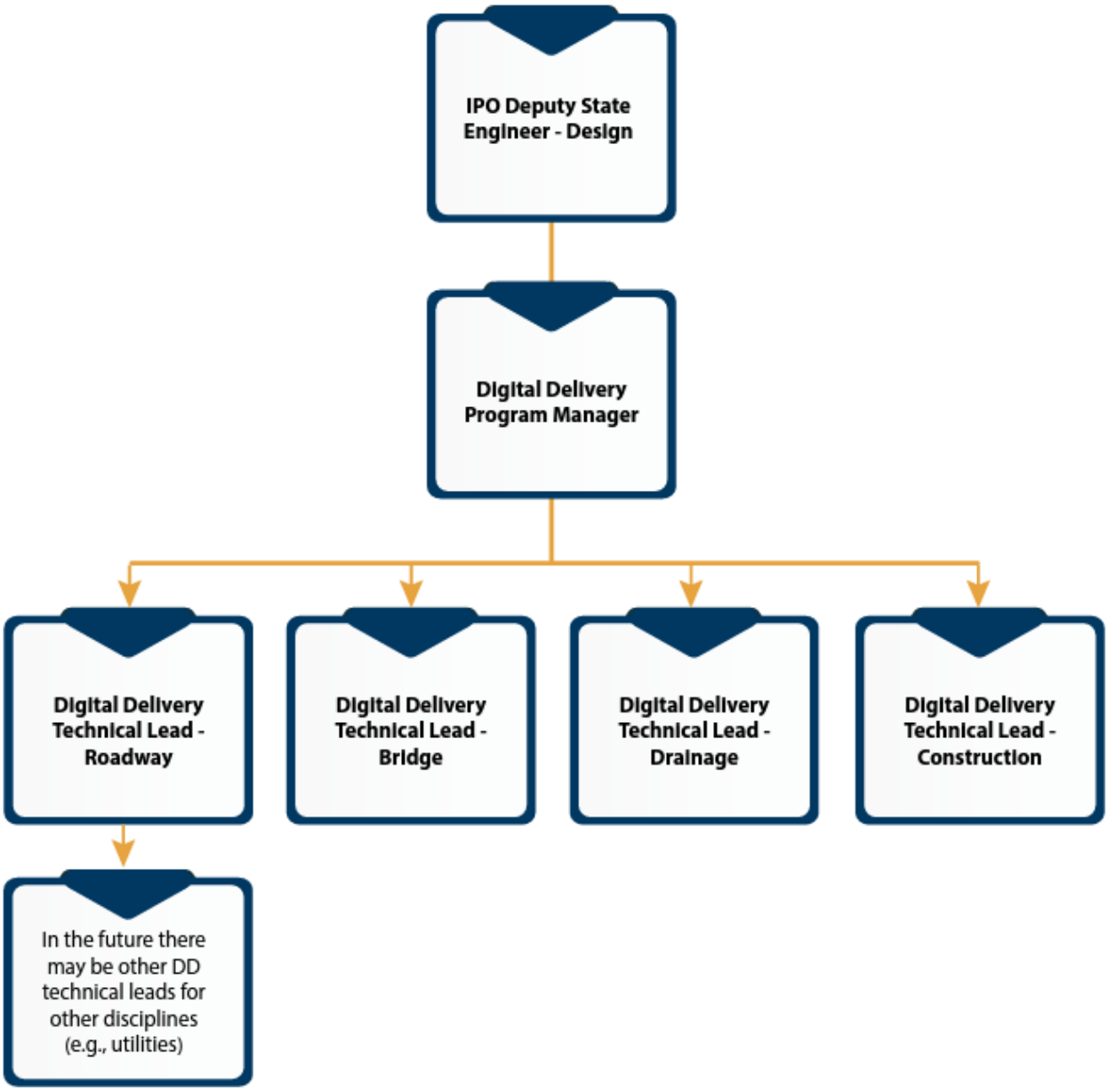
Just-in-Time Training

Training should be provided along a "just-in-time" schedule for the pilot projects that are identified for various use cases. Training will be delivered in various methods; instructor-led, in person, virtual, or webinar based. A training program should be established and tracked for each project, defining the roles of the individual contributors, and scheduling the appropriate training along the project's milestone schedule. For example, those that need to review the model information for a pilot project at Stage 2 would receive training just before the Stage 2 review milestone. While those that are creating model information would receive different training prior to beginning design. Construction inspectors for an identified pilot would receive training pertinent to the scope of the pilot just before construction begins. If a project's start is delayed or scheduled well into the future, a refresher course could be held before actual work begins.

Appendix A. Permanent Organizational Structure for DDP, Roles and Responsibilities

ADOT has an interim organizational structure composed of an executive champion, two digital delivery program leads, and three collaborating committees. While this arrangement is adequate for initiation of the program, ADOT should consider establishing a permanent organizational structure for the digital delivery program with dedicated resources to oversee long-term digital delivery policy, technology deployment and training, and overall technical support of standards, procedures and updates to guidance documents, and communication with internal and external stakeholders as the program matures. With the ambitious timeline to establish the ADOT Digital Delivery Program by end of calendar year 2025, it is recommended that ADOT identifies dedicated resources to start transitioning to a long-term organizational structure as soon as possible. ADOT should consider how a Digital Delivery Program fits into the current organization structure and assign a full-time employee to be the program manager, with two or three additional staff assisting in key areas in the short term, with a plan to expand the program staff in the future as digital delivery becomes the primary business practice. Figure A-1 illustrates a suggested organizational structure for ADOT DDP. Although the DDP is being piloted and started in IDO, the proposed permanent organizational structure for the DDP will leverage relationships to connect and collaborate the digital delivery efforts of the different divisions. These roles could range from model managers at the project level, similar to the role of project manager today, but specific to managing digital delivery requirements for projects to key digital delivery technical leads that assist with CAD and construction applications.

Figure A-1. Suggested Organizational Structure for ADOT Digital Delivery Program



Suggested role responsibilities and core competencies are described as follows:

- **Digital Delivery Program Manager (Program Level Role):** This position serves as the Department's lead and primary SME, and is responsible for change management strategies, digital delivery policy, technology deployment, training, technical support and for ADOT internal and external communication regarding the DDP. Core competencies considerations for these roles include strong leadership and communication skills, practical experience of project development and delivery, and general knowledge of technologies applicable for digital delivery.

- **Digital Delivery Technical Leads (Program Level Role):** These position(s) serve as SMEs for the DDP in their respective technical sections but work closely with other technical experts. Individuals in these positions are also familiar with the relationship of the various information needs and requirements (e.g., models, attributes, metadata) and connectivity between technical sections. These individuals are responsible for working with the technical committee to develop procedures, deploy technology, develop and deliver training for key areas of digital delivery, such as roadway modeling, bridge modeling, drainage modeling, and inclusion of other discipline models, as well as construction inspection. Core competencies considerations for these roles include understanding of the ADOT project development and delivery processes, digital delivery practices and technologies being used for programmatic data, quality management reviews, discipline specific 3D modeling software, and construction 3D model viewing technology.
- **Design Model Manager (Project and Discipline Level Role):** Technical staff responsible for coordinating with the DD Technical Leads to clarify project requirements and assisting project team members with development and execution of a project digital delivery execution plan, coordinating file management and combining or "federating" discipline models, educating project teams on digital delivery processes and expectations, and enforcing protocols for verifying modeling standards and model integrity. This role may only be needed for large complex projects in which multiple disciplines model portions of the project. Each discipline should also have a model manager responsible for discipline specific model integrity and completeness, and compliance with discipline specific CAD and modeling standards. For smaller projects in which only one discipline may be involved, only a discipline model manager may be needed. Core competencies considerations for this role include knowledge of modeling software specific to creating discipline-specific model elements, knowledge of ADOT project development requirements for a specific discipline (roadway, bridge, drainage, etc.)
- **CE&I Model Manager (Project Level Role):** Technical staff responsible for performing activities during construction related to using survey equipment and modeling software (e.g., Trimble Business Center) to assist with verification of locations, elevations, as well as measurement of quantities. This individual will serve as the digital delivery coordinator between the CE&I team, the contractor and the designer. Core competencies considerations for this role include knowledge of construction inspection processes and experience with modern survey data collection platforms, and modeling software. ***Initially, this role may fall under the Program Digital Delivery Technical Leads. However, as the program matures each district may consider having a technical lead that can serve this role for multiple projects. Large projects will require a dedicated person to fulfill this role.***

Appendix B. Communication and Engagement Plan Outline

The successful implementation of the ADOT Digital Delivery Program will include a robust, strategic communication and engagement plan designed to anticipate stakeholders' questions and concerns, to solicit input and provide collaboration among internal and external stakeholders during the implementation phase and, to update those stakeholders on program implementation progress.

Engagement Plan Objective

This communications and engagement plan outline will suggest direction on the design and implementation of engagement tools and tactics. The primary objectives of this plan are to:

- Identify key stakeholder audiences and users, and
- Offer strategies that will maximize engagement opportunities.

Key Messages

The communications and engagement program should highlight the anticipated benefits for the state, the industry, and the public during and after the digital delivery program deployment. Additional messaging should focus on answering two critical questions:

1. What do the key stakeholders most want to know about the program?
   Often, these questions are related to "what's in it for me?" and "how does this affect what I do?" Translating those basic questions into program information will be important to successfully anticipating the right information to share with ADOT staff and industry.
2. What do they need to know about the program to become involved and active participants?
   This question relates to sharing information about critical program milestones and successes and emphasize the program's anticipated benefits.

Target Audiences

The communication and engagement effort supporting implementation of the ADOT digital delivery program will focus on primary target audiences that include:

- ADOT managers and key implementation personnel.
- Industry stakeholders that may partner in the creation of digital files.
- Any additional stakeholder who might be impacted by the implementation and adoption of digital delivery but may not work with data models.

The ADOT digital delivery program surveyed members of the state consulting and contracting communities, which gathered specific input about the type of information these key audiences are most interested, as well as the way in which they preferred to be contacted and the frequency with which they preferred receiving the information. Further evaluation of the survey data – as well as information gathered from internal ADOT interviews and conversations -- will help support the planning and execution of the program outreach and engagement.

Engagement Strategies and Tactics

Tool/Tactic	Description	Deployment
ADOT program webpage **Target Audience: ADOT employees and industry**	A webpage has been developed to provide a program overview and serve as a repository of information detailing the implementation progress. The webpage also allows for the collection of questions and ideas from internal and industry stakeholders. The webpage will grow in size and complexity of information being shared during and after the program implementation phase. Examples include: PennDOT website, which began as a basic site but grew to include a variety of information. UDOT website, designed for a technical audience looking for guidance documents and training material.	One month after initiating the program implementation
Tool/Tactic	**Description**	**Deployment**
E-newsletter **Target Audience: Industry/ADOT staff**	Regular e-mailed updates (recommend quarterly) that share progress on the program, highlight successes and include other information in anticipation of questions and concerns. E-newsletter content and subscription signups will be found on the program webpage.	Quarterly updates starting three months after initiating program implementation
Tool/Tactic	**Description**	**Deployment**
Video **Target Audience: ADOT staff/Industry**	The brief video should be a general overview of what is included in the digital delivery program, highlighting key program milestones and the benefits for ADOT, the industry and the public	First quarter after initiating the program implementation
Tool/Tactic	**Description**	**Deployment**
Information materials **Target Audience: ADOT staff/Industry** **Target Audience: ADOT staff**	These will include a general fact sheet/flier explaining the digital delivery program; frequently asked questions; infographics; and presentations. These materials will be posted on	Ongoing throughout program.

Tool/Tactic	Description	Deployment
Industry presentations **Target Audience: Industry**	Timely presentations and updates will be provided to industry through regularly schedule events including Arizona ACEC Roads and Streets; Arizona AGC meetings; and other key industry activities.	Ongoing and as requested
Tool/Tactic	**Description**	**Deployment**
ADOT presentations **Target Audience: ADOT staff**	Quarterly presentations and updates will be provided to ADOT staff – possibly through video updates or other creative information delivery channels. This effort will differ from industry outreach in that it will focus on the unique challenges, perspectives, and potential insights specific to ADOT staff	Quarterly or more frequent if content and program need requires
Tool/Tactic	**Description**	**Deployment**
ADOT working group meetings **Target Audience: ADOT staff Industry Arizona State Board of Technical Registration**	ADOT DDP Committees will create working groups to lead and provide direct input during and after the implementation period. Each working group should establish goals, timeline, and desired outcomes for their specific tasks. This effort will differ from other industry and ADOT staff engagements in that it will focus on overseeing activities within this implementation plan. Creating smaller working groups provides the opportunity to engage additional stakeholders and empower them to be advisors for their areas of expertise.	Ongoing throughout the program

Measurement

The communication and engagement plan should measure how successfully and effectively program information is being shared and received. Potential measures could include:

- Webpage: number of visits; time spent on the site; information downloaded.
- Newsletters: percent of newsletters opened; click-throughs to articles and information.
- Video: views; time spent watching.
- Industry presentations: number of presentations given; audience size.
- Industry engagements.

Appendix C. Digital Delivery Training Program and Tool Development Plan

Purpose and Organization of Document

Purpose

The purpose of this training and tool development plan is to identify and define the content for specific training courses to develop the necessary competencies and knowledge base for successful implementation of the ADOT Digital Delivery Program. This plan is a living document that should be reviewed on an annual basis to update, revise, or add best practices, training requirements and recommendations, and address new tools and technologies. This plan provides the scope of training needed for each discipline in conjunction with the Implementation Plan which identifies training resources, funding opportunities and roles.

Course Competency Levels

- **Fundamental:** This level provides the foundation for digital delivery concepts, terminology, and application.
- **Intermediate:** This level is for users looking to move beyond the basics in the digital delivery process. Users are typically production level and at least have a basic understanding of the digital delivery process and products.
- **Advanced:** This level is for users who are seen as SMEs. Users have a significant understanding of the digital delivery process and products.

Recommendations for Training Resources

ADOT Resources

The following resources are available to ADOT via internal resources, current contracts, or on-line content. This information is provided to assist ADOT in selecting the appropriate resources for developing the courses identified in this document.

- ADOT Training and Development Section may be a resource to assist in managing training courses and working with subject matter experts to schedule.
- Bentley resources, such as out-of-the box online training (Bentley LEARN), and professional services using credits available as part of ADOT's Bentley 365 agreement. Close collaboration with ITG will be needed to secure the services of Bentley staff.
- ACEC and AGC input via Steering and Technical Digital Delivery Program Committees. and consultant services through current project contract agreements.
- Consultants working on current ADOT projects, or through separate agreements.

Peer State DOT Training Resources

Several agencies have training materials and resources available on-line. The information from other DOTs is typically specific to how that agency does business, and this should be considered when opting to use another DOT's materials. This list is not all inclusive, and it is based on a cursory review of available resources to-date (date of this document) and is continually changing as the software and industry evolve. Lastly, the version of software must be considered when reviewing other DOT training resources to ensure version compatibility.

- Ohio DOT (ODOT)
  - CADD Training Guides | Ohio Department of Transportation
- Pennsylvania DOT (PennDOT)
  - CADD Resources (pa.gov)
- Tennessee DOT (TDOT)
  - TDOT OpenRoads Designer
- Utah DOT (UDOT)
  - UDOT Digital Delivery (utah.gov)

Other Resources

Other sources of information to consider when developing training material include:

- FHWA
  - Building Information Modeling (BIM) for Infrastructure Products | FHWA (dot.gov)
  - Building Information Modeling (BIM) for Infrastructure - BIM - Technologies and Innovations - Construction - Federal Highway Administration (dot.gov)
- FHWA Federal Lands
  - CADD Support | FHWA (dot.gov)
- Transportation Pooled Funds
  - BIM - Structures - Bridges & Structures - Federal Highway Administration (dot.gov)
- Standard Organizations
  - Building Information Management (BIM) Council | National Institute of Building Sciences (nibs.org)
  - bSI Standards - buildingSMART International

Recommendations for Skills Assessment and Refresher Training

To demonstrate proficiency in any given topic, software, or class, it is recommended that certificates and accreditations be leveraged. Certificates and accreditations can be either ADOT generated or an outside vendor, such as Bentley Learning Certificates and Accreditations. Skills assessments create a culture of continuous learning; demonstrate an understanding of concepts, ideas, and software, and encourage stakeholders to adapt to the changing needs of digital delivery.

It is recommended that training be completed "just-in-time" for the user to immediately apply their skills and knowledge. Refresher training is recommended to align with the renewal of certificates,

accreditation and skills assessments which are typically every twelve (12) to twenty-four (24) months. All the courses listed within this plan should be updated to reflect technological changes, and lessons learned through digital delivery pilot projects. If updated appropriately, these courses may also serve as refresher courses at any time.

Cross Training

The following section provides recommendations on the target audience for each course. Many sections, groups and disciplines will benefit from cross training outside of their specialty. For example, roadway, bridge, drainage, GIS, etc., benefit from understanding other information and software outside of their specialty. Specific targeted cross training courses or leveraging recorded trainings may be beneficial to users as the program progresses.

Suggested Courses for Digital Delivery Implementation Plan

This section of the document provides a high-level overview of the training courses that HDR has identified for successful statewide implementation of digital delivery. We have identified two types of courses (1) Digital Delivery Methodology and Processes Knowledge Base, and (2) Modeling Software Skill Set Development. Each recommendation provides:

- Name of the course (Level)
- Course overview and objectives.
- Target audience.
- Course pre-requisites.
- Suggested duration and delivery method.

Digital Delivery Methodology and Processes Knowledge Base Courses

The courses under this category set the foundation for more advanced topics specific to each discipline. The competency level for all courses in this section is "Fundamental". In general, the target audience for the courses listed in this section is any stakeholder who is involved in the project development and delivery of ADOT projects and is new to digital delivery methodology. Because these are foundational courses, it is recommended to deliver their content using live or pre-recorded webinars. Having a library of content to use as reference makes the program sustainable long term. The courses should be reviewed annually to determine if the content should be revised based on changes in technology, policy, or standards. Table C-1 lists the courses described within this section.

Table C-1. Digital Delivery Methodology and Process Knowledge Courses (Fundamental).

Course Name	Pre-requisites[1]	Target Audience	Duration & Delivery Method
Module 1. Digital Delivery Overview	None	All stakeholders involved in ADOT projects	2-hour live or pre-recorded webinar
Module 2. Project Development Data Management Concepts	None	Project development staff	1-hour live or pre-recorded webinar
Module 3. Modeling Standards	Modules 1 and 2	Project development and construction staff	2-hour live or pre-recorded webinar
Module 4. Quality Management	Modules 1, 2, and 3	Project development and construction staff	2-hour live or pre-recorded webinar
Module 5. Project Development Milestone Submittals	Modules 1, 2, 3 and 4	Project design staff preparing milestone submittals	2-hour live or pre-recorded webinar
Module 6. Overview of Digital Workflows for Contracts & Specifications Tasks	Modules 1, 2, 3, 4 and 5	Contract and & Specifications staff	2-hour live or pre-recorded webinar

[1] Listed as minimum requirements but all these courses may be taken at any time as refresher courses. See cross-training section.

Module 1. Digital Delivery Overview (Fundamental)

Course Overview and Objectives

This course introduces users to ADOT's Digital Delivery Program, as well as general digital delivery concepts and definitions. At the conclusion of this course, participants will be able to:

- Describe the vision and objectives of ADOT's Digital Delivery Program.
- Explain general digital delivery concepts and definitions.
- Define the user's role and responsibilities for their portion of the digital delivery lifecycle.
- Explain how digital delivery requirements are defined in a consultant agreement.
- Identify training needs based on group.

Topics covered in this course include:

- Vision, mission, and timeline for ADOT's Digital Delivery Program.
- Definitions for digital delivery, building information modeling, level of development, level of information need, and other key terms.
- List technologies and software packages available for each business function and use cases, and the people who support them.
- Roles and responsibilities for users during the digital delivery project lifecycle.
- Describe milestone deliverables for each phase of the ADOT project development lifecycle and who handles each of those deliverables.
- Provide general guidance on creating scoping documents for consultant agreements.
- Training requirements by groups with most receiving fundamental training and additional intermediate or advanced training as noted.

Target Audience

All stakeholders involved in the development and delivery (construction) of ADOT projects, including internal staff, consultants, contractors, and sister agencies.

Pre-Requisites

None.

Suggested Duration and Delivery Method

A 2-hour live or pre-recorded webinar. An annual 1-hour live or pre-recorded refresher webinar.

Module 2. Project Development Data Management Concepts (Fundamental)

Course Overview and Objectives

This course introduces users to data management concepts used during project development. At the conclusion of this course, participants will be able to:

- Explain the where, why, and how files (CADD, GIS, etc.) are organized.
- Define data management terminology.
- Explain and implement ADOT's standards regarding project setup structure, file naming conventions, and other information management requirements.

Topics covered in this course include:

- Strategies in the organization of projects and in the management of data, including CAD, GIS, spreadsheets, etc.
- Data management specific terminology.
- Project and file structures, file naming conventions.

Target Audience

All stakeholders involved in ADOT projects, including internal ADOT staff, consultants, contractors, and any recipient of ADOT project data.

Pre-Requisites

None.

Suggested Duration and Delivery Method

A 1-hour live or pre-recorded webinar. An annual 1-hour live or pre-recorded refresher webinar.

Module 3. Modeling Standards (Fundamental)

Course Overview and Objectives

This course provides the fundamental skills participants need for working in the new CAD and digital environment. At the conclusion of this course, participants will be able to:

- Describe and apply the requirements for modeling projects in 2D and 3D.
- Document the design intent of a design model.
- Describe and document the authorized use for design elements.
- Describe and implement a federated model structure.

Topics covered in this fundamental course include:

- Model Element Breakdown Structure (MEBs)
- Level of Detail (LOD) and Level of Information Need (LOIN)
- Definitions of use cases and authorized uses.
- Documentation of model design intent through a Digital Delivery Execution Plan (DDEP).
- Federated model structures and best practices.

Target Audience

All stakeholders involved in ADOT projects, including internal staff, consultants, contractors, and any recipient of ADOT project data.

Pre-Requisites

Modules 1 and 2.

Suggested Duration and Delivery Method

A 2-hour live or pre-recorded webinar. Quarterly 1-hour live webinars to revisit modeling standard topics and answer participant questions.

Module 4. Quality Management (Fundamental)

Course Overview and Objectives

This course provides foundational key concepts to be used by project reviewers as a reference for clarifying the standard of care within model-based digital delivery and documenting a consistent, repeatable, and traceable quality management process. This course will focus on the process for reviewing, validating, and documenting reviews regardless of software. This course is intended to be complementary to specific software training for model-based review (i.e., Bentley ProjectWise Design Review). At the conclusion of this course, participants will be able to:

- Describe key concepts for proper quality management procedures.
- Explain the difference between process control versus product control.
- Roles and responsibilities for various stakeholders involved in project development.
- Describe the types of reviews and software options for each type.
- List the requirements for model integrity and design compliance reviews.
- Explain the differences between design compliance and model integrity reviews.

Topics covered in this Fundamental course include:

- General terminology and key concepts related to quality management practices.
- Best practices on approval and record management protocols.
- Applying the requirements and best practices for design compliance reviews.
- Applying the requirements and best practices for model integrity reviews.
- Commercial off-of-the shelf (COTS) software available for performing model-based reviews.

Target Audience

All stakeholders involved in ADOT project development, review, and construction delivery of projects, including internal staff, consultants, contractors, and recipient of ADOT project data.

Pre-Requisites

Modules 1, 2, and 3.

Suggested Duration and Delivery Method

A 2-hour live or pre-recorded webinar. An annual 1-hour live refresher webinar.

Module 5. Project Development Milestone Submittals (Fundamental)

Course Overview and Objectives

This course introduces users to ADOT's project development milestone submittals. At the conclusion of this course, participants will be able to describe:

- Deliverables required for each milestone.
- Methods for preparing and submitting milestone deliverables.
- Data format required for each milestone deliverable.
- Best practices for passing a model from design to construction.

Topics covered in this course include:

- Requirements for milestone digital documents, including digital model files and electronic documents (PDFs).
- Preparing and publishing digital submittals.
- Preparing model files for quality management reviews.
- Setting up review model containers.
- Setting up review sessions for non-CAD users.

Target Audience

All design staff responsible for preparing and submitting milestone deliverables for ADOT projects, including internal staff and consultants. In addition, any stakeholder receiving ADOT project data, such as project managers, Contract & Specifications staff, and external parties (e.g., utilities, sister and regulatory agencies).

Pre-Requisites

Modules 1, 2, and 3.

Module 6. Overview of Digital Workflows for Contracts & Specifications (Fundamental)

Course Overview and Objectives

This course provides an overview of the type of deliverables being submitted by design teams, and methods for transferring, reviewing, and posting those deliverables for the bid letting. At the conclusion of the course, participants will be able to:

- Define the new types of digital deliverables being submitted by design teams.
- Explain how new digital deliverables will be transmitted by design teams.
- Describe the process for reviewing new digital deliverables for contract and specification compliance.
- Explain the process for posting new digital deliverables for the bid letting.

Topics covered in this course include:

- Overview of the deliverables needed to advertise and solicit bids for a digital project.
- Project file structure and file naming conventions.
- Process for reviewing the digital delivery bid package.
- Process for advertising digital files as legal documents.

Target Audience

Contracts & Specifications staff involved in the advertising of digital delivery projects.

Pre-Requisites

Modules 1, 2, 3, 4, and 5.

Suggested Duration and Delivery Method

A 2-hour live or pre-recorded webinar. An annual 1-hour live refresher webinar.

Modeling Software Skill Set Development Courses

The courses under this category build on the concepts learned in the courses designated as fundamental. Courses described in this section are specific to software being used for creating or using digital deliverables and may be specific to each discipline. The competency level for these courses range from fundamental to advanced. In general, the target audience for the courses listed in this section is anyone that uses the software for developing, reviewing, and consuming digital models. Table C-2 provides a quick look at all of the courses described within this section. However, detailed information is provided for each course too.

Table C-2. Modeling Software Skill Set Development Courses.

Course Name	Competency Level	Pre-requisites	Target Audience	Duration & Delivery Method
Module 7. Overview of ORD Modeling & Plan Production	Fundamental	Modules 1, 2, and 3	Project development staff preparing design deliverables	4, 3-hour live webinars covering the course objectives
Module 8. ORD for Survey	Intermediate	Modules 1, 2, 3, 4, and 7	Survey staff	4, 3-hour hands-on sessions
Module 9. ORD for Roadway Modeling Part 1	Intermediate	Modules 1, 2, 3, 4, and 7	Roadway designers	4, 3-hour live webinar demonstrations
Module 10. ORD for Roadway Modeling Part 2	Advanced	Modules 1, 2, 3, 4, 7, and 9	Roadway designers	4, 3-hour live webinar demonstrations
Module 11. OBD for Bridge Modeling Part 1	Intermediate	Modules 1, 2, 3, 4, 5, and 7	Bridge designers	4, 3-hour hands-on sessions
Module 12. OBD for Bridge Modeling Part 2	Advanced	Modules 1, 2, 3, 4, 5, 7, and 11	Bridge designers	4, 3-hour hands-on sessions
Module 13. ORD for Drainage	Intermediate	Modules 1, 2, 3, 4, 5, and 7	Hydrology, Hydraulic, and Drainage designers	4, 3-hour hands-on sessions

Table C-2. Modeling Software Skill Set Development Courses. (Continued)

Course Name	Competency Level	Pre-requisites	Target Audience	Duration & Delivery Method
Module 14. ORD for Utilities and ITS	Intermediate	Modules 1, 2, 3, 4, 5, and 7	Utility and ITS designers	4, 3-hour hands-on sessions
Module 15. Construction Engineering & Inspection for Digital Delivery	Fundamental	Modules 1, 2, 3, and 4	Construction managers, administrators, and inspectors	4, 3-hour hands-on sessions
Module 16. Collection & Submittal of Digital Record Drawings	Fundamental	TBD	TBD	TBD

Module 7. Overview of ORD Modeling & Plan Production (Fundamental)

Course Overview and Objectives

This course provides fundamental CAD and modeling workflows and strategies related to digital delivery of models and plans. At the conclusion of this course, participants will be able to:

- Explain workflows for different elements of work.
- Identify tools and techniques for modeling and plan production in MicroStation CONNECT and OpenRoads Designer.
- Describe best practices for transitioning from MicroStation V8i to MicroStation Connect, and from InRoads SS2 to ORD.

Topics covered in this Fundamental course include:

- Overview of ADOT's CAD standards.
- Strategies for transitioning from legacy products (MicroStation V8i and InRoads) to MicroStation CONNECT and OpenRoads Designer.
- Introduction to working with data sources and terrain models.
- Creating basic geometry, corridors, and placing point features using ORD.
- Creating and viewing dynamic profiles, cross sections, and earthwork.
- Introduction to drawing production techniques.

Target Audience

All users of MicroStation CONNECT, ORD, OBD, or any other OpenX platform for the development of ADOT projects. This course is specific to those developing design deliverables.

Pre-Requisites

Modules 1, 2, and 3.

Suggested Duration and Delivery Method

Four separate 3-hour live webinars covering the course objectives. Quarterly 1-hour live webinars to revisit modeling workflows and strategies and to answer participant questions.

Module 8. ORD for Survey (Intermediate)

Course Overview and Objectives

This course builds on participants' fundamental skills and introduces them to the ORD for Survey workflow and tools. At the conclusion of this course, participants will be able to:

- Import and edit field books from the data collector.
- Learn to import, create, and analyze terrain models.
- Develop and edit civil geometry.
- Learn to cut sheets, place labels and text, and plot sheets.
- Generate reports for review and documentation.

Topics covered in the Intermediate course include:

- Creating project seed files with geographic coordinate systems.
- Importing and reviewing various forms of survey data.
- Using and applying more complex tools and analysis of terrain models.
- Creating existing geometry, including regression tools and COGO points.
- Preparing reports for recording and model-based reviews.

Target Audience

Users of the ORD Survey workflow in the development of survey deliverables for ADOT projects, including internal staff and consultants. This course is specific to those developing engineering survey deliverables.

Pre-Requisites

Modules 1, 2, 3, 4, and 7.

Suggested Duration and Delivery Method

Four separate 3-hour hands-on sessions that focus on proper survey techniques, to ensure a consistent and accurate representation of the existing base mapping, terrain models, and existing alignments. Quarterly 1-hour live webinars to revisit survey modeling workflows and strategies and to answer participant questions.

Module 9. ORD for Roadway Modeling Part 1 (Intermediate)

Course Overview and Objectives

This course builds on participants' fundamental skills and expands their modeling skills in ORD. At the conclusion of this course, participants will be able to:

- Setup and use container files for model and plan production.
- Model more complex roadway elements.
- Apply more complex template library concepts.
- Define and identify model attributes via Item Types.
- Select review tools to perform model integrity and design compliance reviews.
- Set up a federated model (combined discipline models) for design reviews, clash detection, and detailed checks.

Topics covered in the ORD for Roadway Modeling Part 1 course include:

- Best practices and terminology related to advancing modeling skills.
- Best practices for setting up, reviewing, and managing container files.
- Advanced modeling tools and techniques for designing ramps, gores, and intersections.
- Deeper dive into design and modeling workflows for geometry, corridors, and end condition management on small and large projects.
- Expanding civil based plan production workflows for non-standard situations, title block management techniques, introduction to Item Types, and table tools.
- Advancing template library knowledge related to components, constraints, backbones, end conditions, triggers and switches, and best practices for organizing libraries.
- Applying best practices for terrain models, such as creating complex terrain models and methods for creating proposed terrain models.
- Tools and best practices for preparing and using federated models for clash detection and reviews.

Target Audience

Users of ORD for preparing road design deliverables for ADOT projects, including internal staff and consultants. This course is specific to those developing design deliverables.

Pre-Requisites

Modules 1, 2, 3, 4, and 7.

Suggested Duration and Delivery Method

Four separate 3-hour live webinars that provide hands-on modeling training focusing on proper modeling techniques to ensure a consistent and accurate representation of the proposed roadway in a digital environment. Quarterly 1-hour live webinars to revisit roadway modeling workflows and strategies and to answer participant questions.

Module 10. ORD for Roadway Modeling Part 2 (Advanced)

Course Overview and Objectives

This course builds upon the ORD skills learned in the intermediate course and introduces advanced tools and techniques. At the conclusion of this course, participants will be able to:

- Create and manage complex end conditions.
- Create and model corridors.
- Create, manage, and apply model attributes via Item Types.
- Perform model integrity reviews for complex elements.

Topics covered in the Intermediate course include:

- Advanced modeling tools and techniques for complex end conditions, such as various types of walls, roundabouts, and diverging diamond interchanges.
- Creating staged construction models.

Target Audience

Advanced users of ORD in the development of roadway deliverables for ADOT projects, including internal staff and consultants. This course is specific to those developing design deliverables.

Pre-Requisites

Modules 1, 2, 3, 4, 7, and 9.

Suggested Duration and Delivery Method

Four separate 3-hour live webinars that provide hands-on modeling training focusing on proper modeling techniques to ensure a consistent and accurate representation of the proposed roadway in a digital environment. Quarterly 1-hour live webinars to revisit roadway modeling workflows and strategies and to answer participant questions.

Module 11. OBD for Bridge Modeling Part 1 (Intermediate)

Course Overview and Objectives

This course builds on participants' fundamental skills and introduces them to OBD. At the conclusion of this course, participants will be able to:

- Describe the typical workflow for modeling structures in 2D and 3D using OBD.
- Describe the files needed before starting to model a structure in 2D and 3D.
- Access and navigate the OBD interface.
- Describe bridge types and catalog of components and templates.
- Reference roadway geometry and terrain models into OBD files.
- Define a bridge centerline and add support pier locations.
- Place superstructure and substructure elements using delivered library templates.
- Locate roadway superelevation information and assign it to a bridge.
- Create various reports for review and documentation.
- Describe and implement the plan production process related to bridges.
- Prepare bridge models for model integrity and design compliance reviews.

Topics covered in this course include:

- Overview of the OBD interface.
- Referencing ORD data.
- Best practices and terminology for OBD.
- Fundamentals of 2D and 3D modeling for structure projects, including file and model federation.
- Creating bridge geometry from bridge template libraries.
- Bridge libraries, substructure, and connections.
- 2D and 3D drafting and modeling techniques and requirements.
- Plan production tools and techniques.
- Preparing bridge models and reports for review.

Target Audience

Users of OBD in the development of structure 3D model deliverables for ADOT projects, including internal staff and consultants. This course is specific to those developing bridge design deliverables.

Pre-Requisites

Modules 1, 2, 3, and 4.

Suggested Duration and Delivery Method

Four separate 3-hour hands-on modeling training sessions that focus on proper modeling techniques, address structural analysis and design of structures within the digital environment and how those

applications/processes ensure a consistent and accurate representation of a bridge in a digital environment. Quarterly 1-hour live webinars to revisit bridge modeling workflows and strategies and to answer participant questions.

Module 12. OBD for Bridge Modeling Part 2 (Advanced)

Course Overview and Objectives

This course builds upon the OBD skills learned in the intermediate course and introduces advanced tools and techniques for OBD and ProStructures. At the conclusion of this course, participants will be able to:

- Create parametric functional components for custom bridge elements.
- Use advanced tools for bridge modeling, including reinforcement detailing.
- Model various types of bridges, such as concrete girders or post tensioned.
- Set up bridge libraries.
- Interoperate between OBD and bridge analytical products, such as LEAP bridge, ProConcrete, and ProStructures.
- Describe the process for excavation.
- Describe the workflow for creating structural details using ProStructures.
- Add reinforcing to bridge models and produce reinforcing schedules.
- Create a variety of steel parts and connections.
- Prepare bridge models for model integrity and design compliance reviews for complex elements.

Topics covered in this course include:

- Modeling various types of bridges including prestressed beam, steel girder, and segmental.
- Creating functional and parametric components for custom bridge elements, such as abutments.
- Interoperability workflows between OBD, ProConcrete, ProStructures, and LEAP bridge.
- Creating and modeling bridge details.
- ProStructures role within the bridge modeling workflow.
- Adding reinforcing to concrete elements.
- Assigning bar marks to reinforcing and generating rebar schedules.
- Adding steel plates and shapes to bridge models.
- Creating bolted connections between steel parts.

Target Audience

Advanced users of OBD and ProStructures in the development of structural deliverables for ADOT projects, including internal staff and consultants. This course is specific to those developing design deliverables.

Pre-Requisites

Modules 1, 2, 3, 4, 5, 7, and 11.

Suggested Duration and Delivery Method

Four separate 3-hour hands-on modeling training sessions that focus on advanced topics showing parametric design and complex modeling concepts. Quarterly 1-hour live webinars to revisit bridge modeling workflows and strategies and to answer participant questions.

Module 13. ORD for Drainage (Intermediate)

Course Overview and Objectives

This course builds on participants' fundamental skills and introduces them to ORD drainage workflow and tools. At the conclusion of this course, participants will be able to:

- Explain best practices related to drainage workflows.
- Describe the typical process for modeling drainage networks using ORD.
- Model drainage specific elements, such as channels and ponds.
- Describe how 3D cells and conduits are assembled and function in a 2D and 3D view.
- Describe how to use drainage system layout and hydrologic/hydraulic analysis tools.
- Describe the hydrologic/hydraulic model components, design constraints, and prototypes.
- Run scenarios and alternatives, and how to manage and create flex tables, queries, and calculation reports.
- Explore other tools such as StormCAD and SewerCAD to create hydraulic analysis for closed and open channel drainage systems.
- Perform model integrity and design compliance reviews for hydrology, hydraulic, and drainage systems.

Topics covered in the Intermediate course include:

- Best practices for drainage tasks.
- Using site modeling and non-corridor modeling tools for channels and ponds.
- Referencing roadway and other discipline models.
- Placing, importing, and designing drainage features, including the relationship of 2D and 3D elements.
- Creating drainage plans, profiles, sections, and details.
- Understanding the hydrologic/hydraulic analysis tools, such as rainfall curves, routing methods, drainage options, and engineering standards.
- Reviewing and analyzing hydraulic properties and models.
- Performing clash detection and conflict review.
- Introduction to model attributes.

- Preparing models for model integrity and design compliance reviews for hydrology, hydraulic, and drainage systems.

Target Audience

This course should be designed for those who use ORD in the development of drainage, hydraulic, and hydrology deliverables for ADOT projects, including internal staff and consultants. This course is specific to those developing design deliverables.

Pre-Requisites

Modules 1, 2, 3, 4, 5, and 7.

Suggested Duration and Delivery Method

Four separate 3-hour hands-on training sessions that focus on proper drainage modeling techniques, site modeling, and hydraulic/hydrologic analysis. Quarterly 1-hour live webinars to revisit drainage and modeling workflows and strategies and to answer participant questions.

Module 14. ORD for Utilities and ITS (Intermediate)

Course Overview and Objectives

This course builds on ORD fundamental skills and introduces ORD for designers responsible for modeling utilities and ITS elements. At the conclusion of this course, participants will be able to:

- Define and apply best practices for modeling utility and ITS elements.
- Explain the typical process for modeling utility and ITS elements in 3D.
- Use 2D and 3D tools specific to layout and design of utility and ITS elements.
- Reference other discipline data, such as roadway and structural models, and existing terrain models.
- Create utility plans and profiles.
- Perform and document clash detection and identify conflicts.
- Explain model attributes.

Topics covered in this course include:

- Use tools specific to utility and ITS design, such as extracting existing utilities from graphics and placing nodes and conduits.
- Model utility trenches.
- Explore utility features for isolating utility information.
- Create utility plans, profiles, and details.
- Prepare and generate clash detection files and reports between existing and proposed utilities and other disciplines, such as roadway, bridge, ITS, traffic, and drainage.
- Preparing models for detail checking and quality reviews.

Target Audience

Users of ORD in the development of utility deliverables for ADOT projects, including internal staff and consultants. This course is specific to those developing design deliverables.

Pre-Requisites

Modules 1, 2, 3, 4, 5, and 7.

Suggested Duration and Delivery Method

Two separate 3-hour hands-on training sessions that focus on proper utility modeling techniques. Quarterly 1-hour live webinars to revisit utility and modeling workflows and strategies and to answer participant questions.

Module 15. Construction Engineering & Inspection for Digital Delivery (Fundamental)

Course Overview and Objectives

This course provides an overview of using 2D and 3D model-based deliverables to perform contract project administration, as well as inspection in a 2D and 3D model-based environment. At the conclusion of this course, participants will be able to:

- Open and navigate a 2D and 3D model using a model-based construction application.
- List and explain tools used for obtaining model-based information.
- Explain the process for managing data files and updates during construction.
- Create, update, submit, and approve construction forms, such as RFIs or daily reports, that can be tagged to model objects and information.
- Describe the process for accessing information from a model that was traditionally found in contract plans.
- Describe the general requirements and process for accepting digital as-built models from contractors.

Topics covered in this course include:

- Selecting the right tools for contract management and inspection.
- Transitioning from traditional plans to model-based data.
- Specifications and best practices for managing model updates during construction.
- Data collection tools for field inspection and documentation.
- Form creation and workflows for reviewing and/or approving RFIs, work reports, issue resolutions, etc. that are tied to model elements.
- Specifications and requirements for accepting digital as-built models from contractors.

Target Audience

Construction managers, administrators, inspectors, and surveyors that are involved in the construction delivery of projects.

Pre-Requisites

Digital Delivery Overview and Project Development Data Management Concepts.

Suggested Duration and Delivery Method

Two separate 4-hour hands-on training sessions that focus on equipment and tools, techniques, and processes of collecting field data for record drawings, record drawings, and asset management. Quarterly 1-hour live webinars to revisit workflows and strategies, answer participant questions, and share lessons learned.

Module 16. Collection & Submittal of Digital Record Drawings (Fundamental)

Course Overview and Objectives

This course provides a general overview of collecting and submitting digital as-builts during construction. At the conclusion of this course, participants will be able to:

- Define what information should be included in a digital as-built record, and why it is important to ADOT.
- Describe technology and procedures for collecting and validating digital as-built records.
- Explain the differences in digital as-built records versus record drawings.
- Define the roles and responsibilities for collecting, verifying, and submitting digital as-built records.
- Identify standards for collecting and recording as-built data.

Topics covered in this course include:

- Purpose of digital as-built records and importance of consistent, quality, and prompt data collection.
- Roles and responsibilities for collecting, submitting, and approving digital as-built records.
- Information delivery requirements for digital as-built records defining the data to be collected and details regarding its accuracy.
- Technology for collecting and recording digital as-built records.
- Proper review techniques, including object attribution, and proper validation of the record drawings before final submittal to the ROAD Portal or designated archival location.
- State of the practice by other DOTs.

Target Audience

All staff responsible for collecting, validating, and submitting digital as-built records.

Pre-Requisites

TBD.

Suggested Duration and Delivery Method

TBD.

Example Training Matrix

Table C-3. Examples of a Training Matrix

Training Paths	Bridge	Construction	C&S, PMG	Drainage	Environmental	Geotech	Right-of-Way	Roadside	Roadway	Surveying	Traffic and ITS	Utilities
Fundamental (Data Management)	X	X	X	X	X	X	X	X	X	X	X	X
Fundamental (MicroStation CONNNECT)	X			X	X	X	X	X	X	X	X	X
Fundamental (ORD)	X			X	X	X	X	X	X	X	X	X
Fundamental (Survey)	X	X		X			X		X	X	X	X
Fundamental (Review)	X	X	X	X	X	X	X	X	X	X	X	X
Fundamental (Construction)		X										
Intermediate (MicroStation CONNNECT)	X			X	X	X	X	X	X	X	X	X
Intermediate (Drainage)				X								
Intermediate (Bridge)	X											
Intermediate (ORD)									X			
Intermediate (R/W)							X					
Intermediate (Survey)										X		
Intermediate (Utilities)									X	X	X	X
Advanced (Drainage)				X								
Advanced (Bridge)	X											
Advanced (ORD)									X			
Advanced (R/W)							X					
Advanced (Survey)										X		

Training Delivery Options

Various avenues exist for training users, from in person to virtual. Most users lose focus after a couple of hours and productivity/retention reduces. In the initial rollout, more intensive, longer, training may be required to bring users to a fundamental level. Over time, the training may be best delivered using one or more of the methods. The Table C-4 below provides recommendations on the various training delivery options.

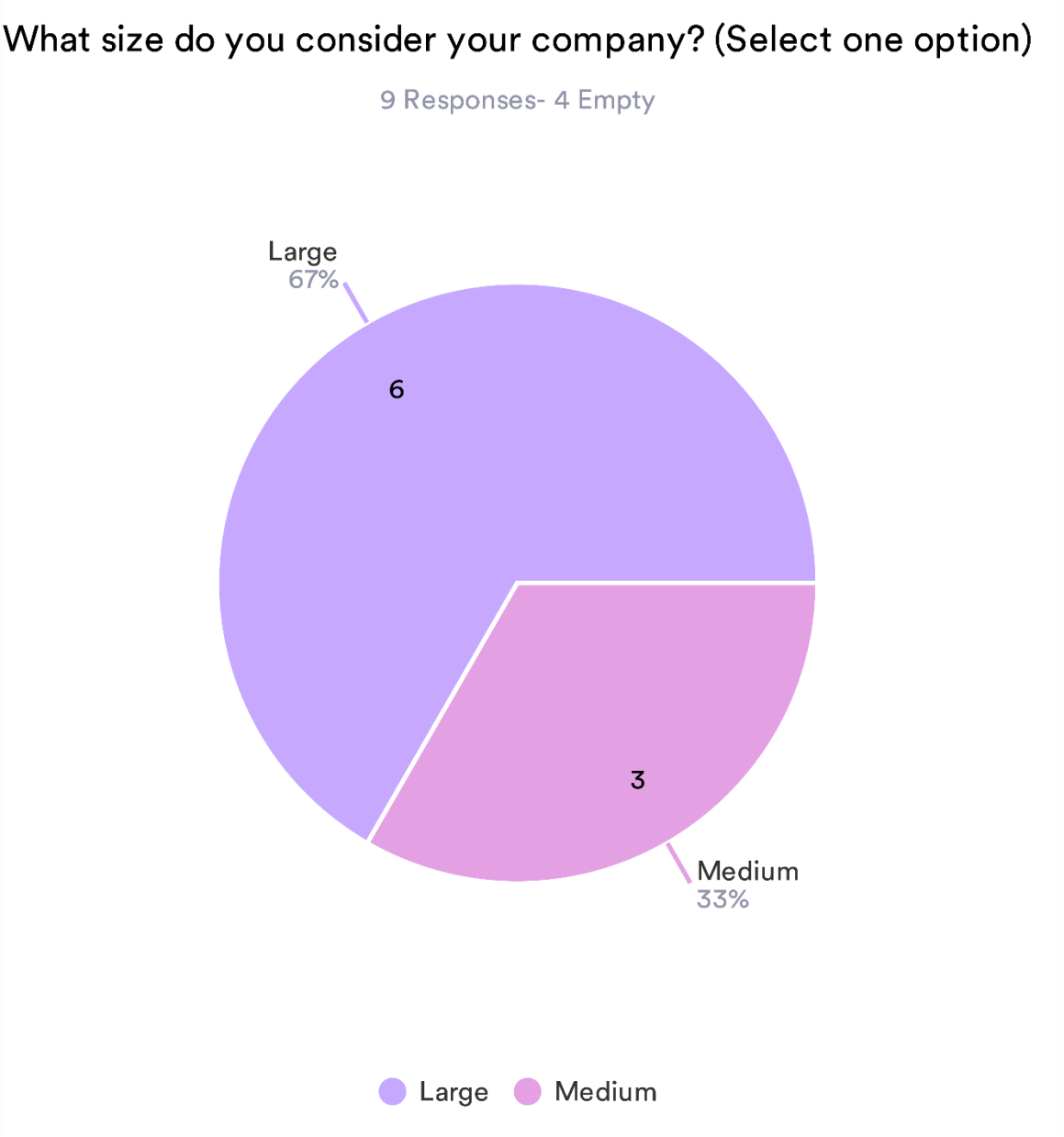
Table C-4. Recommendations on the Various Training Delivery Options

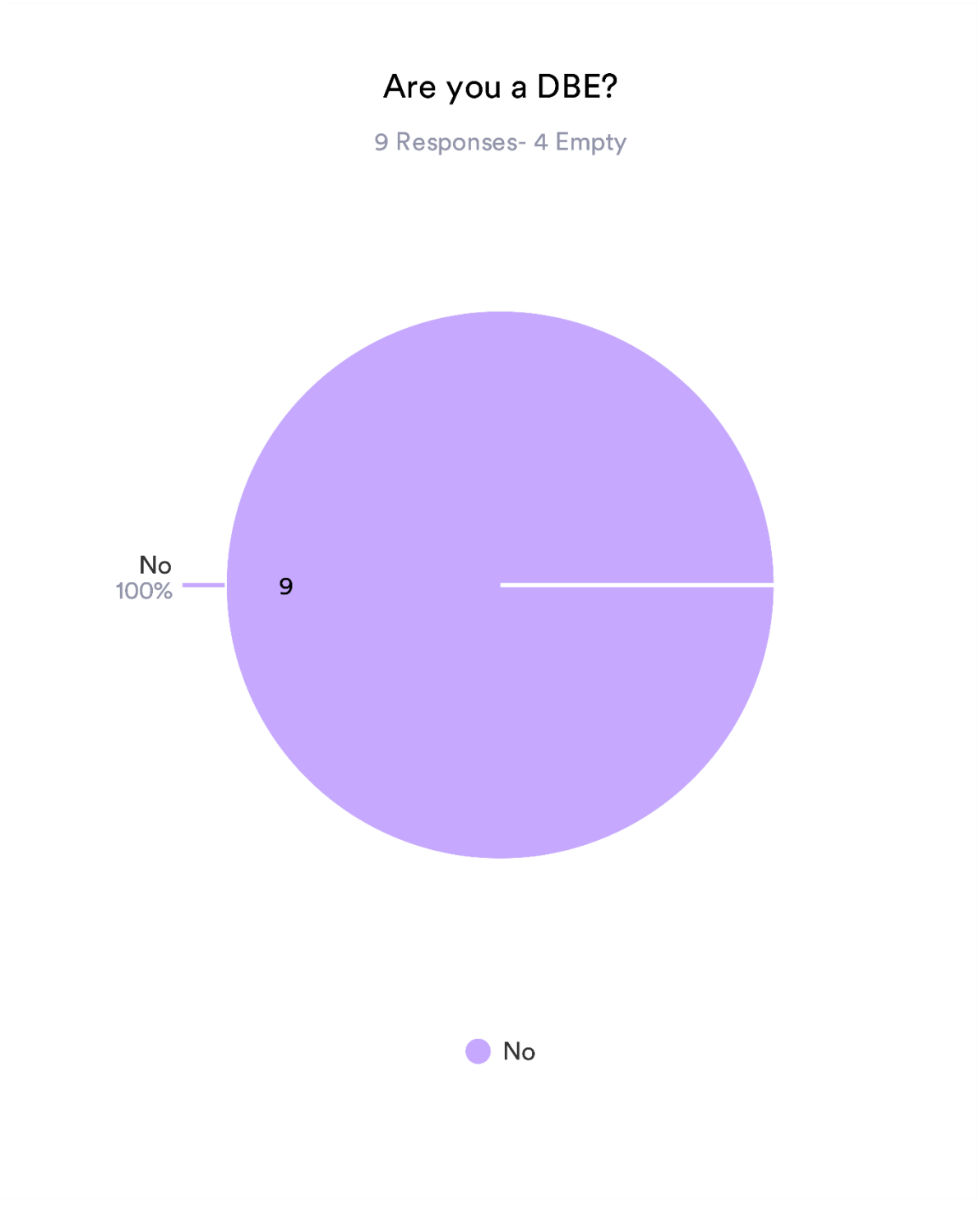
Delivery Method	Virtual	In-Person	Recorded	Duration	Audience Size	Notes
Brown Bags	X	X	X	1 hour	No Limit	
Tech Talks	X		X	< 1 hour	No Limit	Specific to topic, may be pre-recorded
Webinars	X		X	1 to 2 hours	No Limit	
Instructor Led	X	X		May be Multiple Days @ 6 to 8 hours per day	20 or less	Reserved for complex topics and introductory classes
On-line modules	X		X	2-3 hours	No limit	Conversion of instructor led courses as short on-line modules to be offered through a learning management system
Bentley Learning Paths	X		X	Varies based on Training	Individual	Users can work at their own pace, with predefined course work and training material.
YouTube	X		X	Varies	No Limit	Several Bentley and DOT training videos are currently available.

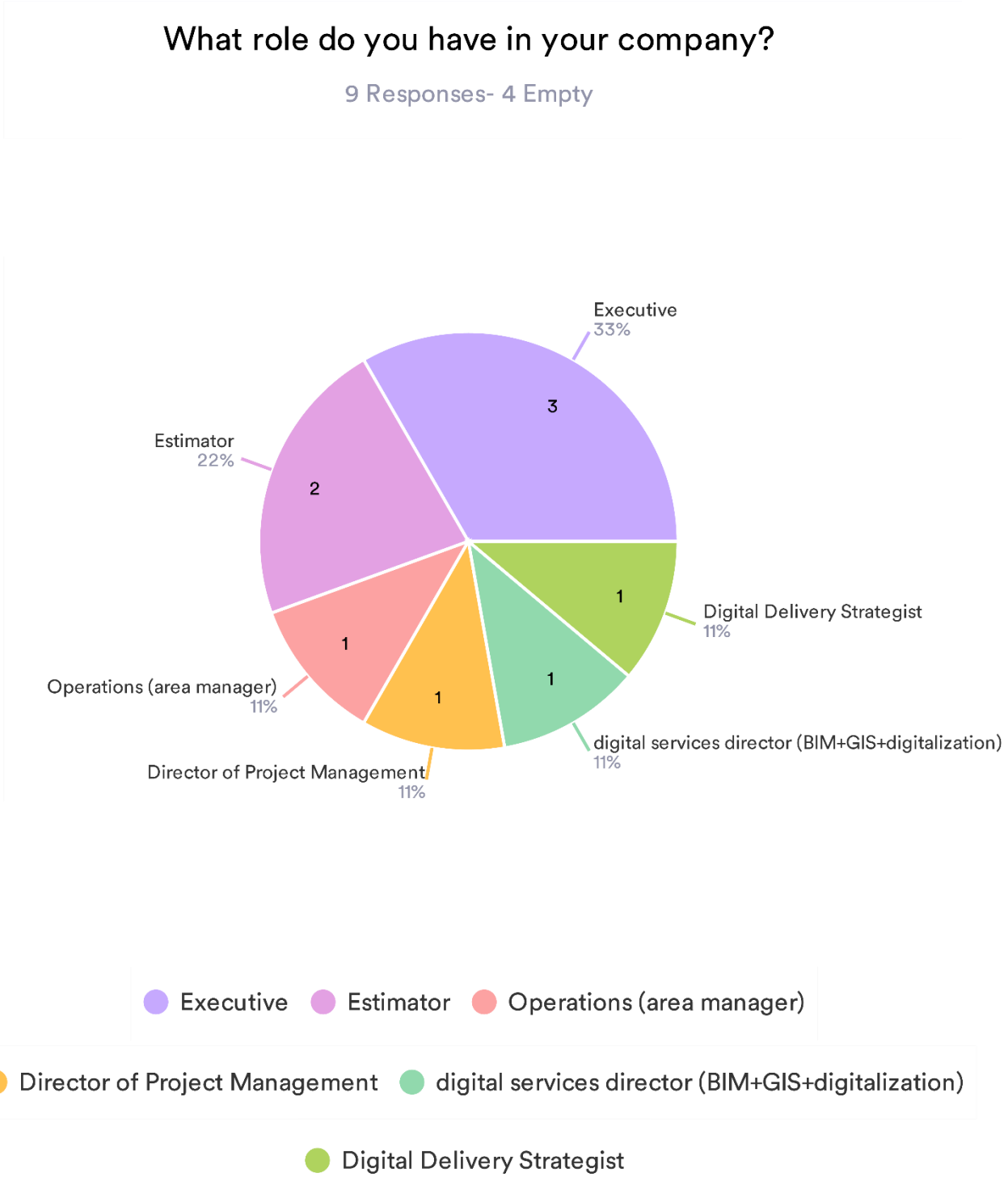
Appendix D. Industry Survey Results

Contractor Surveys

A survey was distributed to members of the AGC to solicit input regarding ADOT's DDP initiative. The survey was designed to capture relevant information to understand how the Department's initiative will affect the contracting community.

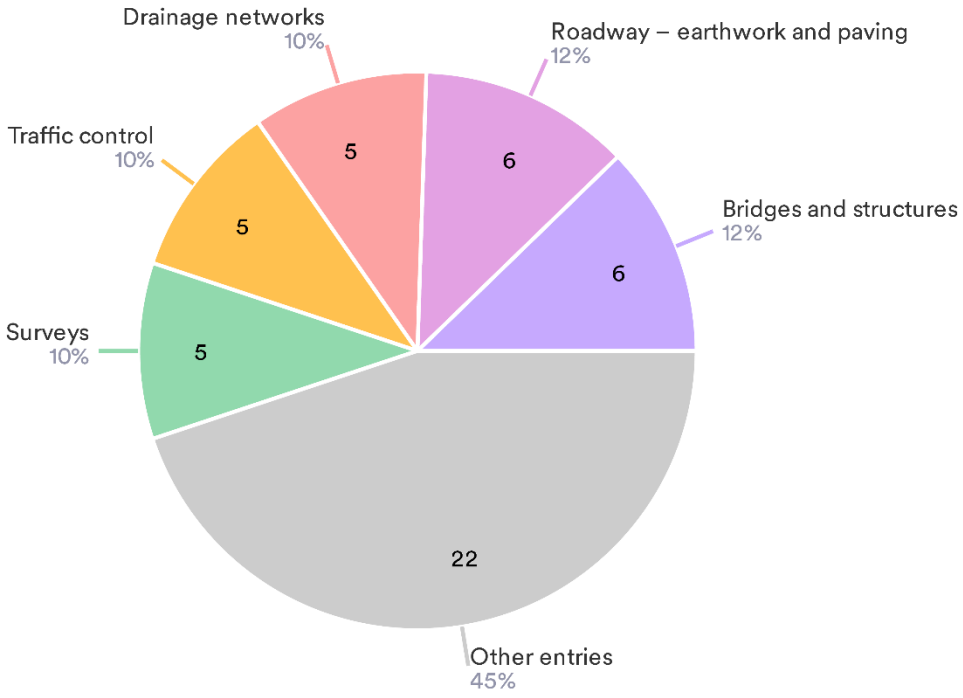



Are you a DBE?
9 Responses- 4 Empty
No
100%
9
No


What role do you have in your company?
9 Responses- 4 Empty
Executive
33%
3
Estimator
22%
2
1
Digital Delivery Strategist
11%
1
Operations (area manager)
11%
1
1
digital services director (BIM+GIS+digitalization)
11%
Director of Project Management
11%
Executive
Estimator
Operations (area manager)
Director of Project Management
digital services director (BIM+GIS+digitalization)
Digital Delivery Strategist

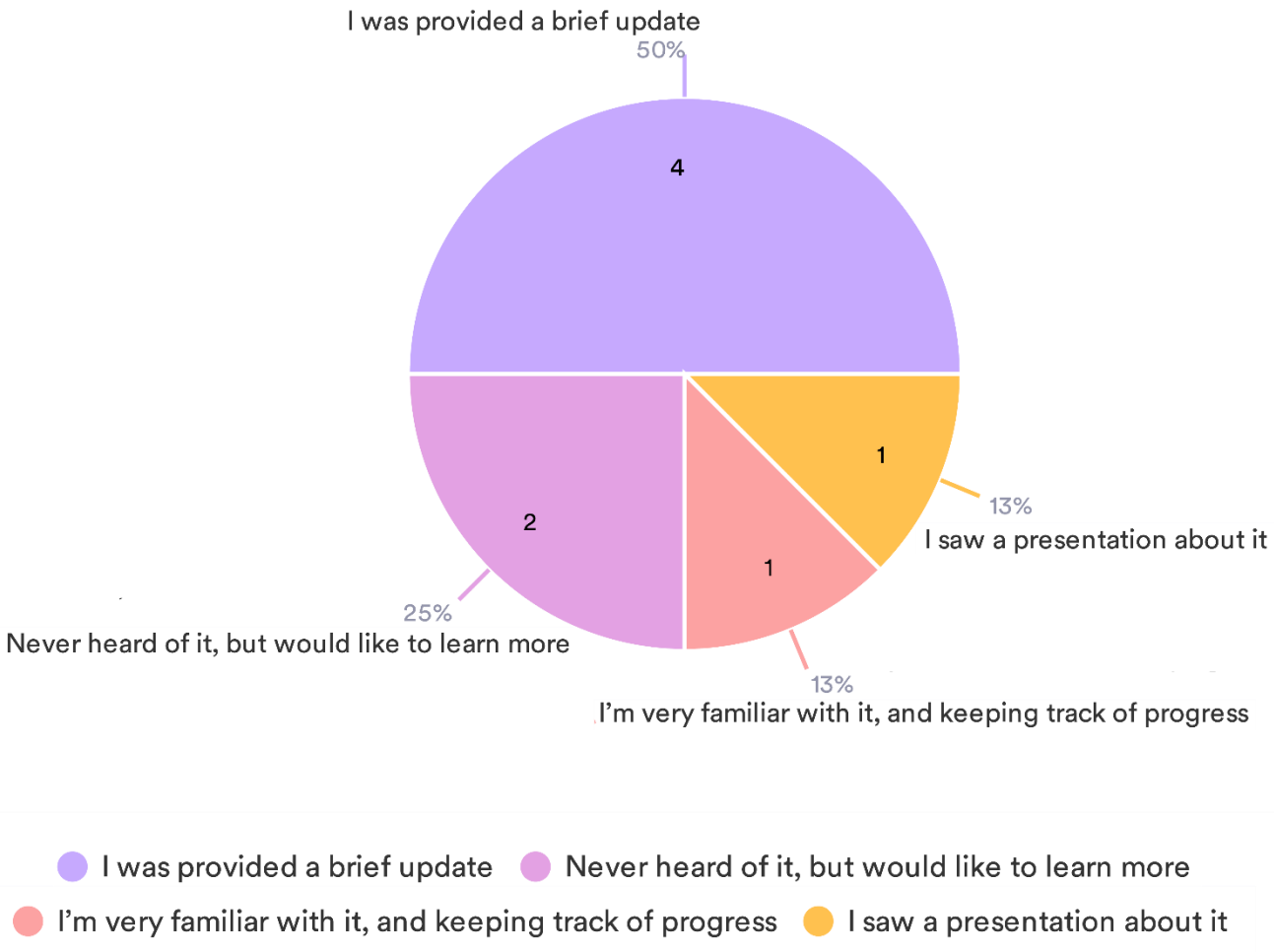
What types of services does your company typically do on ADOT construction projects? (Select all that apply)

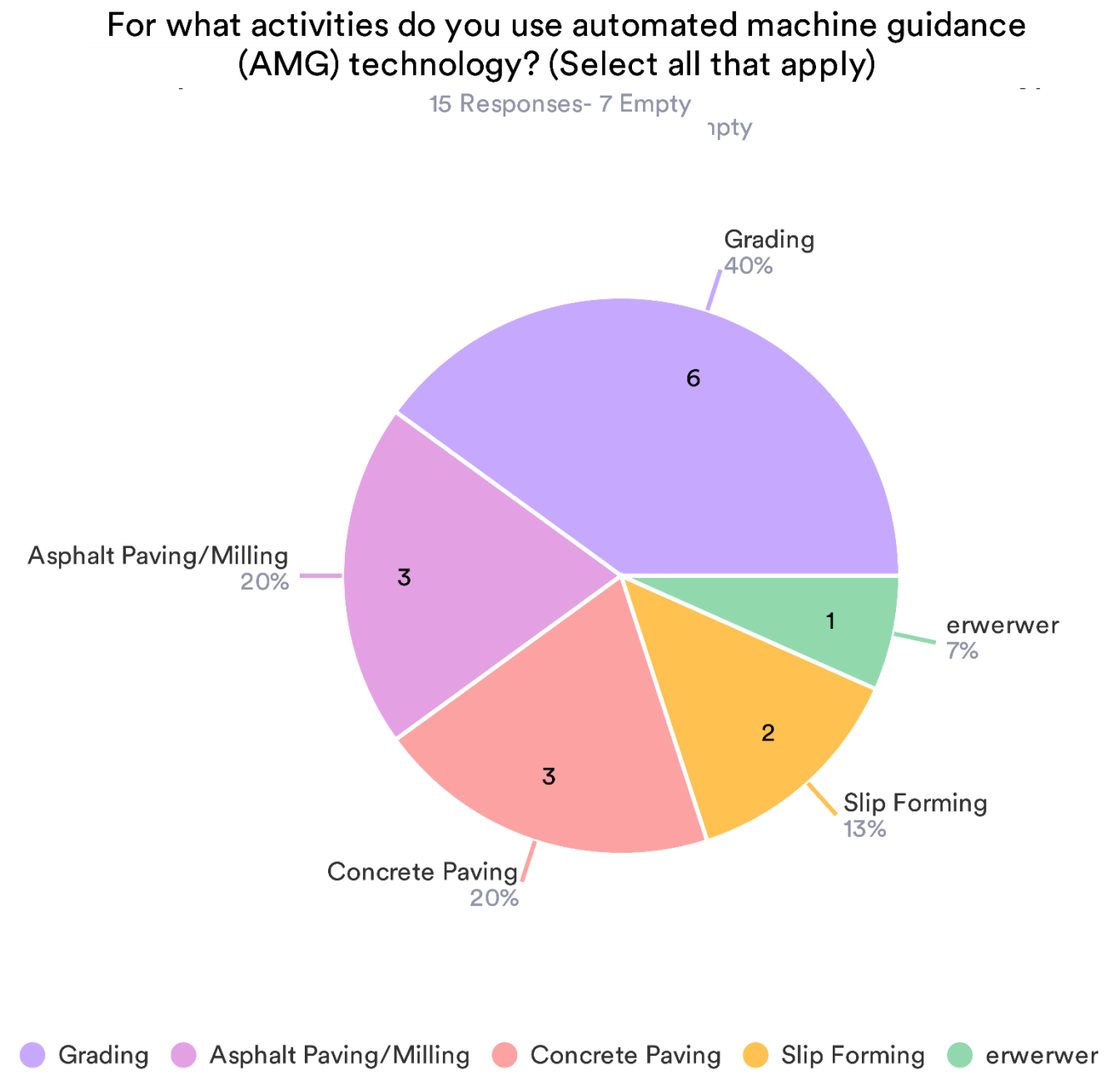
49 Responses- 4 Empty



How familiar are you with ADOT Digital Delivery Project? (Select one option)

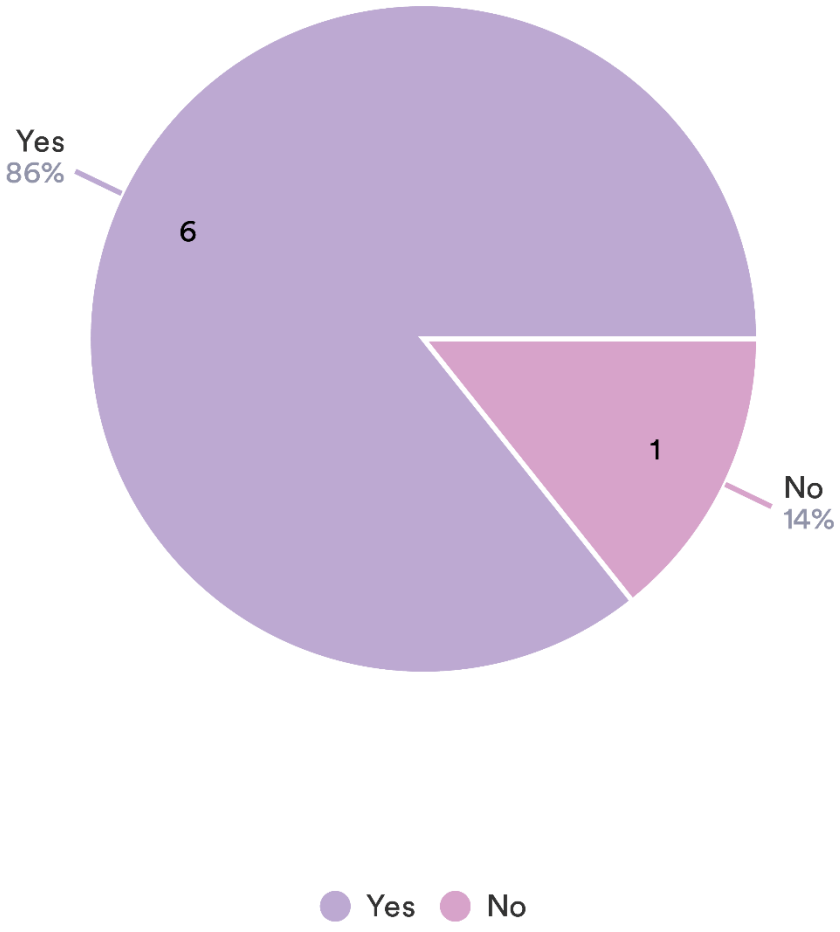
8 Responses- 5 Empty




For what activities do you use automated machine guidance (AMG) technology? (Select all that apply)
15 Responses- 7 Empty
Grading
40%
6
Asphalt Paving/Milling
20%
3
1
erwerwer
7%
2
3
Slip Forming
13%
Concrete Paving
20%
Grading
Asphalt Paving/Milling
Concrete Paving
Slip Forming
erwerwer

Do you have experience providing digital as-builts to the owner?

7 Responses- 6 Empty



Please explain:

5 Responses- 8 Empty

Data	Responses
I have provided digital as-builts to owners and consulted with owners on how to set requirements for digital as-builts since 2012. Clients have included the USACE, USDOS, VA, NYSTA, and others. Most notably was the delivery of the As-Built model for the Gov. Mario M. Cuomo bridge for NYSTA.	1
Provided point sheets for different features with Northing, Easting, and Elevation overlaid on the plan sheets.	1
WE HAVE EXPERIENCE PROVIDING OUR OWN BIM MODELS DURING CONSTRUCTION, BEAR IN MIND THAT AS BUILT MODELS ARE THE EVOLUTION ONF THE DESIGN MODELS THROUGH THE CONSTRUCTION	1
New Mexico	1

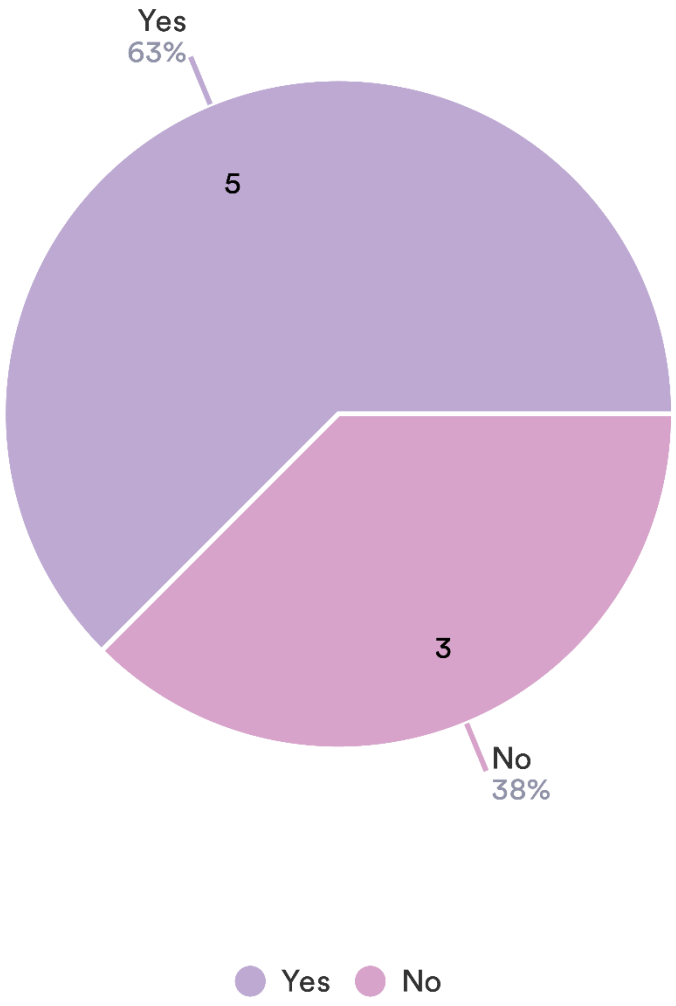
What software do you use for quantity takeoffs?

8 Responses- 5 Empty

Data	Responses
AGTEK, Blue Beam, Excel	1
Open Roads Designer, Civil 3D, Trimble Business Center	1
Agtek and Auto CAD Civil 3D	1
several, synchro, openroads, navisworks, bluebeam, it all depends on how the data is available	1
Bluebeam	1
Blue beam and agtek	1
Excel	1

Do you rely on digital terrain models provided by design teams? Yes/No (please explain)

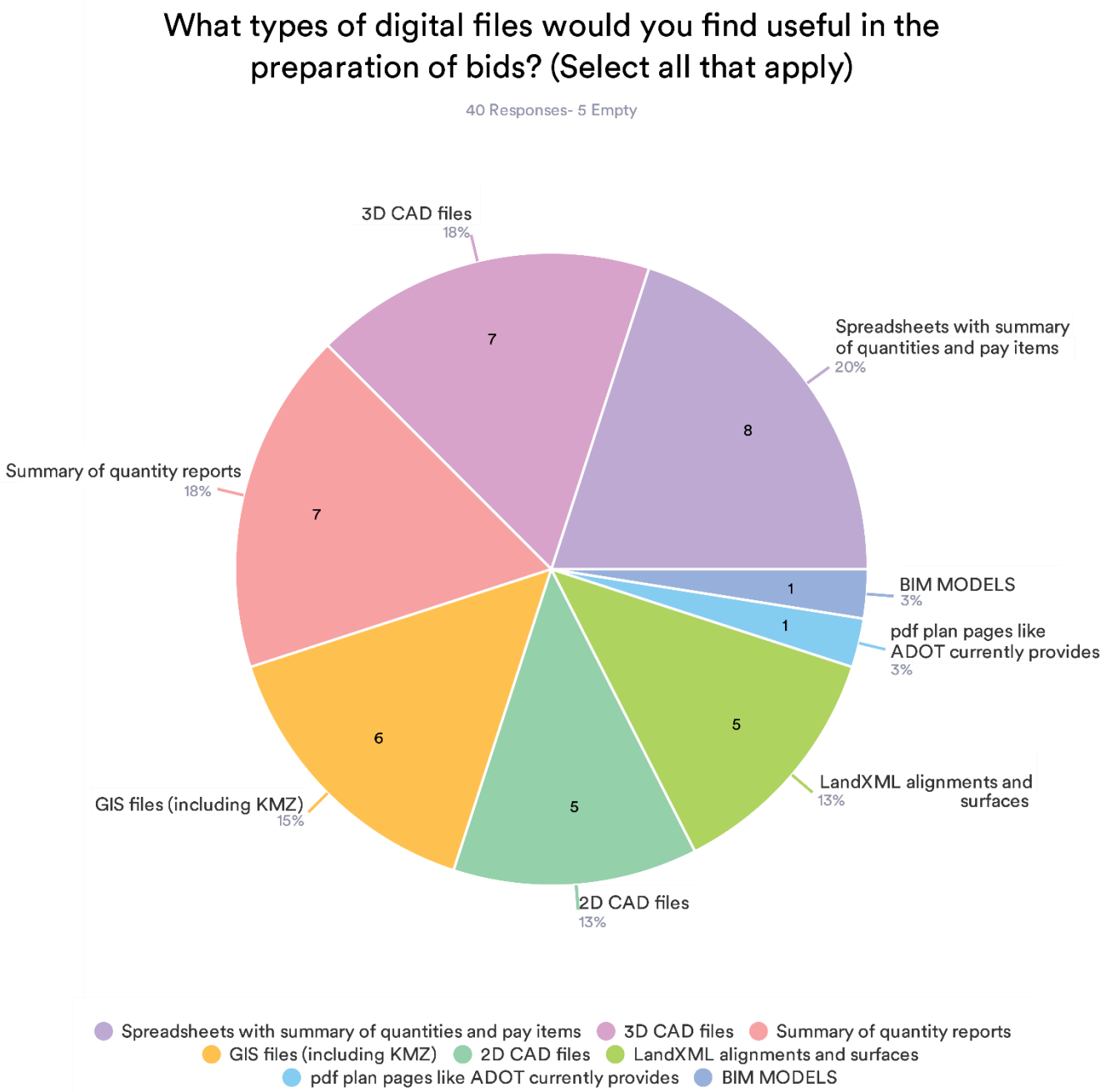
8 Responses- 5 Empty



Please explain:

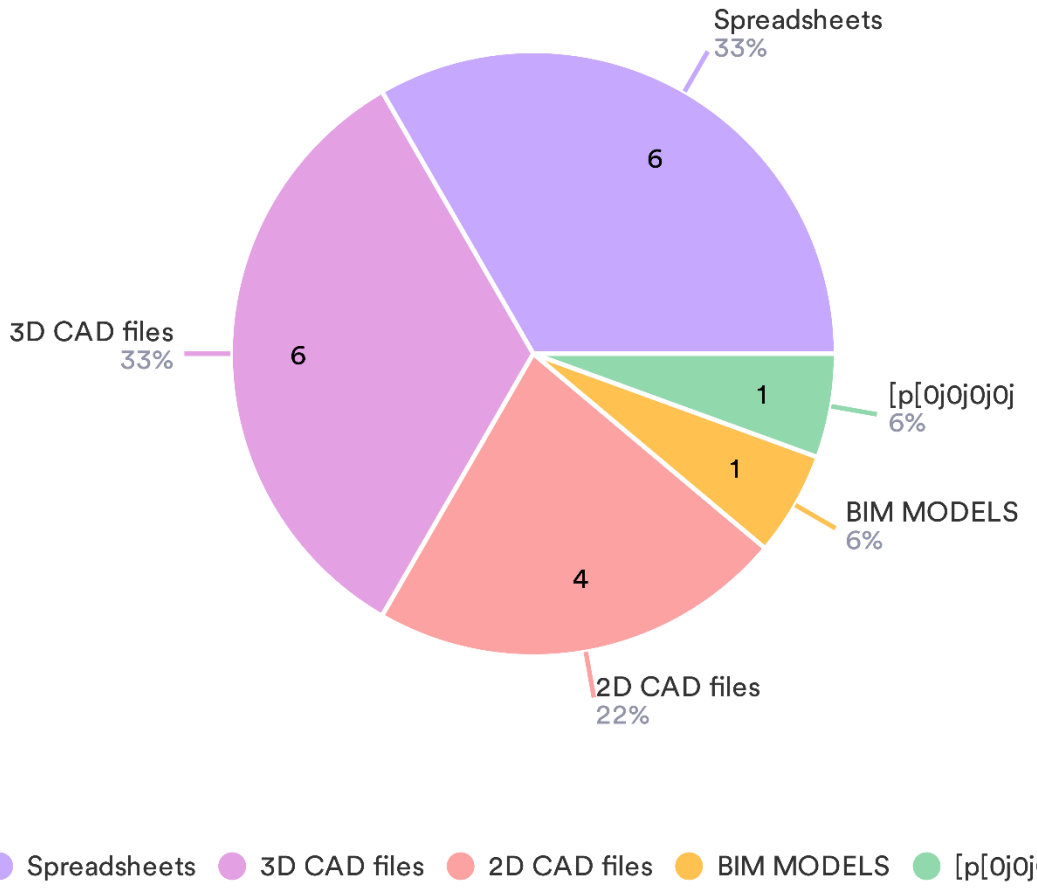
6 Responses- 7 Empty

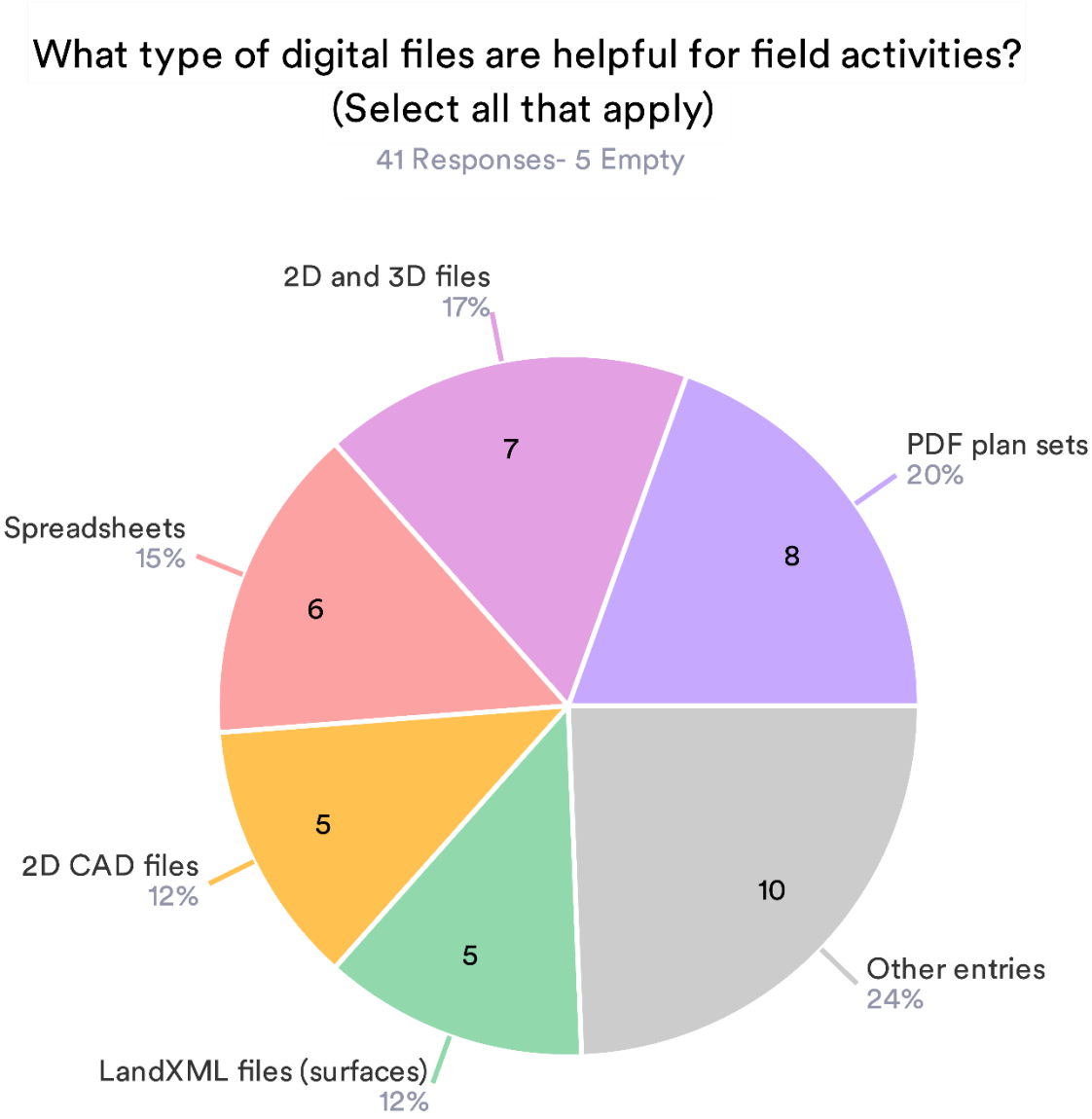
Data	Responses
We use cross sections for earthwork calculations only. Digital files are typically not useful for paving or bridge structures quantity takeoffs. Electronic DTM's would be great for earthwork, but no where near as useful as pdf plan pages for other scopes of work.	1
Yes but digital terrains provided by the design teams, must be quality checked with existing conditions certified by the surveyor of record.	1
We build our own in-house	1
We always verify the information provided by third parties, if someone certified that the info is accurate at a certain level and take the responsability of that, then yes, we would be able to rely on these	1
Yes kind of. We don't truct them and do our own	1


What types of digital files would you find useful in the preparation of bids? (Select all that apply)
40 Responses- 5 Empty
3D CAD files
18%
7
Spreadsheets with summary of quantities and pay items
20%
8
Summary of quantity reports
18%
7
1
BIM MODELS
3%
1
pdf plan pages like ADOT currently provides
3%
5
LandXML alignments and surfaces
13%
6
GIS files (including KMZ)
15%
5
2D CAD files
13%
Spreadsheets with summary of quantities and pay items
3D CAD files
Summary of quantity reports
GIS files (including KMZ)
2D CAD files
LandXML alignments and surfaces
pdf plan pages like ADOT currently provides
BIM MODELS

What type of digital files are helpful for fabrication? (Select all that apply)

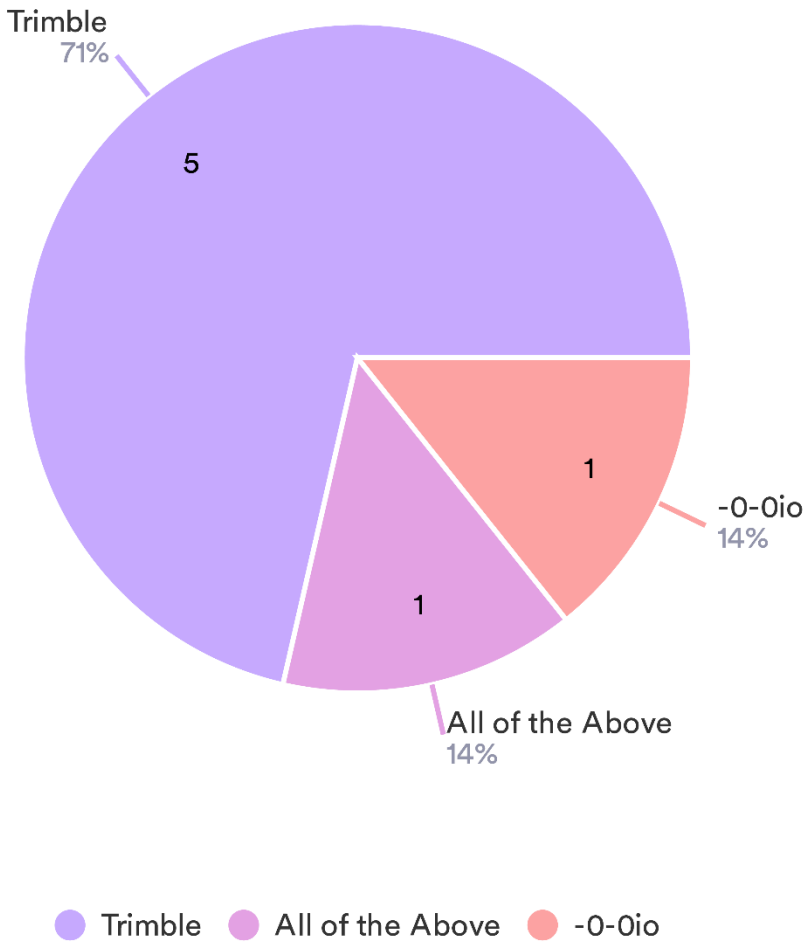
18 Responses- 6 Empty




What type of digital files are helpful for field activities? (Select all that apply)
41 Responses- 5 Empty
2D and 3D files
17%
7
PDF plan sets
20%
8
Spreadsheets
15%
6
5
2D CAD files
12%
10
Other entries
24%
5
LandXML files (surfaces)
12%

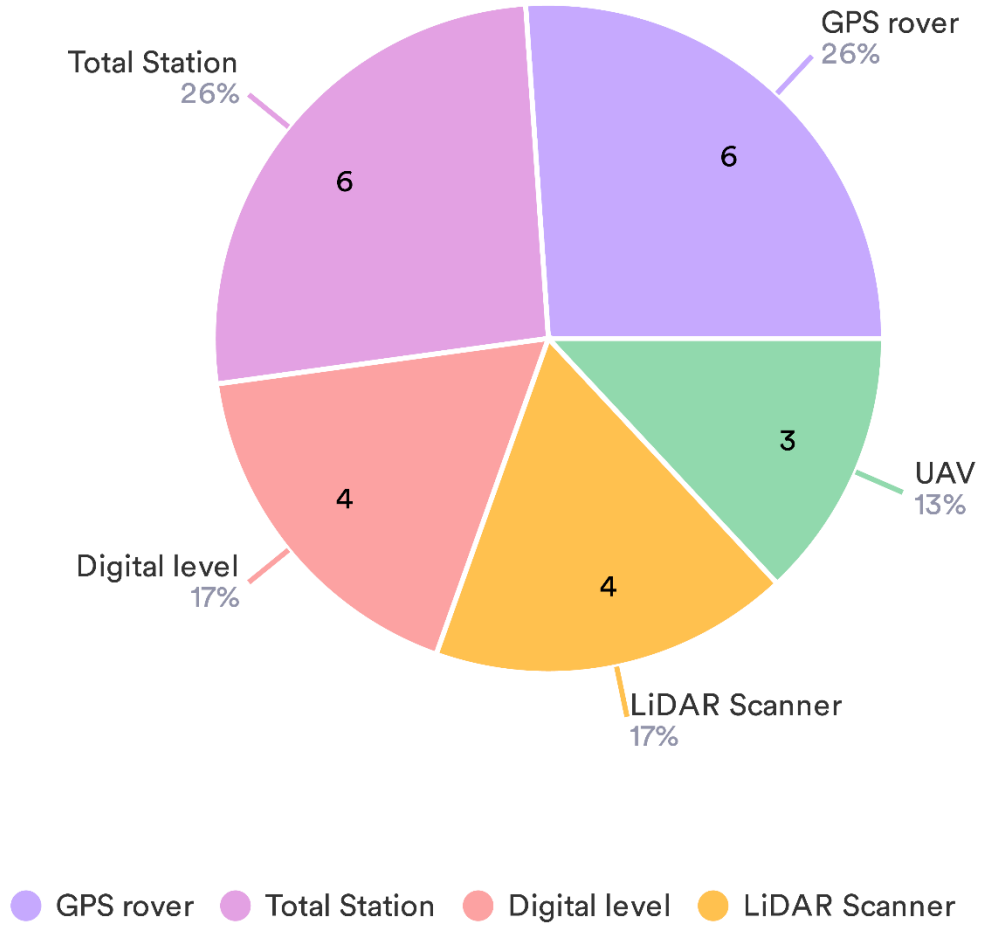
What AMG hardware/software do you currently use? (Select one option)

7 Responses- 6 Empty



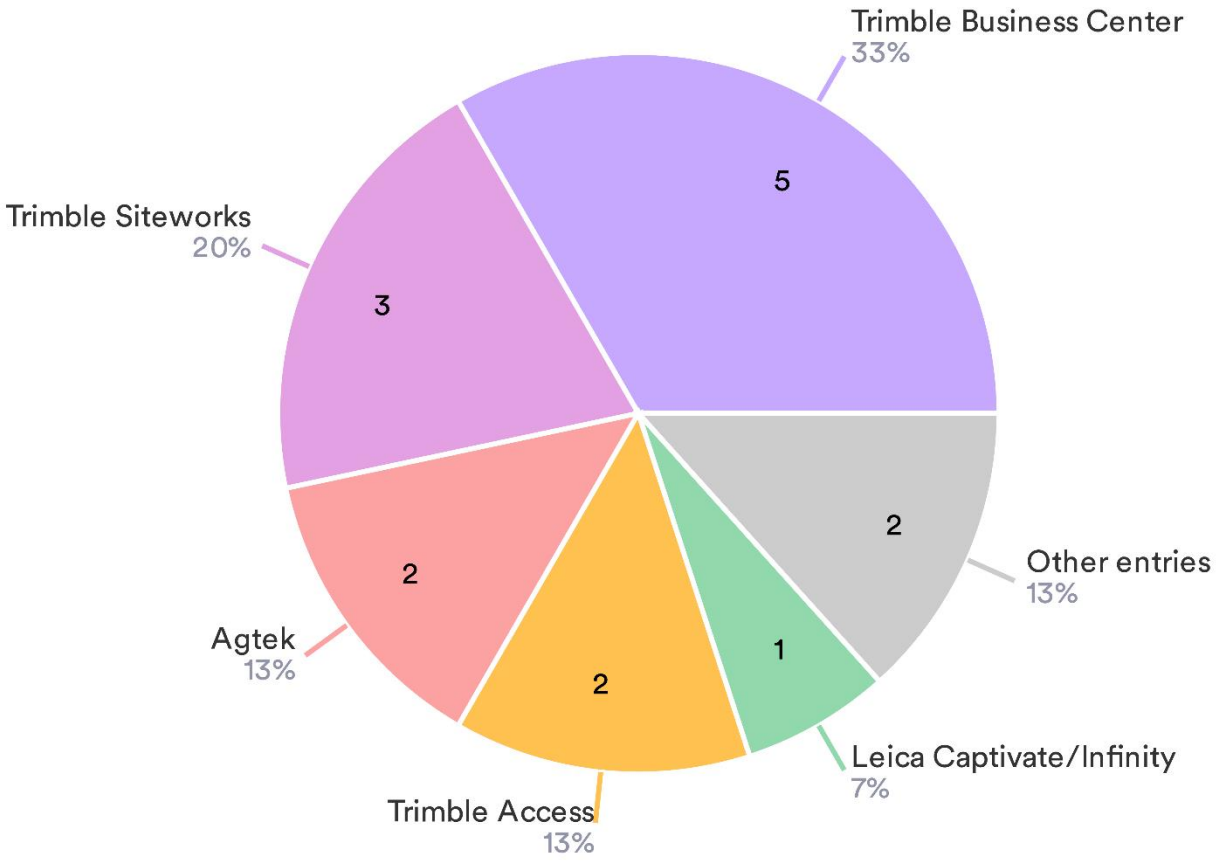
What survey equipment do you use on a typical project? (Select all that apply)

23 Responses- 6 Empty



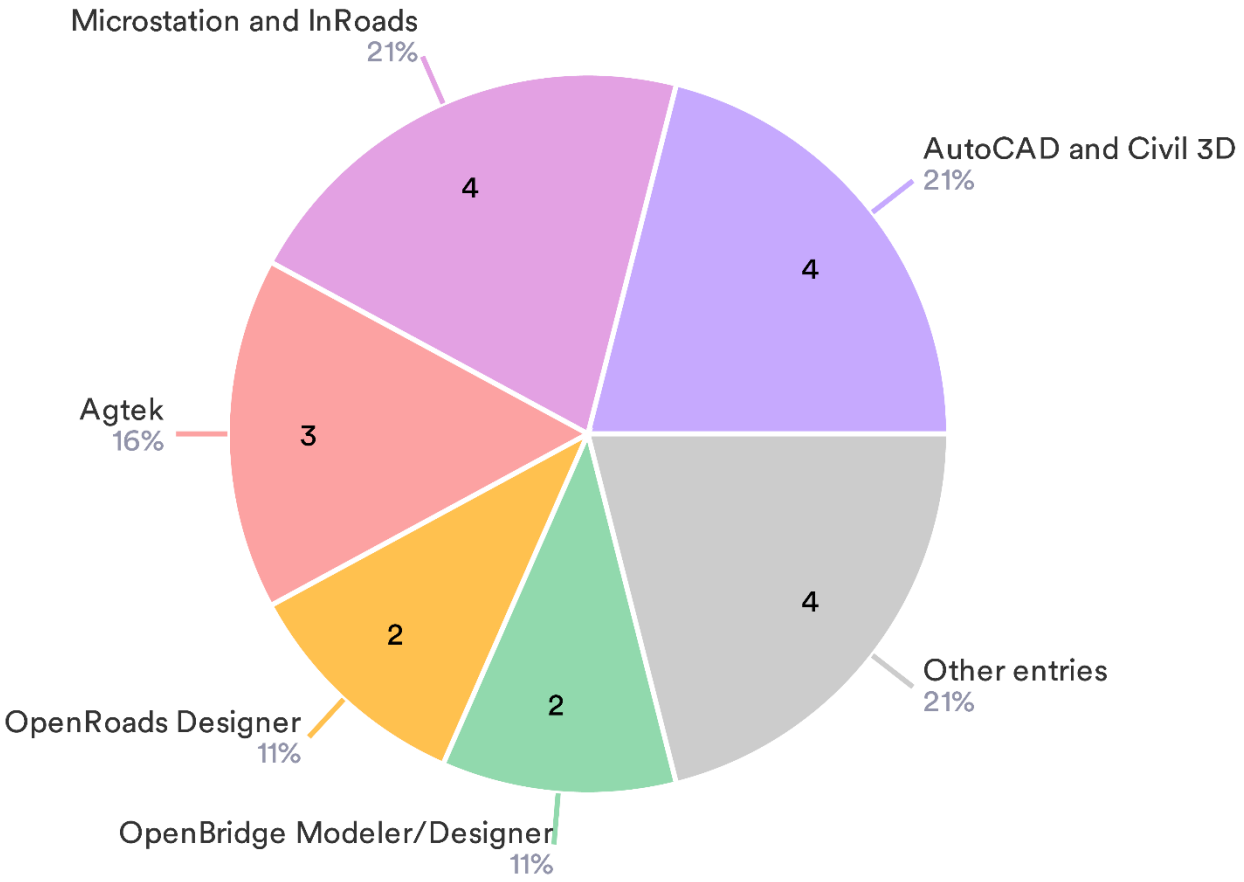
What survey software do you use? (Select all that apply)

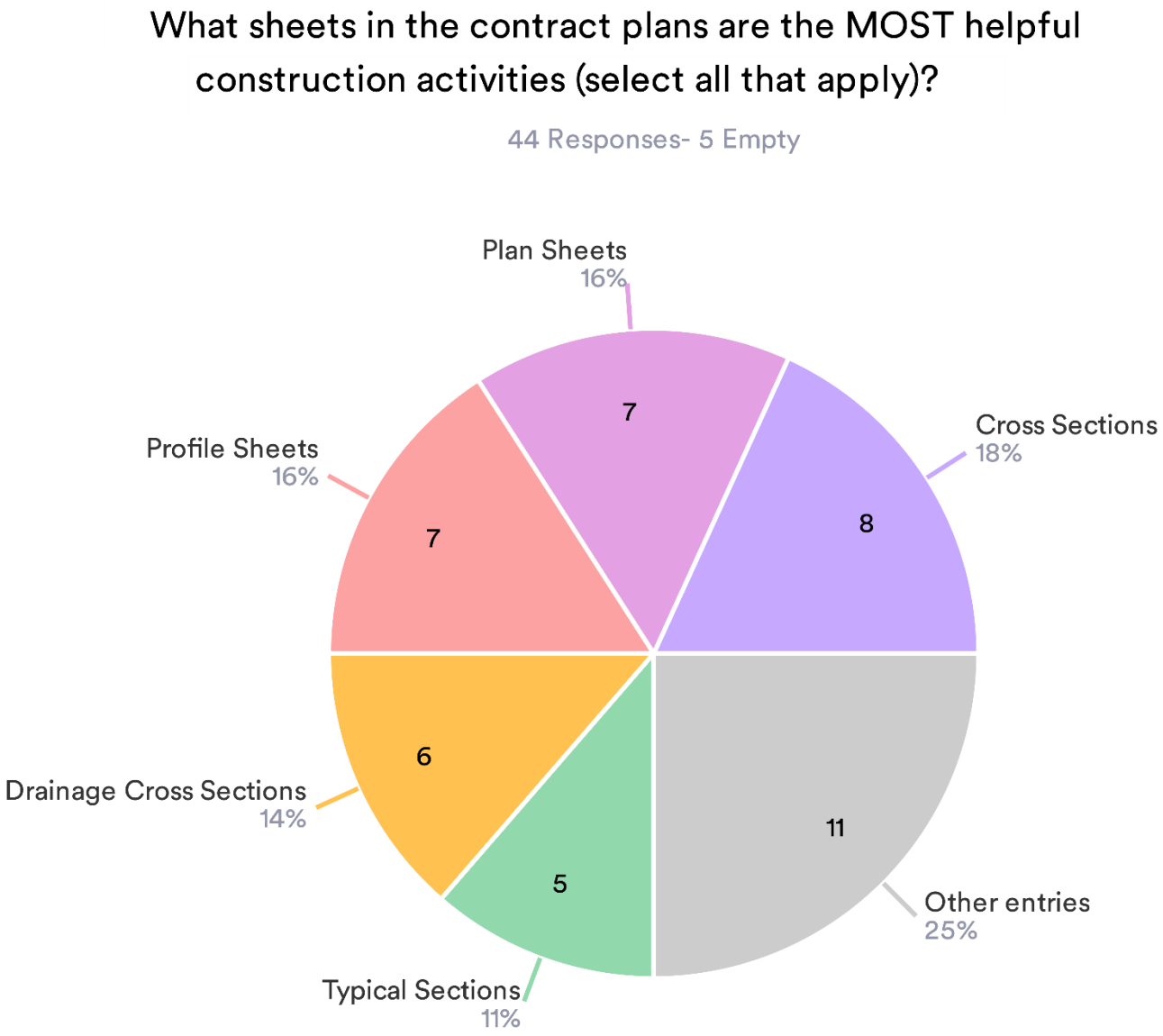
15 Responses- 6 Empty



What software do you use for preparing 3D models? (Select all that apply)

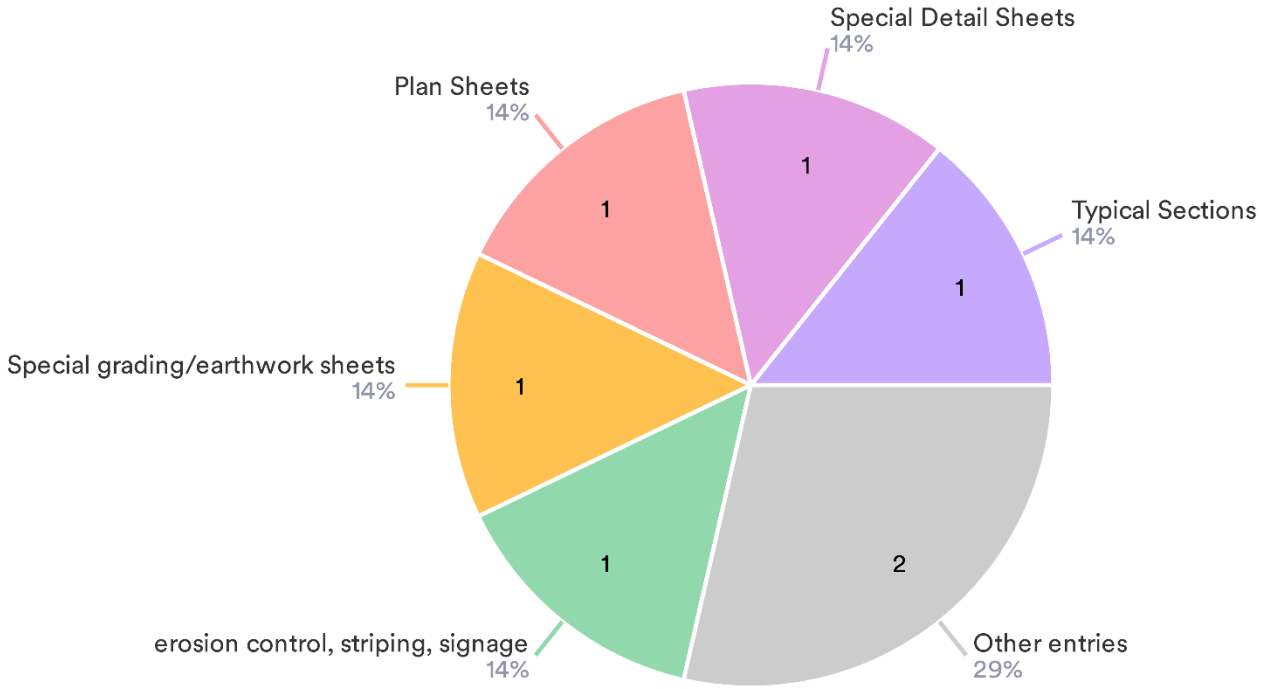
19 Responses- 6 Empty




What sheets in the contract plans are the MOST helpful construction activities (select all that apply)?
44 Responses- 5 Empty
Plan Sheets
16%
7
Cross Sections
18%
8
Profile Sheets
16%
7
6
Drainage Cross Sections
14%
5
Typical Sections
11%
11
Other entries
25%

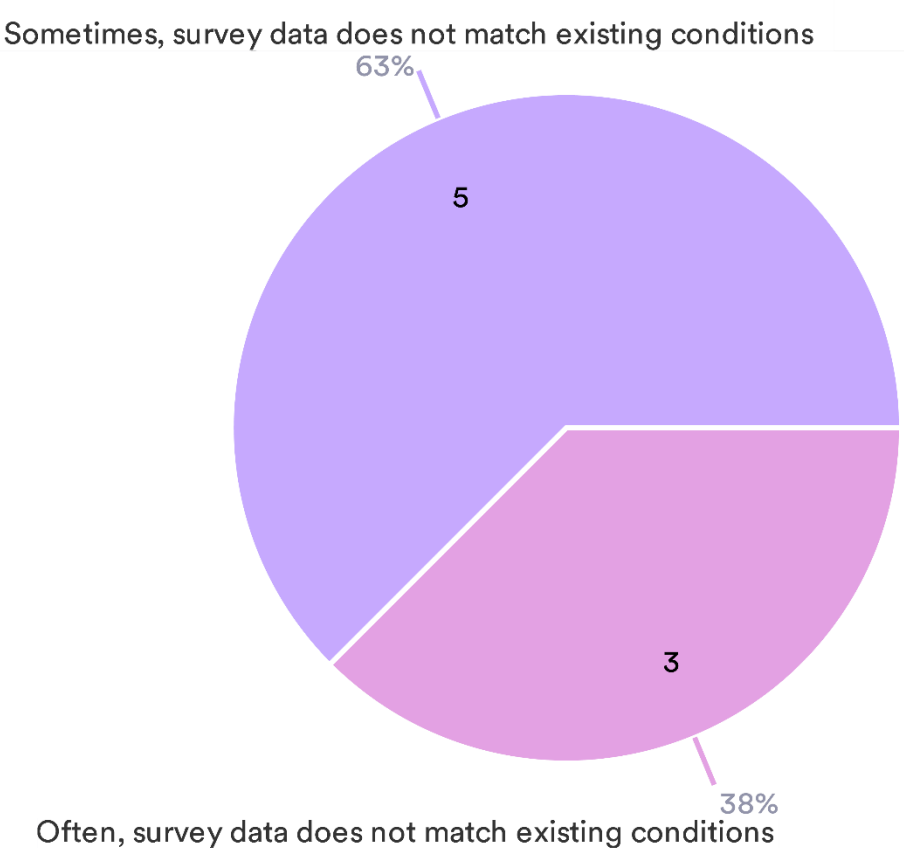
What sheets in the contract plans are the LEAST helpful for construction activities (select all that apply)?

7 Responses- 7 Empty



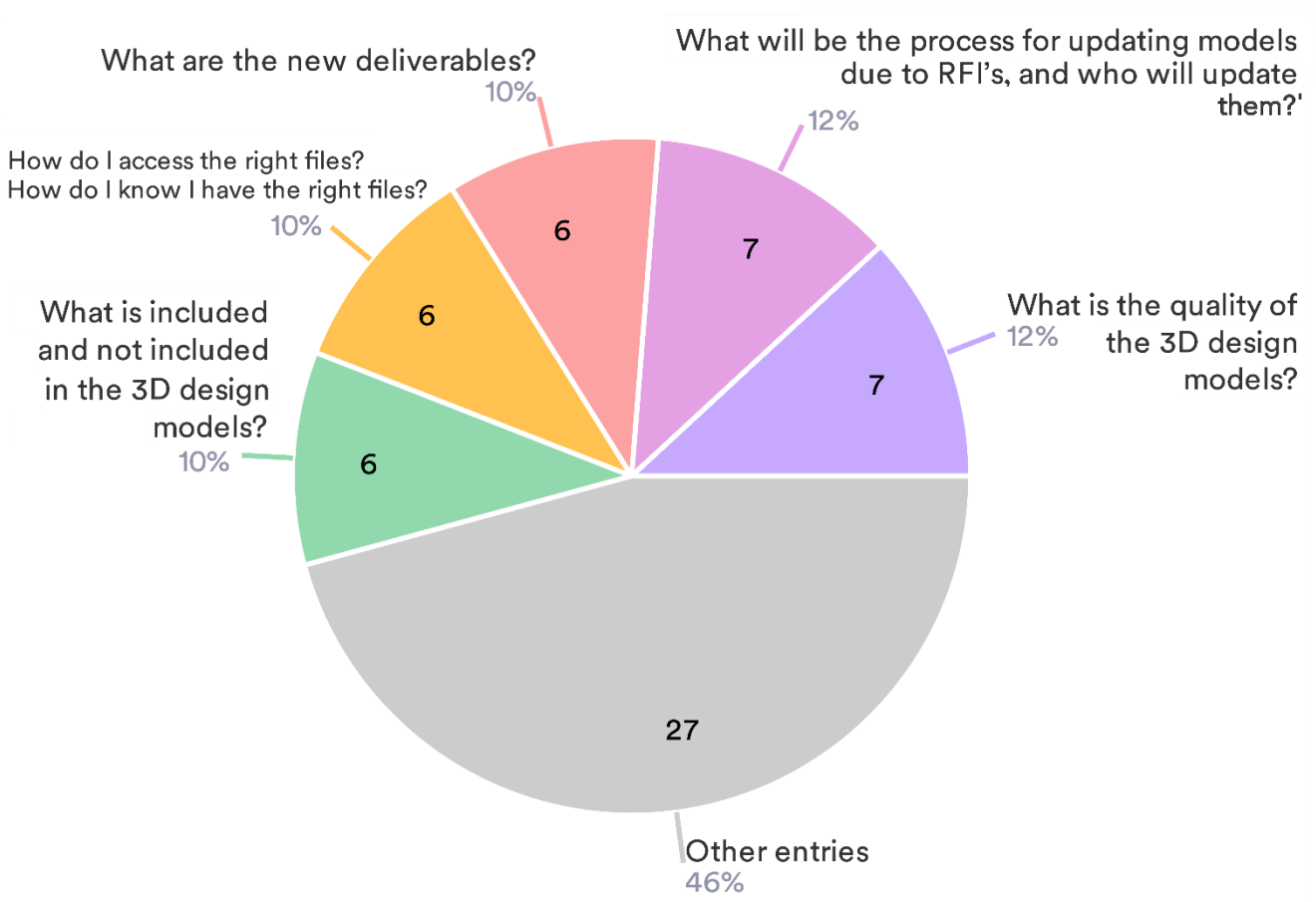
What challenges do you have today with existing ground survey data provided for ADOT projects? (Select one option)

8 Responses- 5 Empty



If ADOT contractually required the use of design data for construction activities, what concerns or questions do you have? (Select all that apply)

59 Responses- 5 Empty



Please provide specific examples of any challenges or roadblocks you or your company has experienced using digital models for construction.

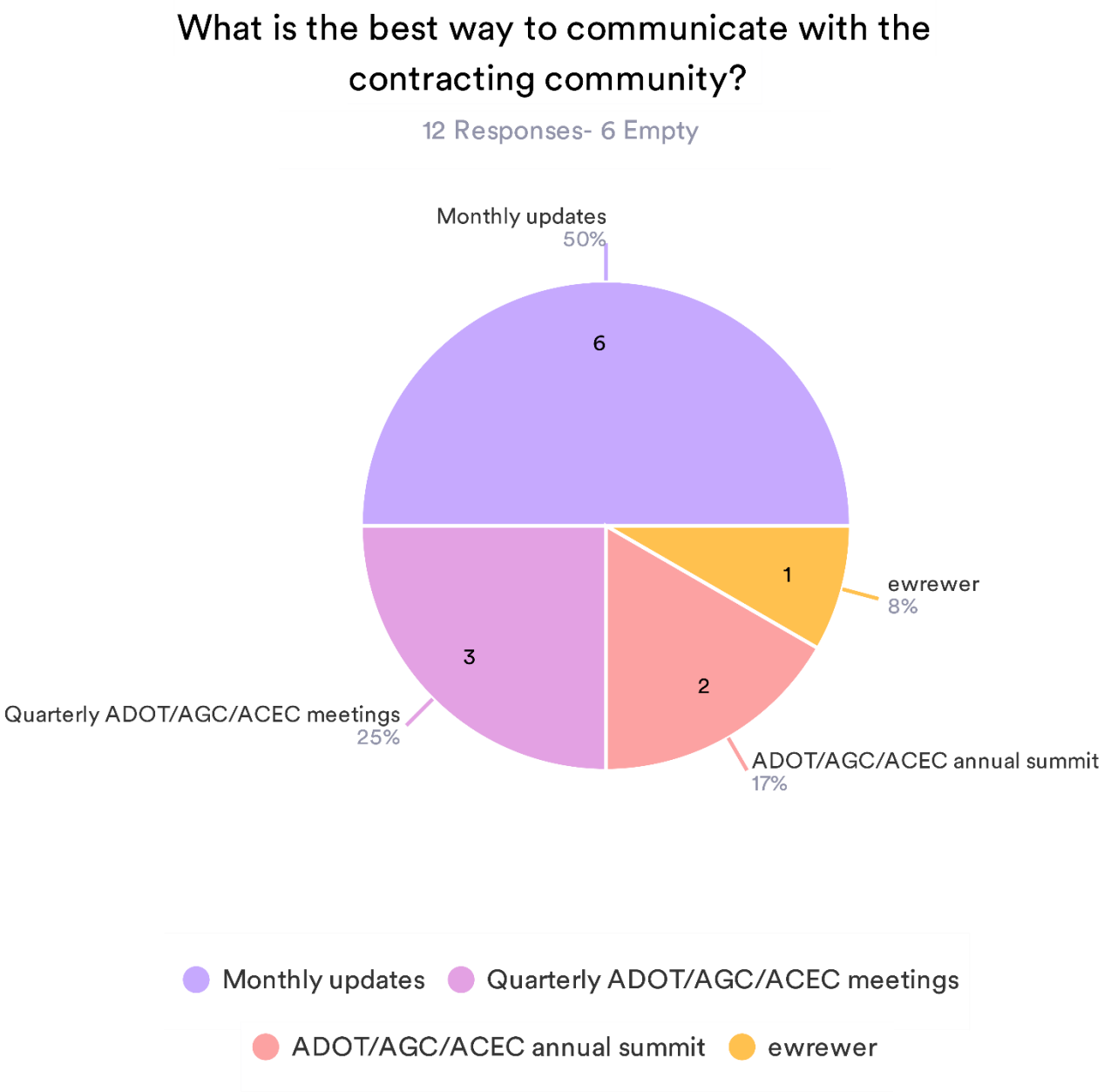
4 Responses- 9 Empty

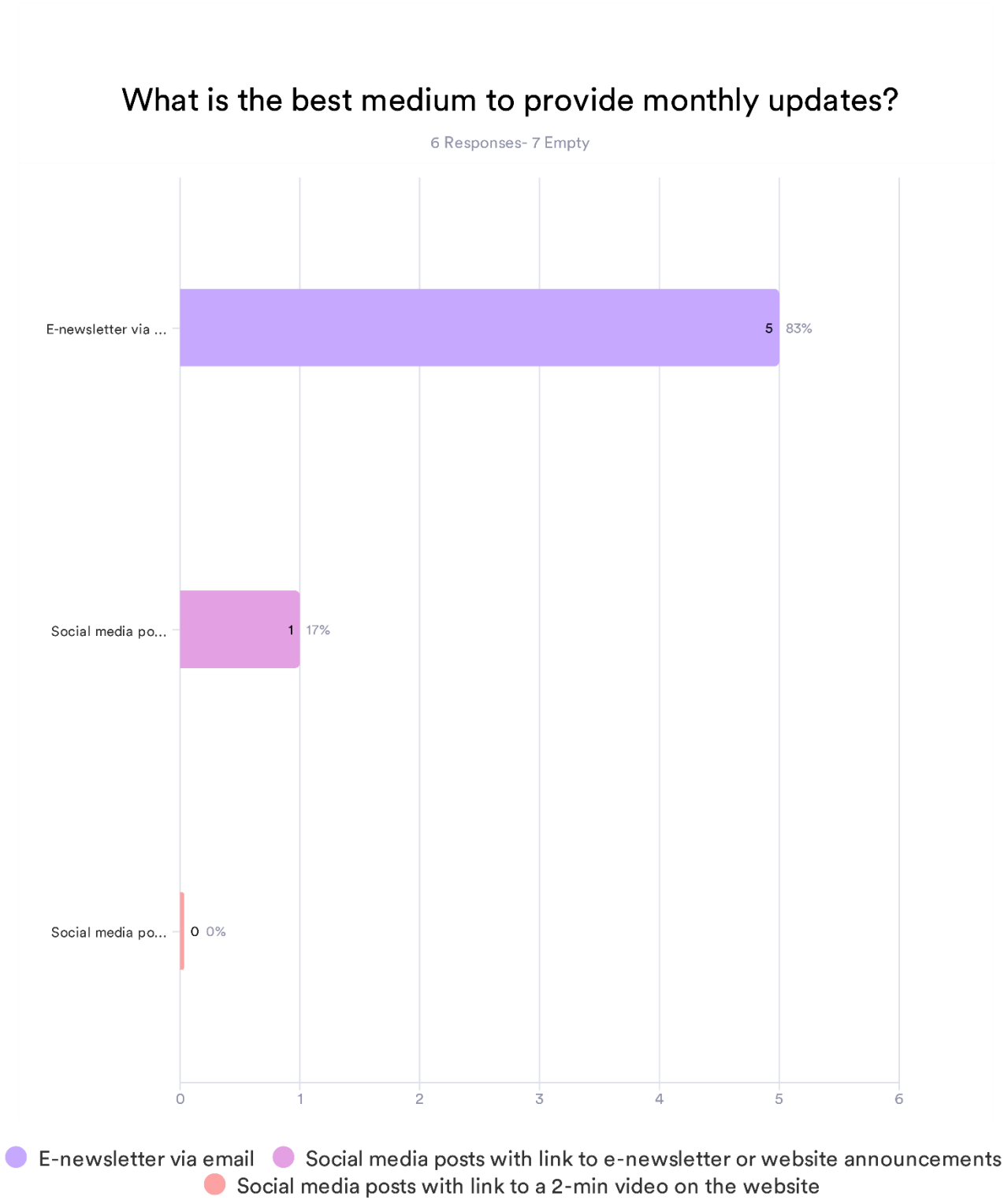
Data	Responses
Accuracy, conflicting drawings, field use	1
- Workspaces that do not include necessary features - Software limitations for atypical projects - Incomplete models - Incorrect or outdated models	1
TIPICALY THERE ARE DESIGN MODELS AND CONTRUCCTION MODELS, THE LOD OF EACH MODEL IS ADJUSTED TO NECESITY	1

What would prevent you or your company from moving forward with delivering and constructing projects in a digital format (without physical contract plan sets)?

5 Responses- 8 Empty

Data	Responses
Accuracy, conflicting drawings, field use, computer power & licensing of the programs	1
If it was requested by ADOT there is nothing that would keep Kiewit from delivering and constructing. A challenge from current business as usual, will be the verification of quality control. Currently we QC all model construction activities against the RFC plan set.	1
NOT HAVING CLEAR AND SPECIFIC DIGITAL STRATEGY FROM THE CLIENT. - WHAT DO YOU NEED -WHY DO YOU NEED IT -WHAT ARE YOUR INTENTIONS FOR FUTURE USE OF THE MODELS. WE NEED A CLEAR AGREEMENT AND UNDERSTANDING OF THE BIM USES FOR ALL THE PHASES . ADOT O&M/FACILITIES MANAGEMENT DEPARMENT INPUT IS CRITICAL	1
capital outlay and training	1


What is the best way to communicate with the contracting community?
12 Responses- 6 Empty
Monthly updates
50%
6
ewrewer
8%
1
Quarterly ADOT/AGC/ACEC meetings
25%
3
ADOT/AGC/ACEC annual summit
17%
2
Monthly updates
Quarterly ADOT/AGC/ACEC meetings
ADOT/AGC/ACEC annual summit
ewrewer


What is the best medium to provide monthly updates?
6 Responses- 7 Empty
E-newsletter via ...
5
83%
Social media po...
1
17%
Social media po...
0
0%
0
1
2
3
4
5
6
E-newsletter via email
Social media posts with link to e-newsletter or website announcements
Social media posts with link to a 2-min video on the website

How often would you like to receive communications from ADOT regarding digital delivery? (Please explain)

5 Responses- 8 Empty

Data	Responses
when changes are made	1
For me as often as possible. But quarterly at a minimum.	1
PERSONALLY I WOULD LIKE TO HAVE A MONTHLY, EVEN WEEKLY INPUT, I WOULD LIKE TO BE ABLE TO INTEARCT WITH THE DIGITAL DELIVERY TEAM	1
As soon as something changes	1

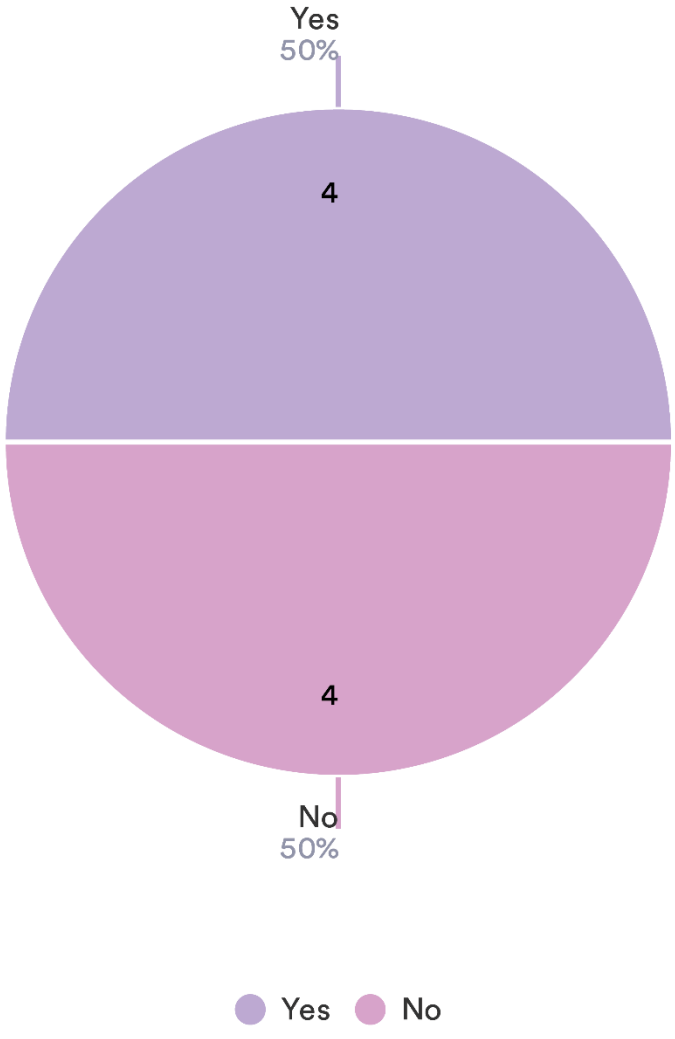
What other information would you like to share with ADOT? (Please explain)

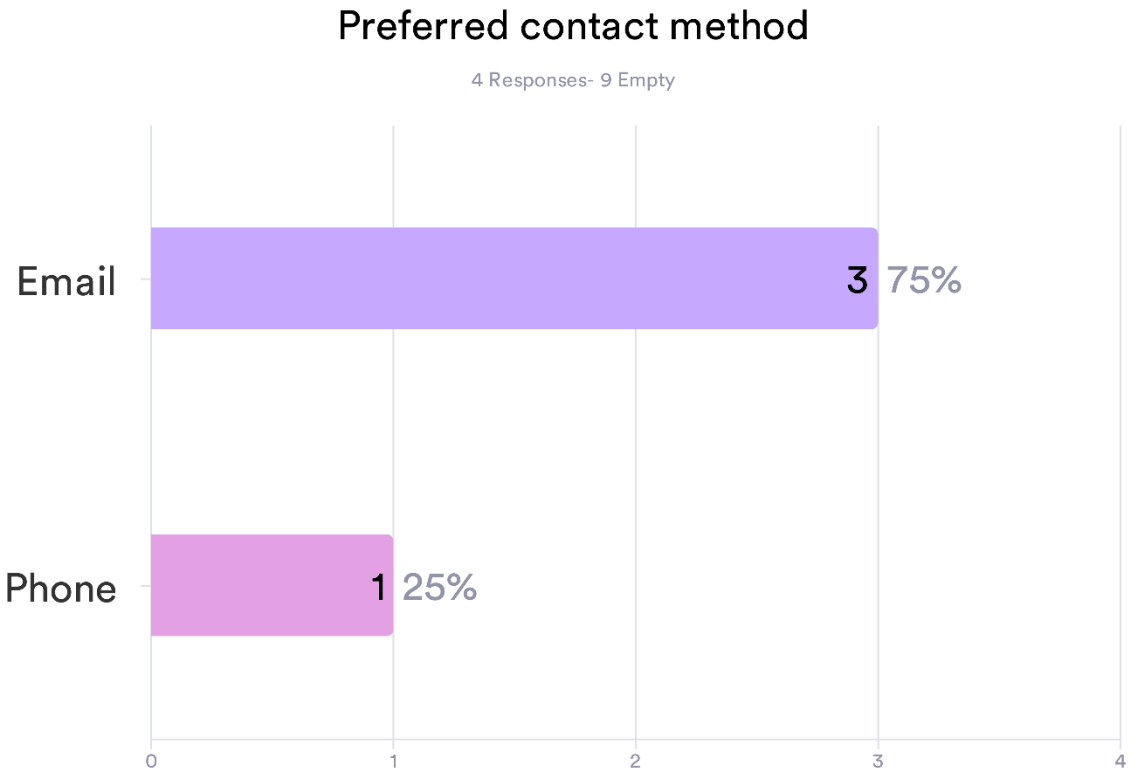
4 Responses- 9 Empty

Data	Responses
it will be a big struggle to get the inspectors and field staff on the same wavelength when not being able to have pdf/paper plansets	1
We have a varied degree of experinces with Digital Delivery on projects across several DOT's and would welcome the opportunity to discuss our expereinces with ADOT.	1
THE IMPLEMENTATION OF A PROJECT MANAGEMENT TOOL WILL BE KEY FOR SUCEESS , PROCORE CAN REALLY HELP	1

Will you be willing to be contacted for a follow-up discussion?

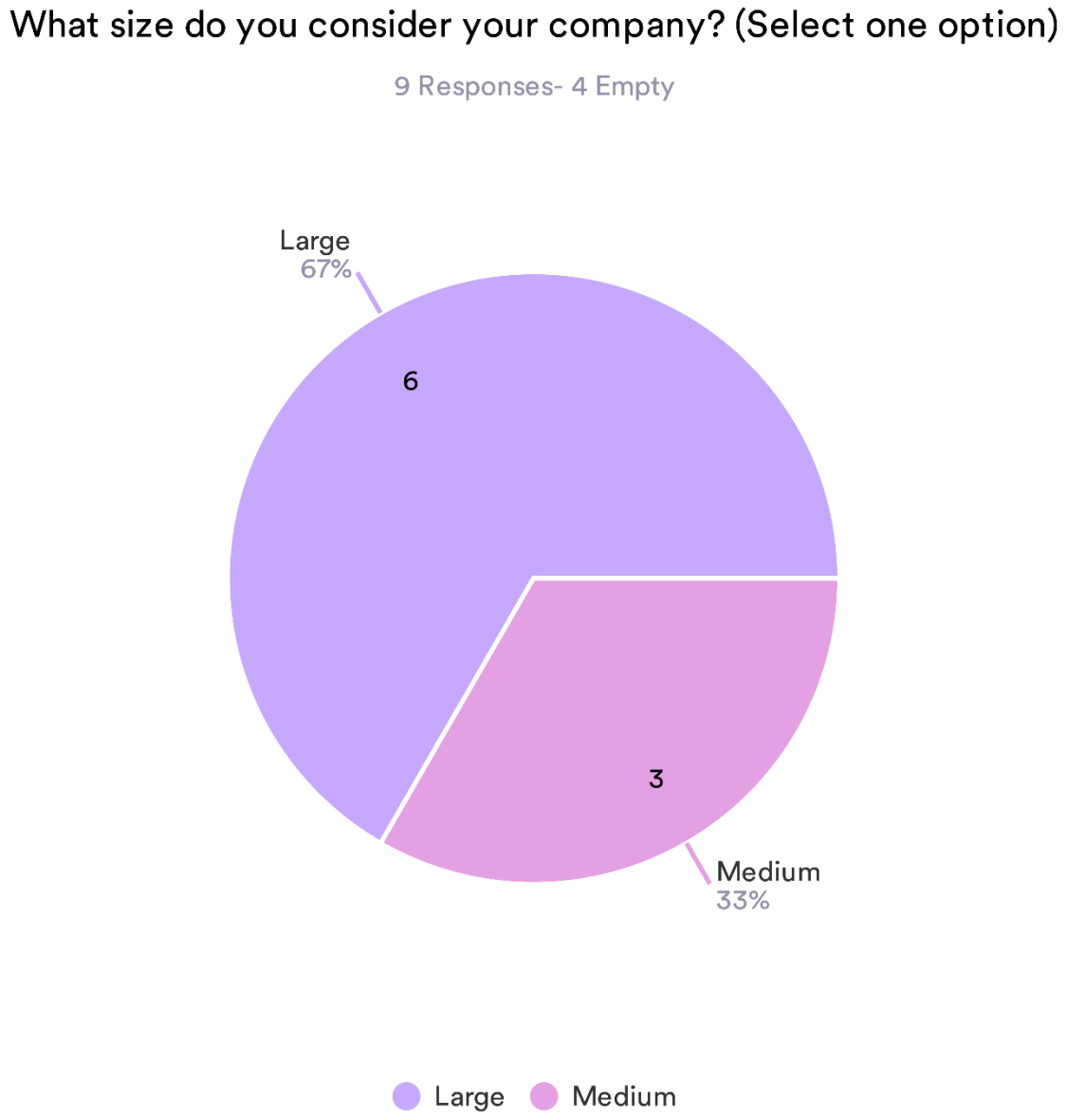
8 Responses- 5 Empty

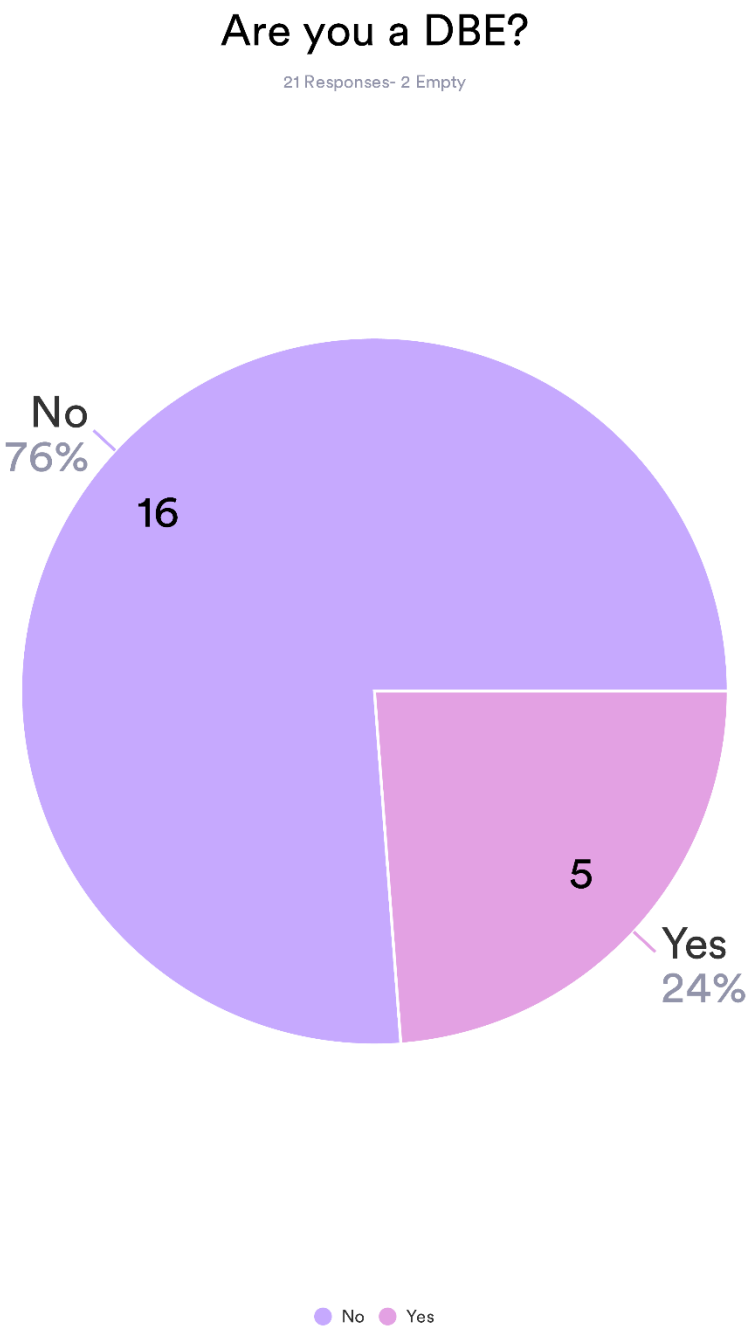


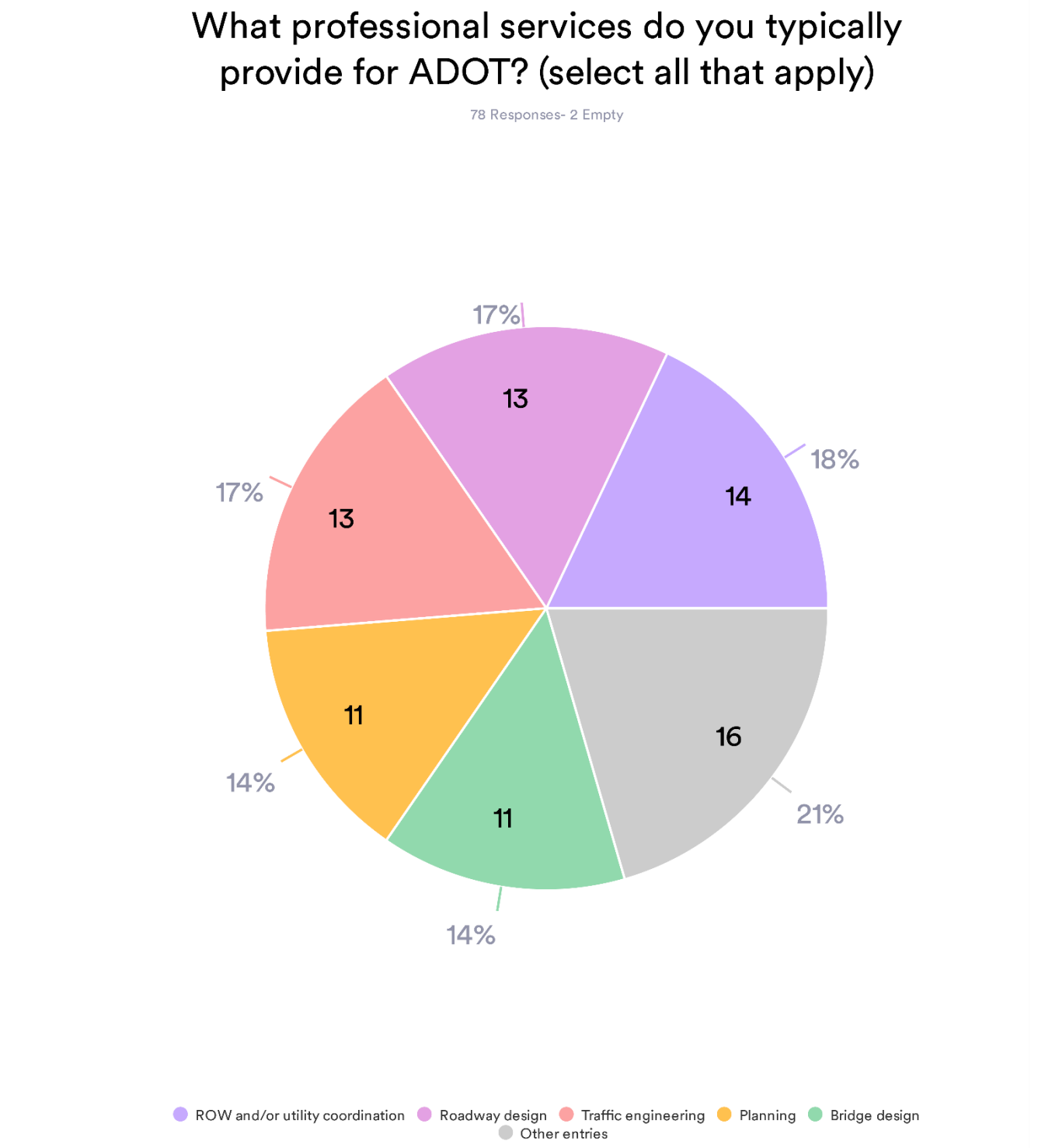

Preferred contact method
4 Responses- 9 Empty
Email
3 75%
Phone
1 25%
0
1
2
3
4

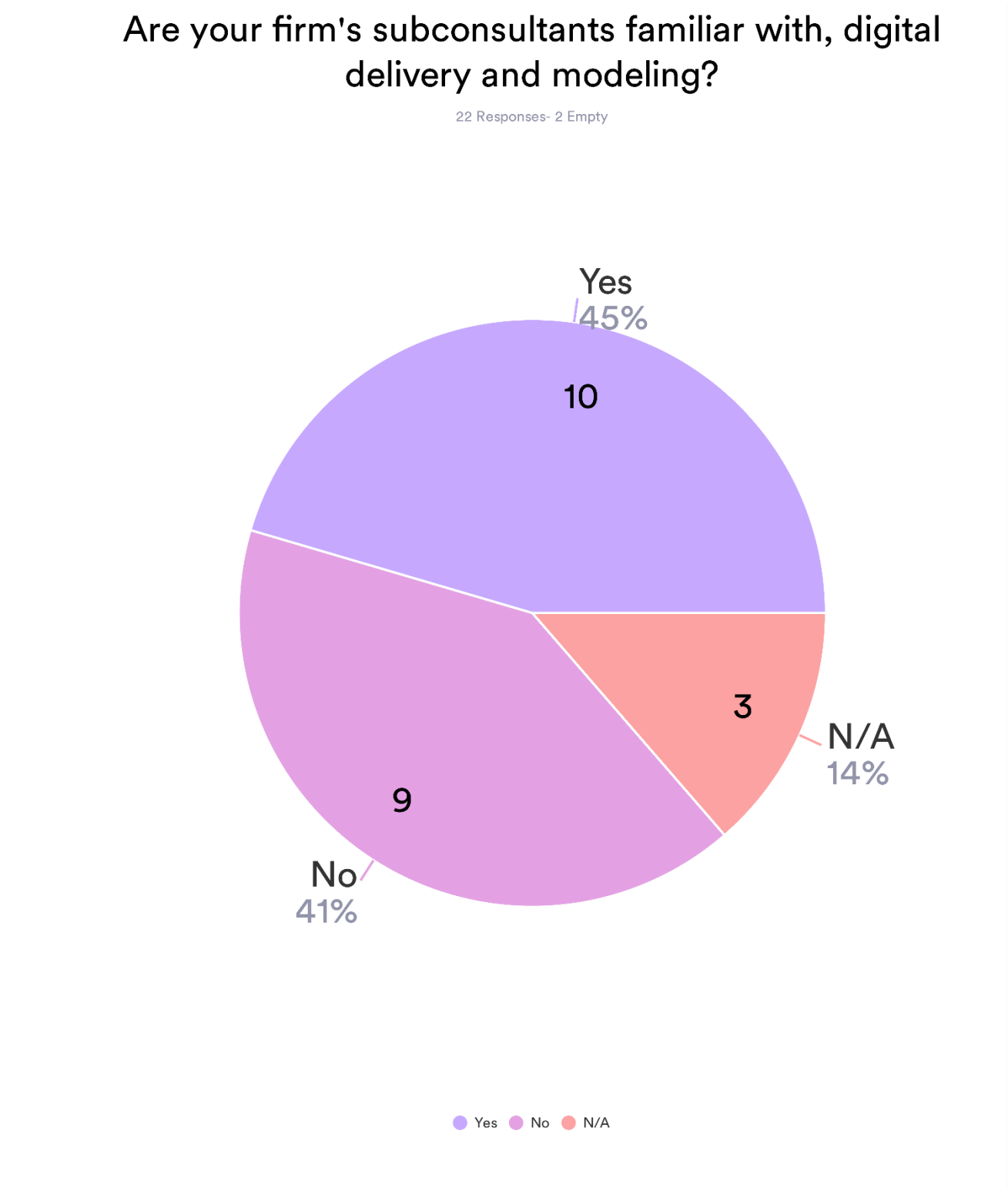
Consultant Surveys

A survey was distributed to members of the ACEC to solicit input regarding ADOT's DDP initiative. The survey was designed to capture relevant information to understand how the Department's initiative will affect the consulting community.



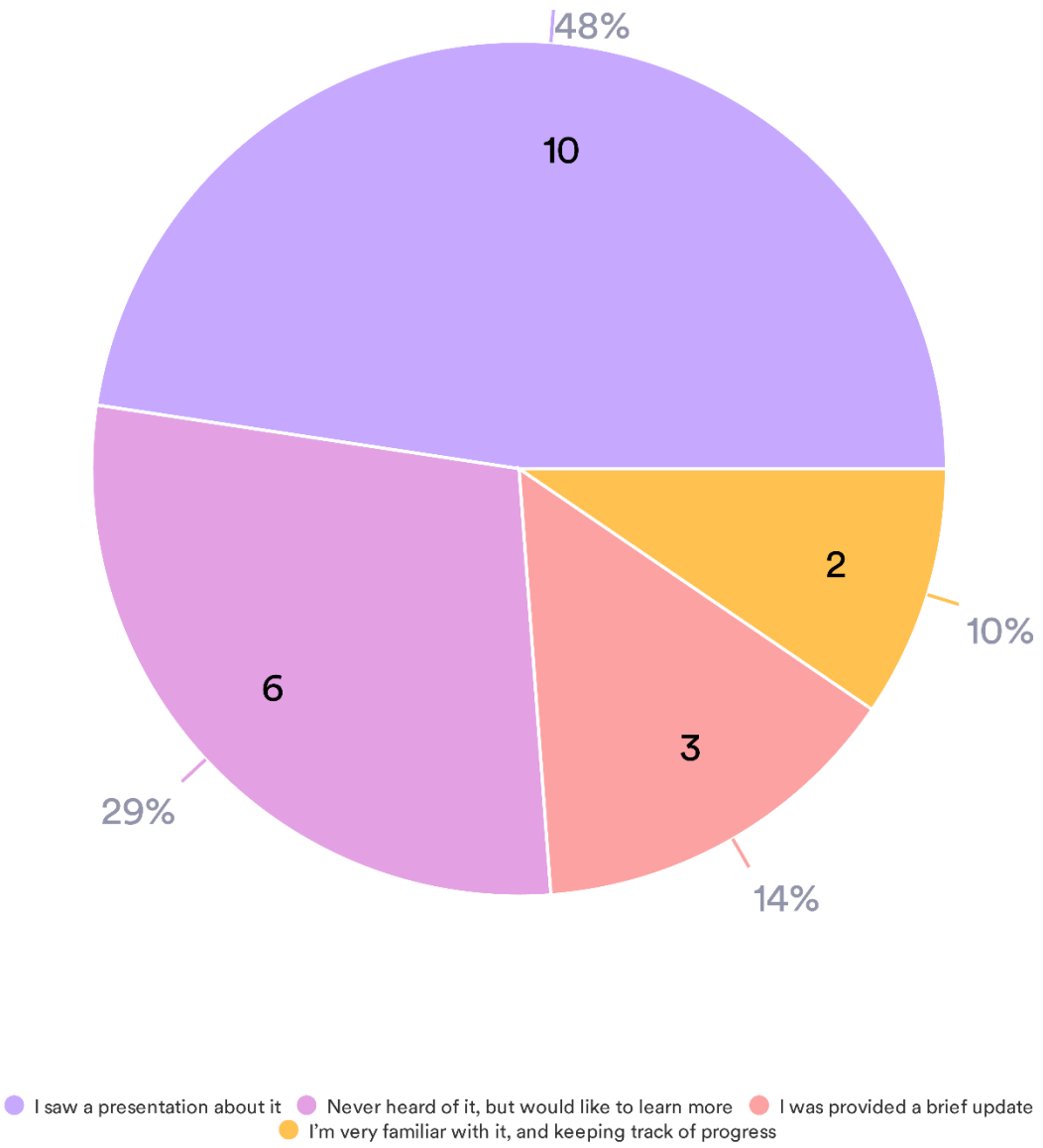

Are you a DBE?
21 Responses- 2 Empty
No
76%
16
5
Yes
24%
No
Yes


What professional services do you typically provide for ADOT? (select all that apply)
78 Responses- 2 Empty
17%
13
18%
14
17%
13
11
14%
16
21%
11
14%
ROW and/or utility coordination
Roadway design
Traffic engineering
Planning
Bridge design
Other entries


Are your firm's subconsultants familiar with, digital delivery and modeling?
22 Responses- 2 Empty
Yes
45%
10
3
N/A
14%
9
No
41%
Yes
No
N/A

How familiar are you with ADOT Digital Delivery Project? (Select one option)

21 Responses- 2 Empty



What is your firm's experience producing corridor 3D models for roadway projects?

21 Responses- 2 Empty

Best Response

5

43%

Percentage

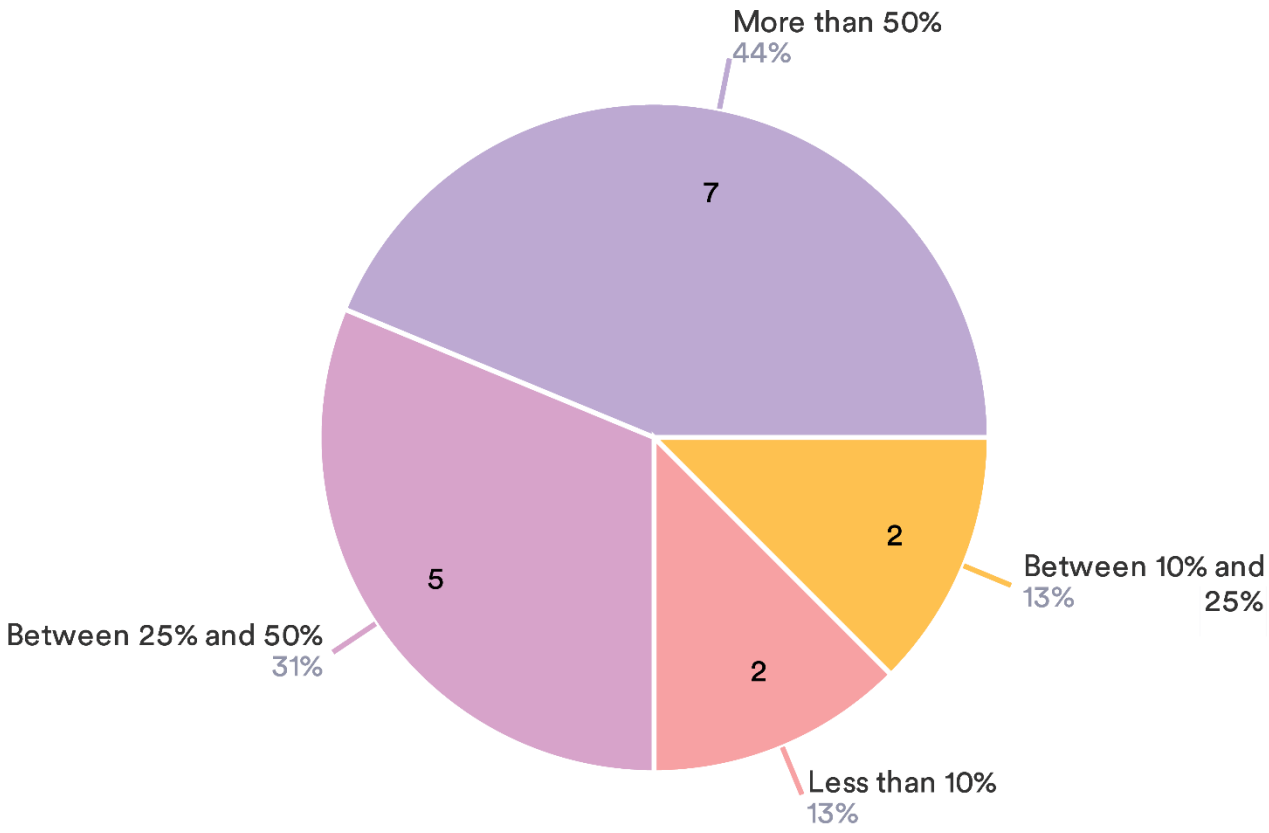
21

Responses

Data	Response	%
5	9	43%
1	5	24%
4	5	24%
2	2	10%
3	0	0%

Follow-up question: What percent of your roadway designers would you consider expert modelers?

16 Responses- 7 Empty



What is your firm's experience producing 3D models for drainage networks and utilities?

21 Responses- 2 Empty

Best Response

1

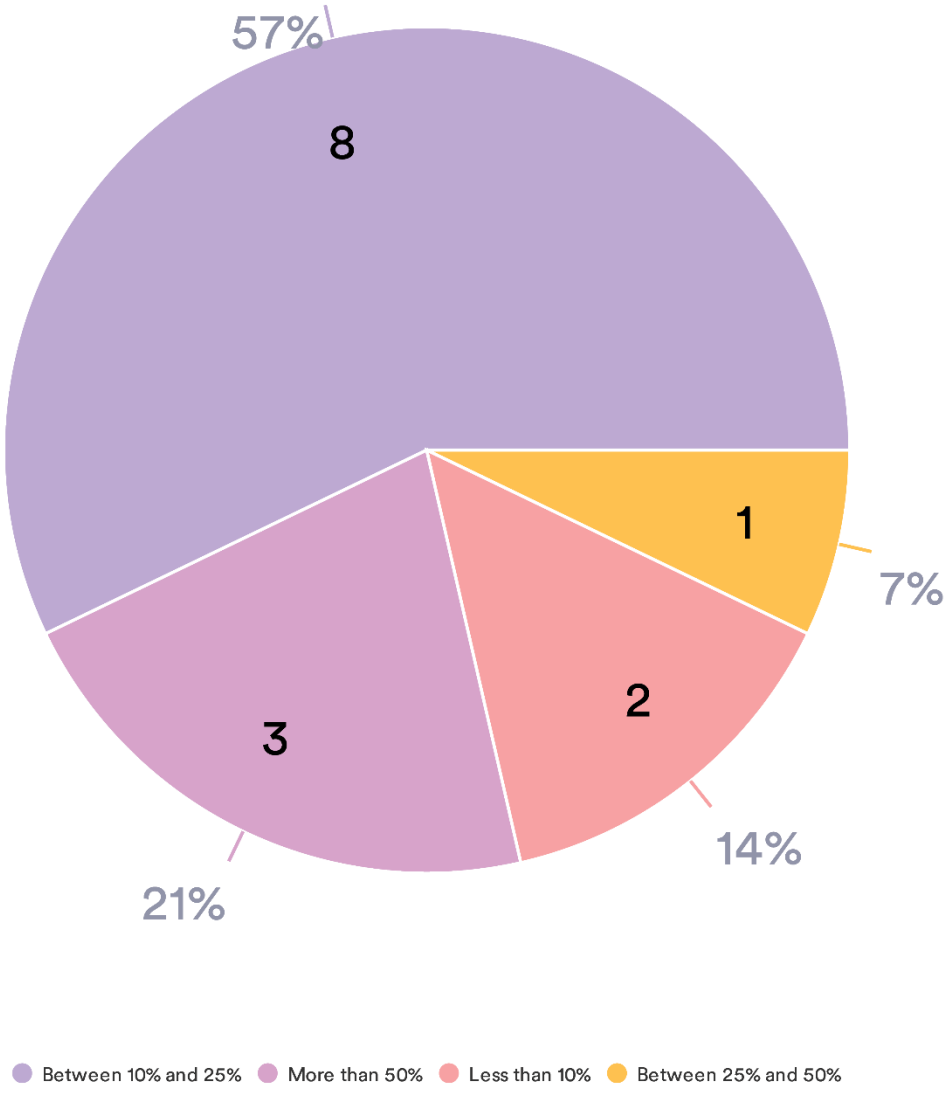
38%
Percentage

21
Responses

Data	Response	%
1	8	38%
4	5	24%
3	3	14%
5	3	14%
2	2	10%

Follow-up question: What percent of your drainage and utility designers would you consider expert modelers?

14 Responses- 9 Empty



What is your firm's experience producing structures 3D models bridge projects?

21 Responses- 2 Empty

Best Response

1

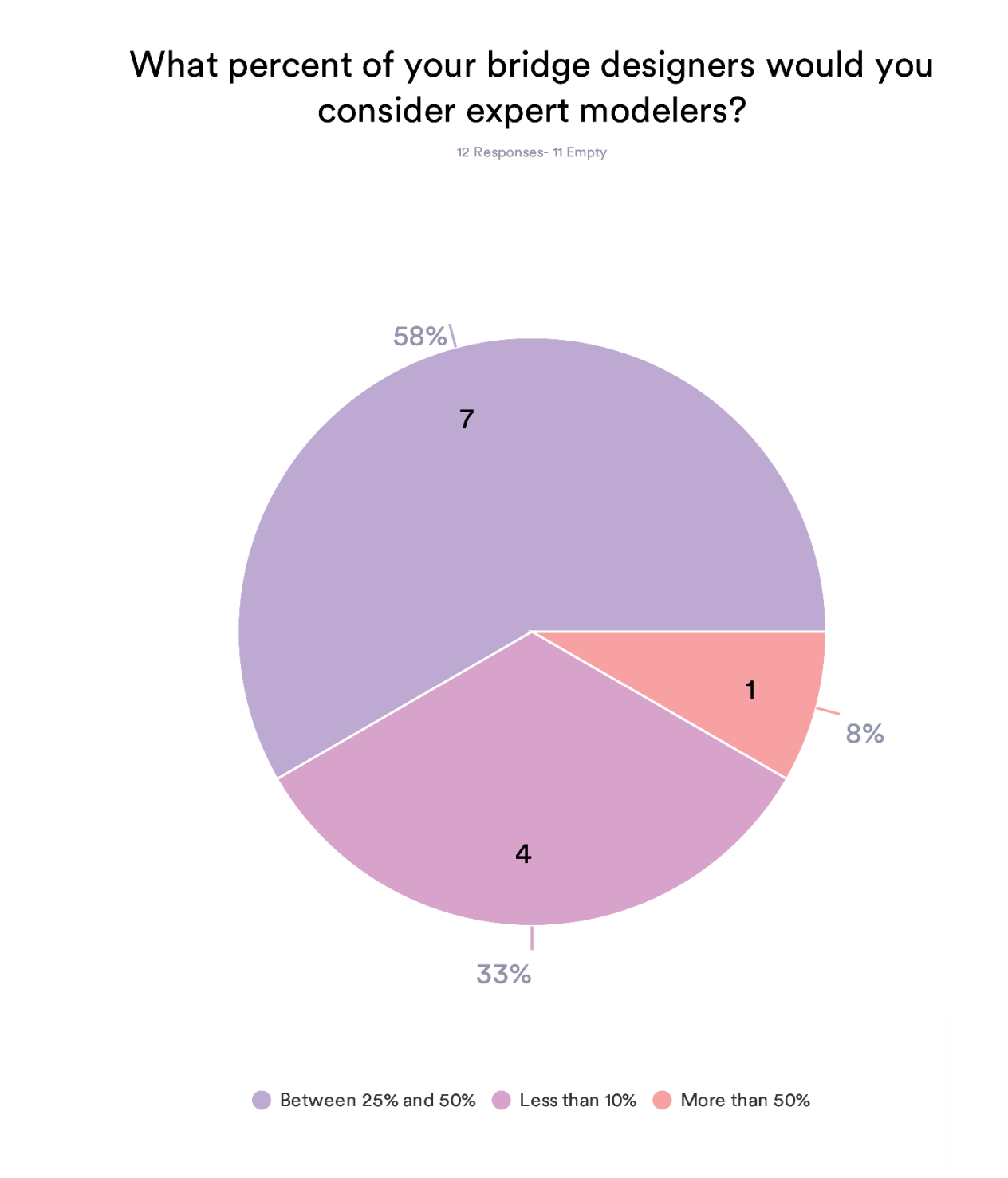
48%

Percentage

21

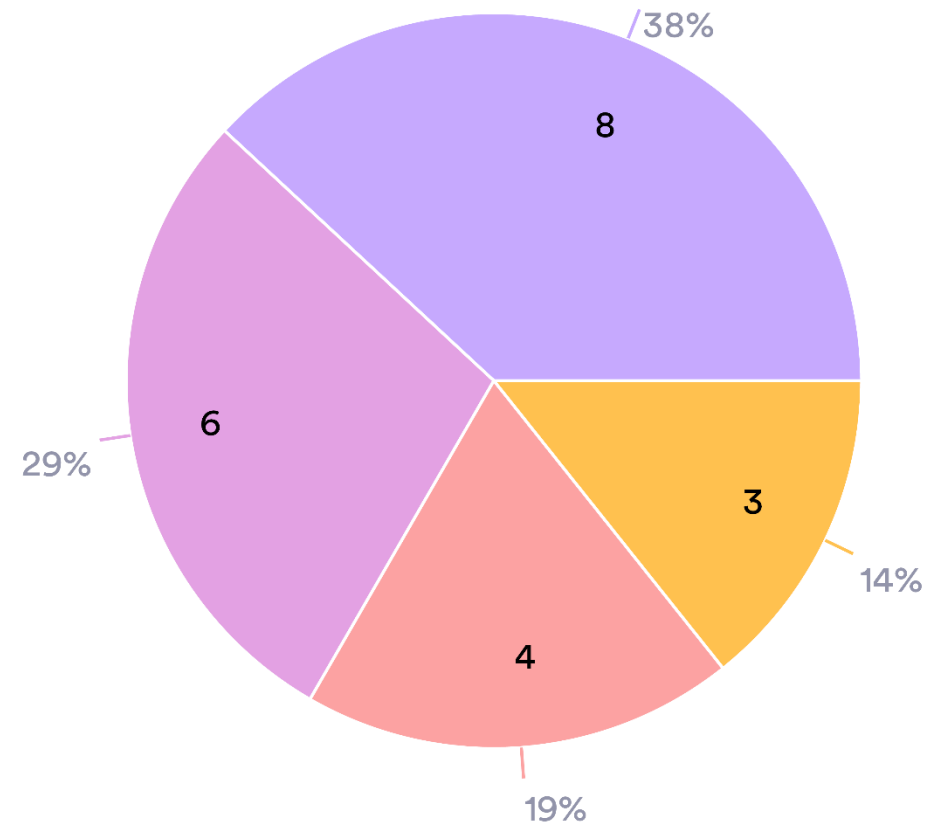
Responses

Data	Response	%
1	10	48%
4	4	19%
5	4	19%
2	3	14%
3	0	0%


What percent of your bridge designers would you consider expert modelers?
12 Responses- 11 Empty
58%
7
1
8%
4
33%
Between 25% and 50%
Less than 10%
More than 50%

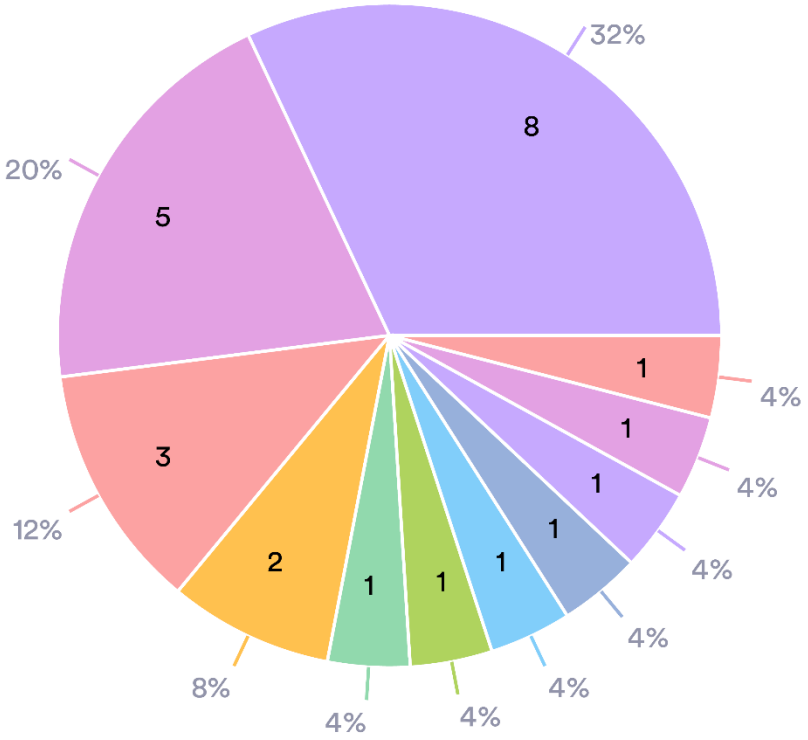
What skill level designer typically develops your 3D models?

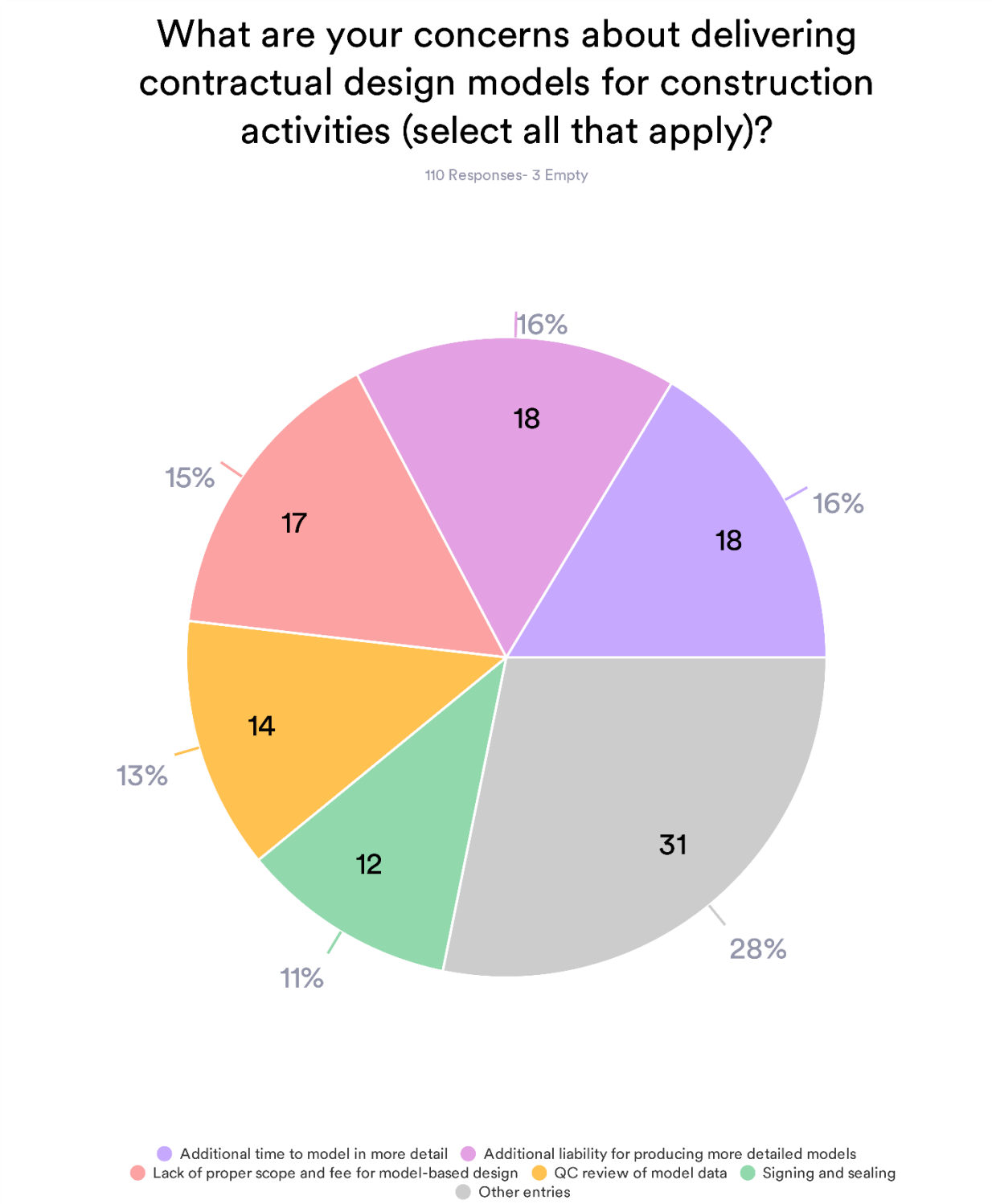
21 Responses- 2 Empty



How are you incorporating bid documentation, such as pay items, specifications or model object attributes in your design models? (select all that apply)

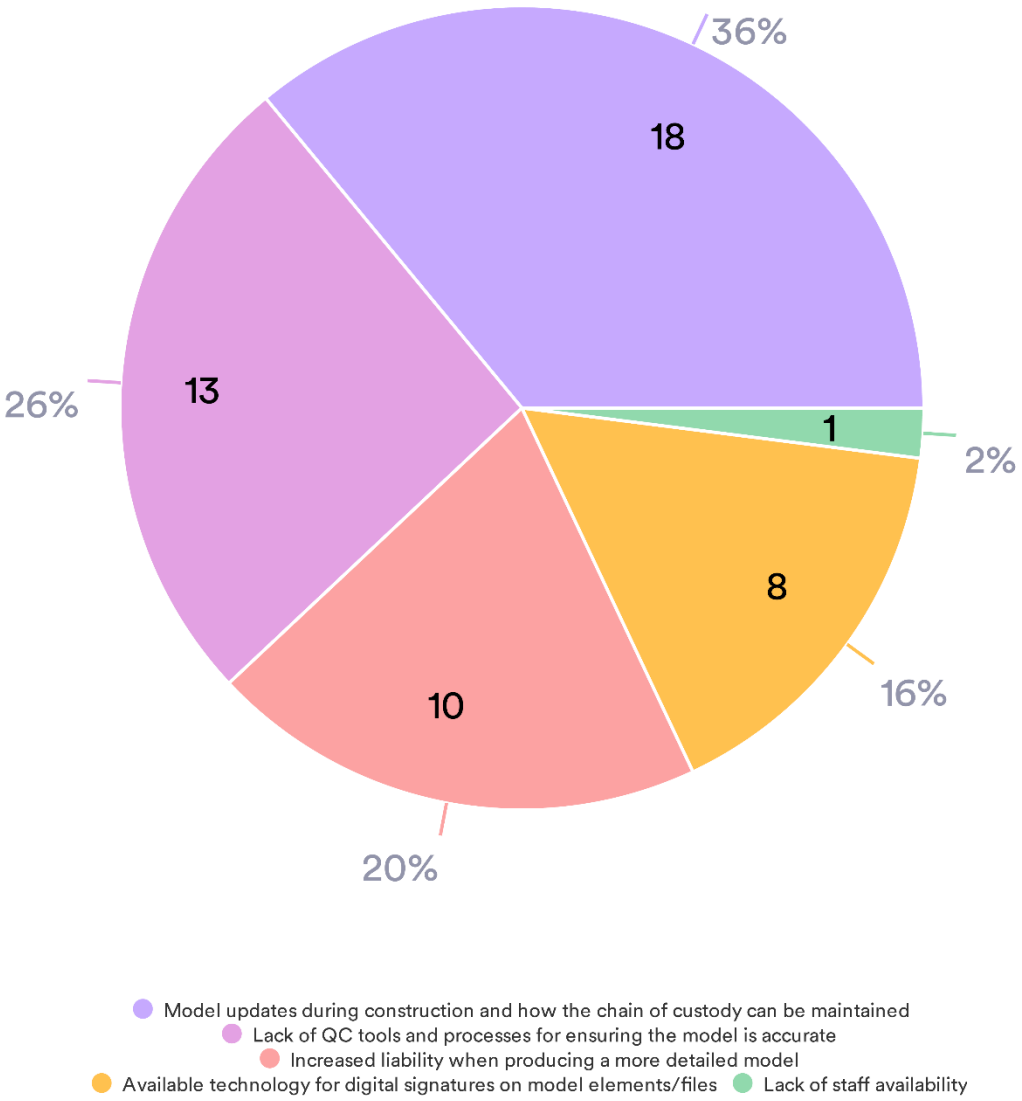
25 Responses- 3 Empty




What are your concerns about delivering contractual design models for construction activities (select all that apply)?
110 Responses- 3 Empty
16%
18
16%
18
15%
17
14
13%
12
11%
31
28%
Additional time to model in more detail
Additional liability for producing more detailed models
Lack of proper scope and fee for model-based design
QC review of model data
Signing and sealing
Other entries

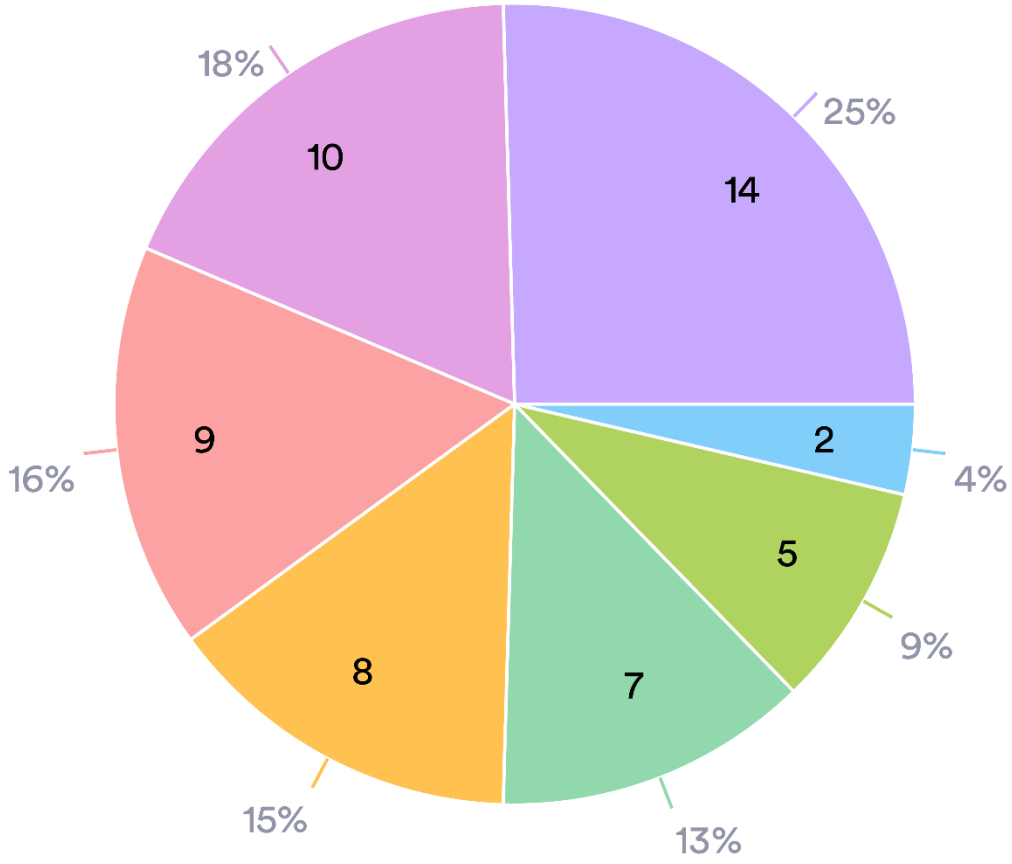
What concerns do you have about digitally signing and sealing a design model (select all that apply)?

50 Responses- 4 Empty



What aspects of model-based design and delivery do you feel is an advantage over plan production and delivery (select all that apply)?

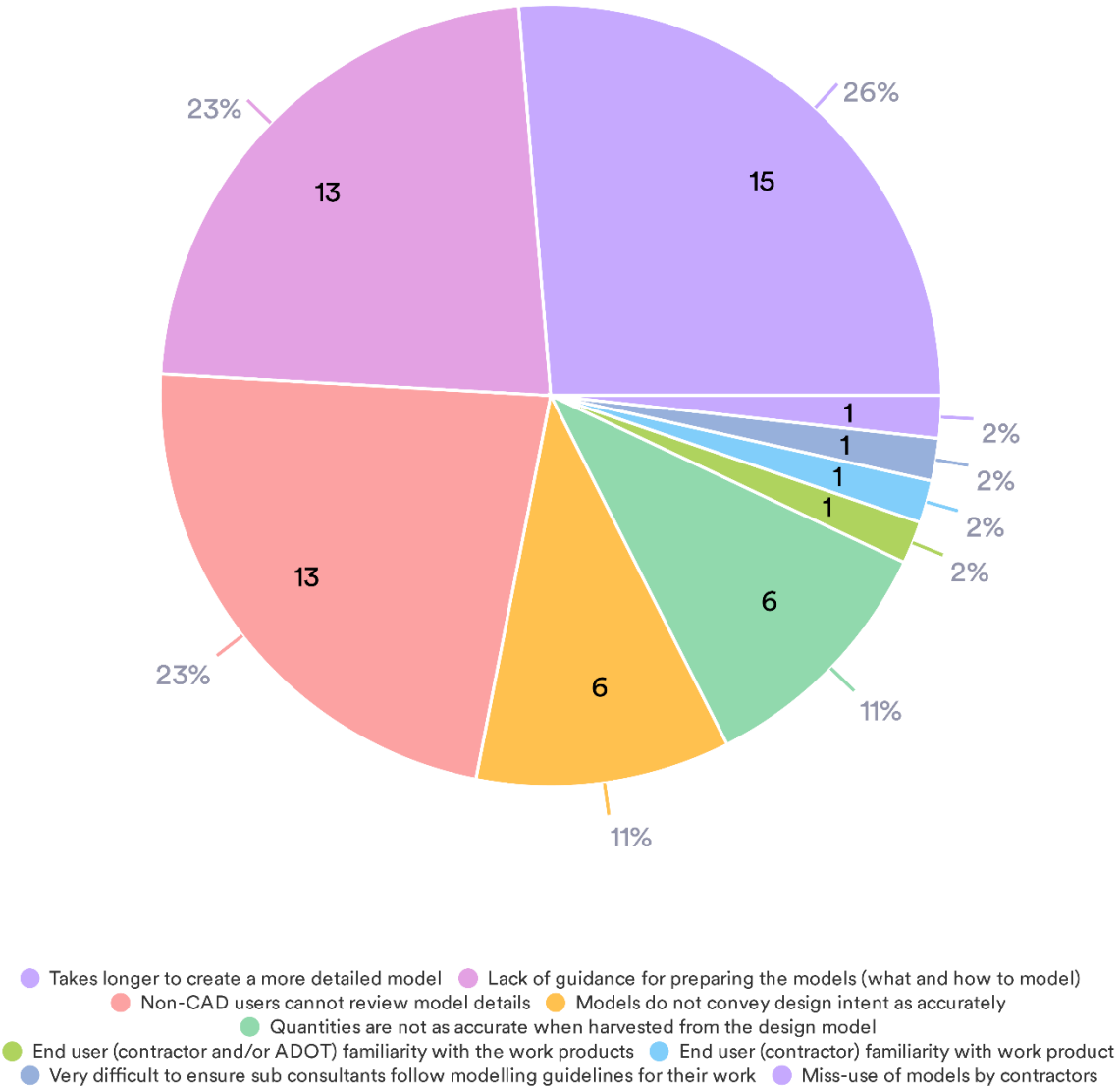
55 Responses- 6 Empty



Better and easier clash/conflict detection
Less redundancy when creating notes, summary tables, annotations, etc.
Automation of quantity takeoffs
Reduced time in creating sheets
Easier to change the design when you don't need to create updated sheets
More accurately conveyance of the design intent
Easier to change the design when you don?t need to create updated sheets

What aspects of model-based design and delivery do you feel is a disadvantage or concern versus traditional plan delivery (select all that apply)?

57 Responses- 4 Empty



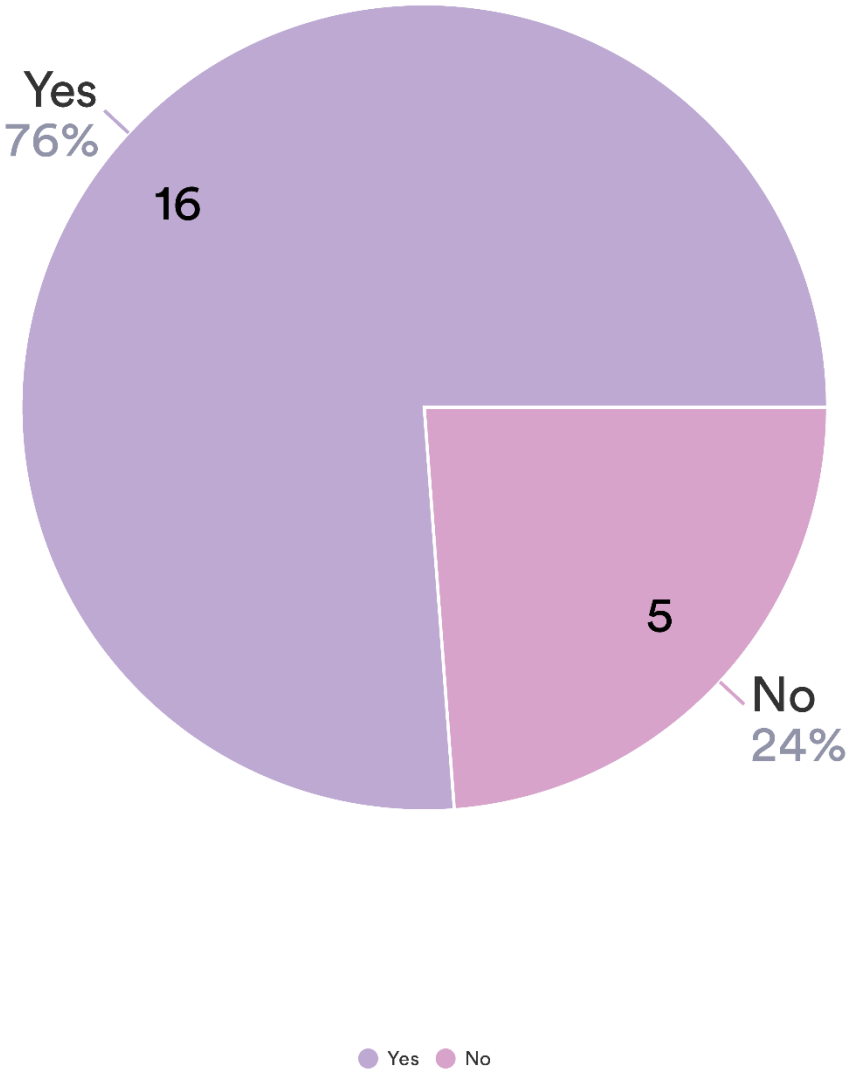
Please give specific examples of challenges/roadblocks you have faced developing and delivering digital models for construction.

14 Responses- 9 Empty

Data	Responses
Setting standards for expectations; Risk management and full development of model; interpretation by end usurs of deliverables.	2
Added time to create detailed models is not generally available in the design schedule. Detailed models increase file size which can overwhelm workstations, create bandwidth issues, slow down production, and file updating/sharing processes. Senior engineering staff and QC staff do not have the most current software and training. This complicates the design checking and quality process. Field questions/adjustments will lack easy "redline" capability with digital delivery. Will the contractor develop a model for engineer review? Do they have those capabilities yet?	1
Lack of universal expectation on level of detail of modeling, universally accepted format. Difficulty for non-technical agency users to review design. Lack of consistent field equipment technology among contractors to be able to fully utilize 3D model benefits.	1
Our folks have found that OpenBridge has limited capabilities for complex structure analysis	1
Digital model produces cords on horizontal & vertical curves based on template drop intervals. How will this effect use of model for construction?	1
OpenBridge Modeler has limited capabilities in analyzing complex structures	1
Have not had many specific issues yet	1
Accuracy of information insufficient for fabricator take-offs. Many dimensions are not know until the fabricators supply the products. Contractors, in design build environments, substitute products that require model changes for accuracy, it is difficult to price this at bid time and difficult to get compensated for the extra work.	1
Traditional plan delivery is gradually being replaced by 3D model-based design in many industries. The 3D model-based design offers several advantages, including improved collaboration, better visualization of the design, and reduced errors and rework during construction. Additionally, 3D models can be used for a variety of purposes, such as quantitative analysis and construction sequencing. Overall, both approaches have their advantages and disadvantages, and the choice between them depends on factors such as project size, complexity, budget, and client requirements. However, 3D model-based design is increasingly becoming the preferred approach for many construction projects due to its many benefits.	1
Contractors are using a lot of non-technically proficient labor and expectation that they will implement the design as the model presents has been an issue so far. Staking data generated from models is still subject to interpretation when applying standard details which has resulted in significant field construction errors and rework.	1
Linear models are fairly straightforward. It is the customized/unique areas like intersections, basins, etc. that require significant modeling efforts.	1

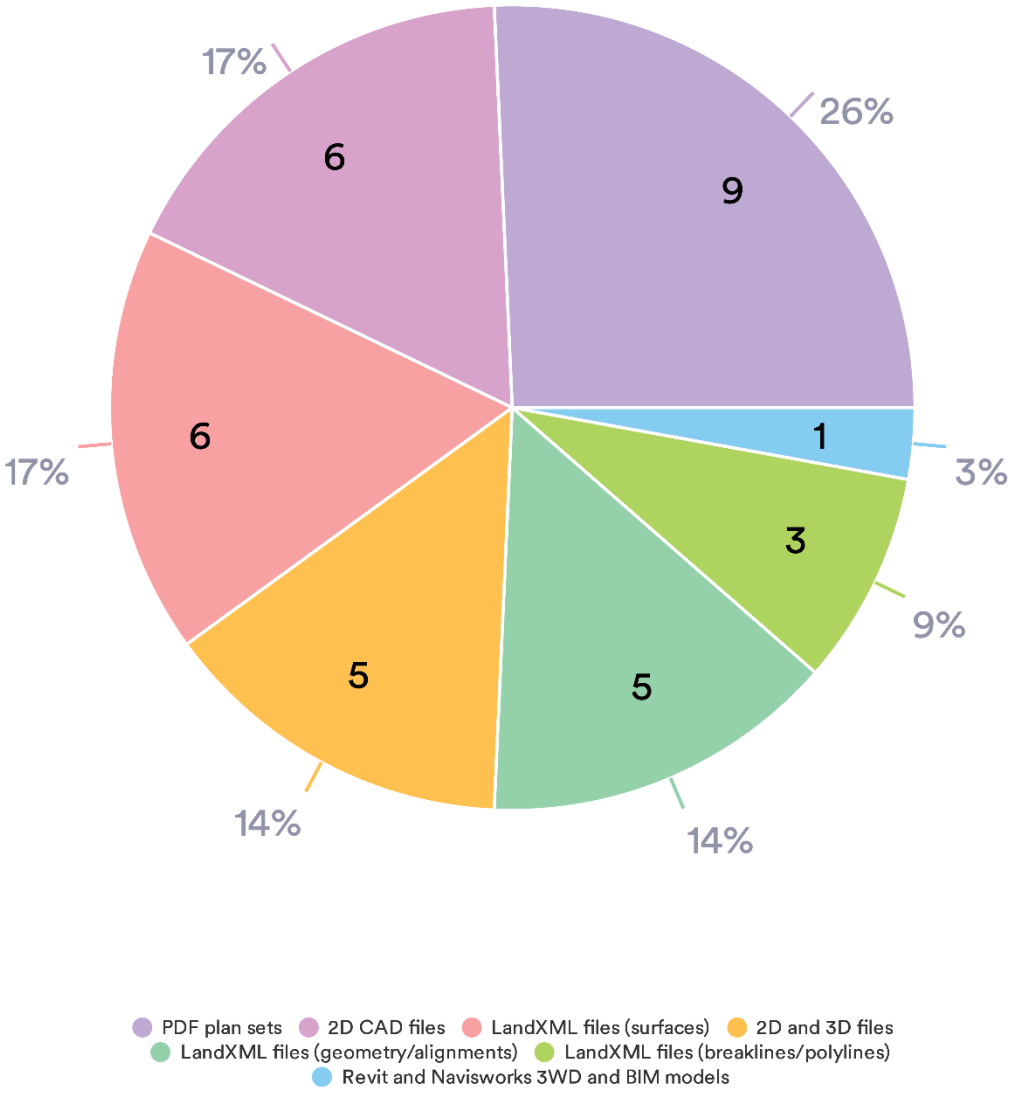
Do you work for contractors on Design Build projects?

21 Responses- 2 Empty



If yes, what do you deliver to the contractor from your designs (select all that apply)?

35 Responses- 13 Empty



If other, please describe:

1 Response- 22 Empty

Data	Responses
technical reports	1

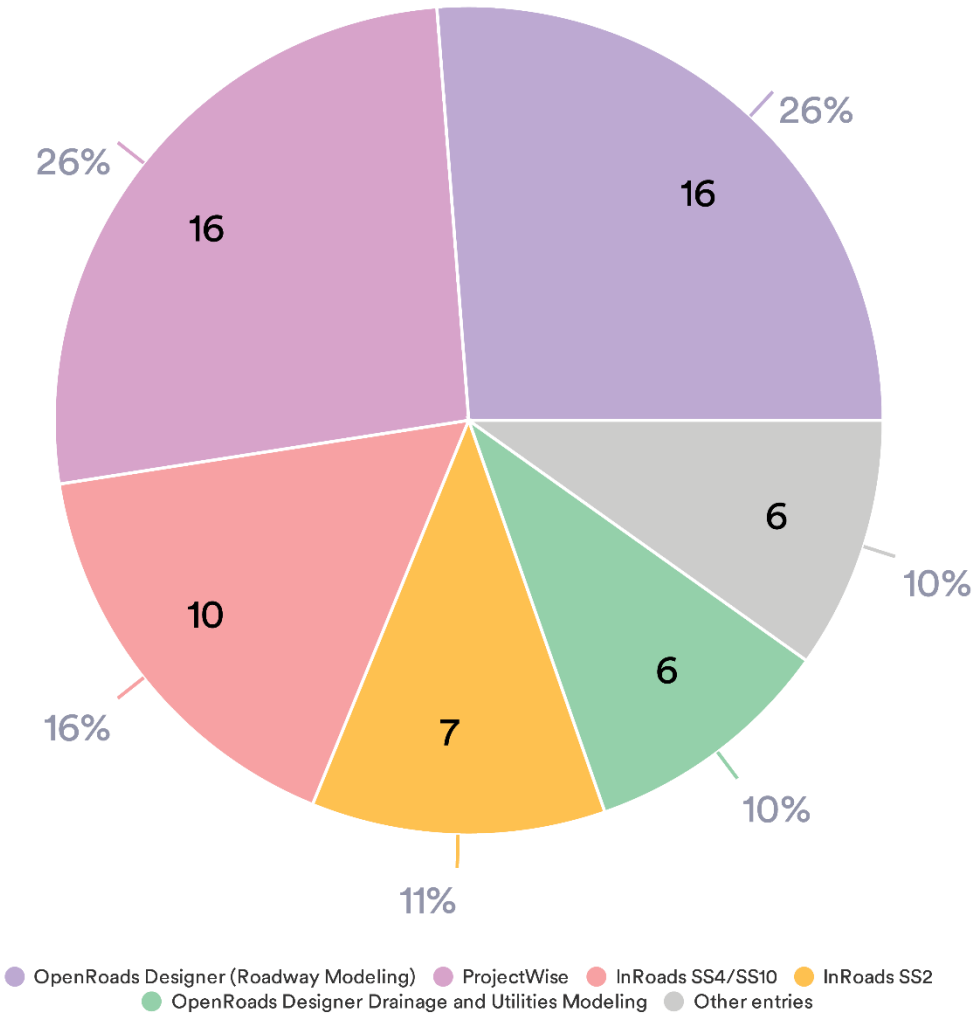
If producing models for contractors, what feedback have you gotten from them that has helped you to produce construction-ready data?

6 Responses- 17 Empty

Data	Responses
N/A	2
ADOT required design software is almost never used by the construction community. They have their preferred software and file formats that sync with their earthwork packages, automated machine control, etc. Designers have to export/convert 3D info into file formats that are not easily checked or utilized by the root design software (InRoads/ORD). Contractors are usually using this information at their own risk and generating a number of iterations between designers and contractors to arrive at the contractor's desired outcome.	1
Breaking models into 'construction stages' (rough grade, excavations, subgrade, finished grade) provides value for constructability, enables their automated equipment to be more efficient.	1
We've never provided a construction-ready digital model to a contractor on a DB project.	1
Models are only as good as the existing information (topo or other data). Field personnel can sometimes rely too heavily on models and not correctly match field conditions.	1

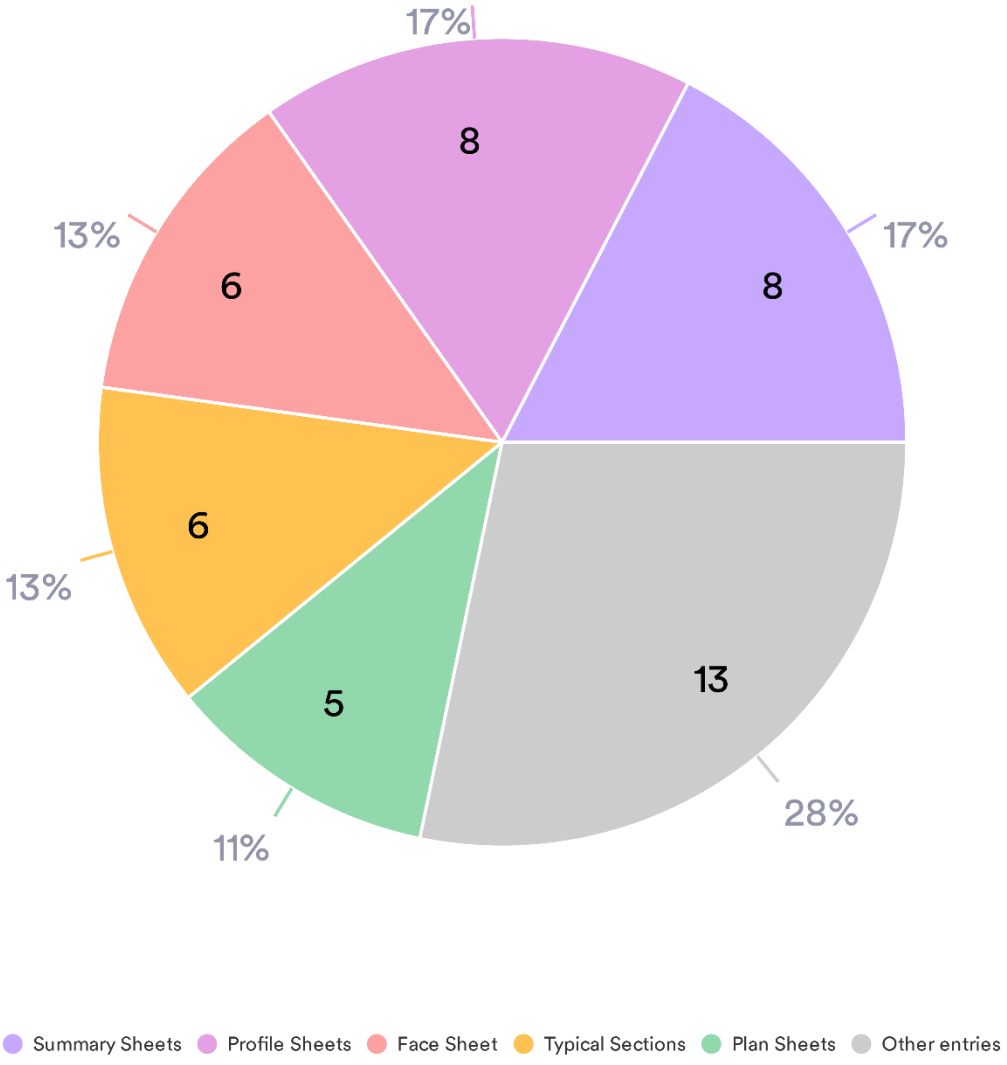
What Bentley products is your firm using to produce ADOT project submittals (select all that apply)?

61 Responses- 6 Empty



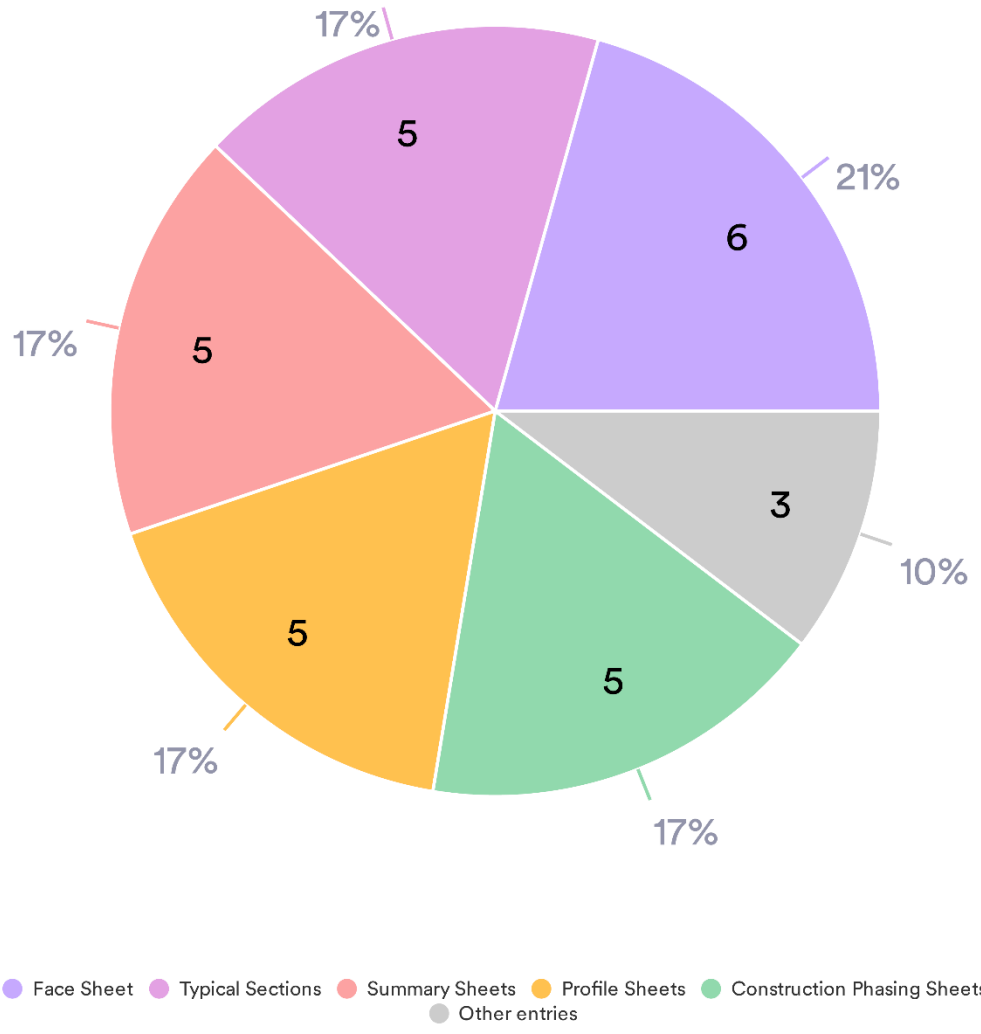
What current ADOT Roadway plan sheets do you feel could be eliminated or significantly reduced if the design model was used as the contractual deliverable to construction (select all that apply)?

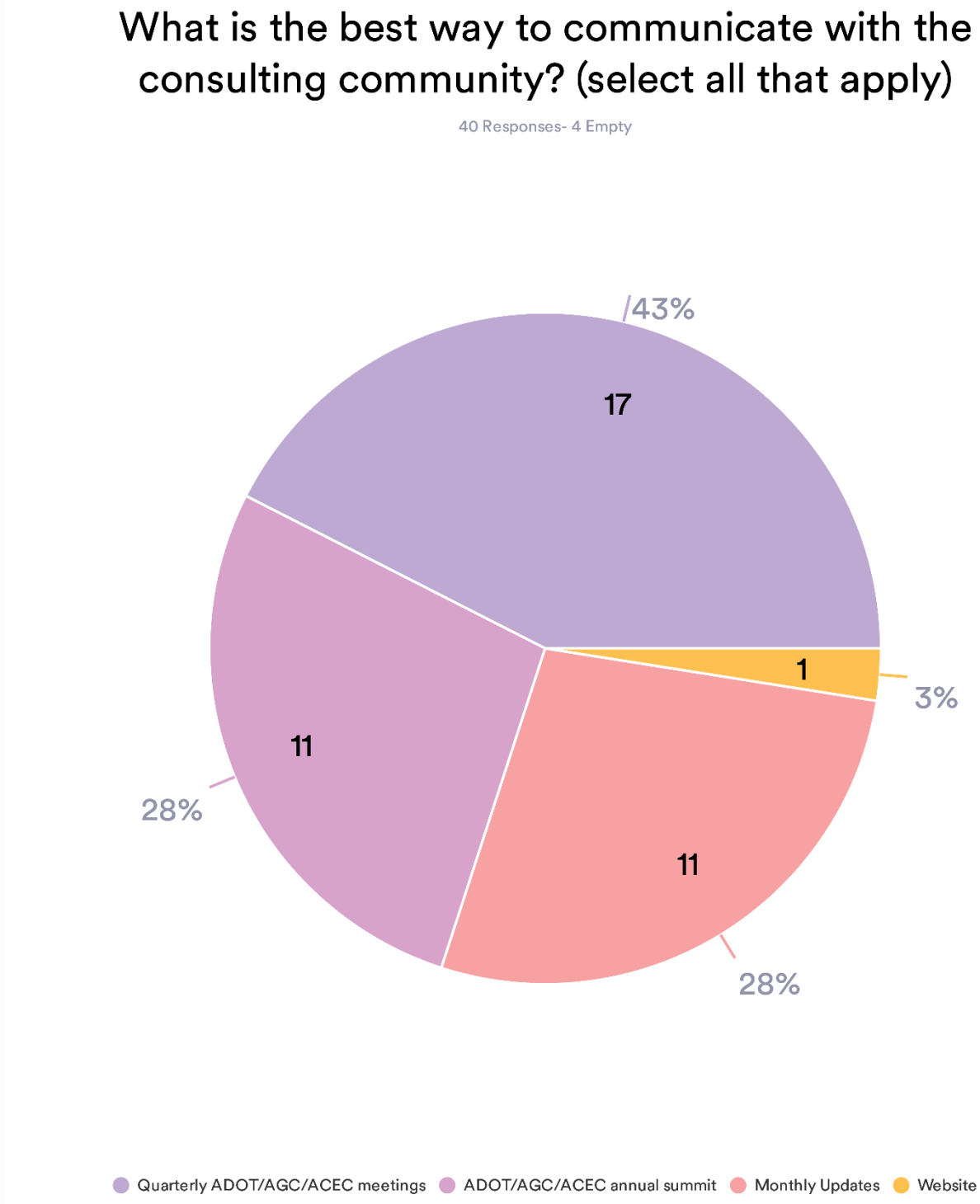
46 Responses- 8 Empty



What current ADOT Bridge sheets do you feel could be eliminated or significantly reduced if the design model was used as the contractual deliverable to construction (select all that apply)?

29 Responses- 11 Empty




What is the best way to communicate with the consulting community? (select all that apply)
40 Responses- 4 Empty
43%
17
1
3%
11
28%
11
28%
Quarterly ADOT/AGC/ACEC meetings
ADOT/AGC/ACEC annual summit
Monthly Updates
Website

How often would you like to receive communications from ADOT regarding digital delivery? (Please explain)

13 Responses- 10 Empty

Data	Responses
With the implementation timeframe, quarterly would be ideal.	2
As often as changes occur. Since this is a major shift in our industry, it would be advantageous to stay as informed as possible. The design community needs to be aware of ADOT's goals, plans, decisions, and timelines so that we can best prepare to support ADOT in delivering quality design projects.	1
As frequently as there are meaningful updates/changes to progress toward implementation. Advanced communication helps us to prepare for the future, and give feedback while the process is being developed.	1
INformation should be easily searchable so that users can find when they need it.	1
Project web site for Digital Delivery Project	1
monthly, preferable, if there is movement; quarterly, minimum, seeing as there are perhaps 11 quarters until the transition is to occur	1
As often as possible when changed information or new information is available. Minimum quarterly	1
It all depends on your specific needs and interests. If we engage in a project that requires regular updates on the digital delivery plan, we may want to receive communications on a frequent basis, such as weekly or monthly. On the other hand, if we are only interested in high-level updates, we may prefer to receive communications less frequently, such as quarterly or biannually. The frequency of communications should be determined by your specific needs and the importance of the information being shared.	1
quarterly	1
Quarterly	1
Regularly as ADOT continues development and refinement of desired practices to be implemented,	1
When there are updates/changes to the policies	1

What would prevent you or your firm from moving forward with delivering and constructing projects in a digital format (without physical contract plan sets)?

17 Responses- 6 Empty

Data	Responses
Resolving risk management elements; working with subs who are capable of performing services. DBE firms are limited in number as-is, and this could limit the number of capable firms further. One of the challenges we have seen in the industry is inflexibility between ORD versions with Bently, and we have engaged Bently at the leadership level to discuss these items. Having a good approach on software and/or model version control, and consistency with Department expectations, will help this process go smoothly.	2
Vague or poorly defined guidelines and standards would be harmful to this shift in project delivery. Clear requirements and expectations from all parties involved - Contractors, ADOT, Field personnel, oversight, and design community would be critical to successful implementation. It is what ADOT has currently and would need to be in place for effective digital delivery. Is there a change in firms' liability and E&O insurance requirements? How are digital designs sealed by the engineer?	1
Lack of clear expectations from ADOT on what the deliverables need to entail. Also note the inputs need to be good (survey quality) to reflect a quality output model.	1
unlcear expecations what is needed from reviewers and unclear what is needed from field staff to execute construction	1
Knowledge or guidelines from AZBTR regarding sealing digital models	1
Clear guidance on what is expected from ADOT reviewers as well as construction/field staff.	1
document security concerns ability of subconsultant teaming partners to be as fluent with the technology (costs may be prohibitive for smaller firms to buy in)	1
Not having full integration/implementation between consultants, contractors and ADOTSubconsultants (especially smaller firms) that do not have the capacity/resources to acquire and use the software	1
Legal hurdles from AGC or our E/O Insurance	1
There can be several factors that may prevent some firms from moving forward with delivering and constructing projects in a digital format. Some examples could be lack of expertise, resource constraints (software training), resistance to change, compatibility issues, and cybersecurity concerns. All of the above examples have been addressed by our firm but many more can arise as we continue to move forward with digital format.	1
software costs, training, staff expertise	1
Qualified Staff	1
ADOT not recognizing the extra cost and level of detail effort needed to develop a truely refined accurate model with every aspect and element carrying precision that is needed to build.	1
Limited modeling expertise	1

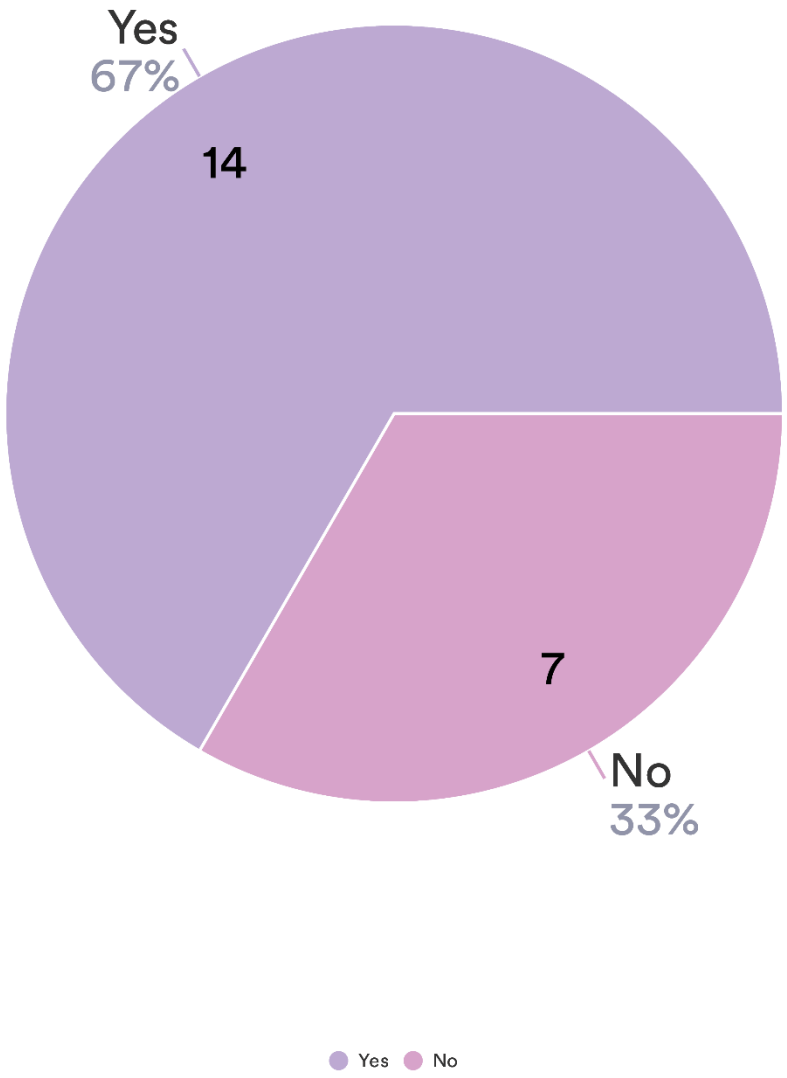
What other information would you like to share with ADOT? (Please explain)

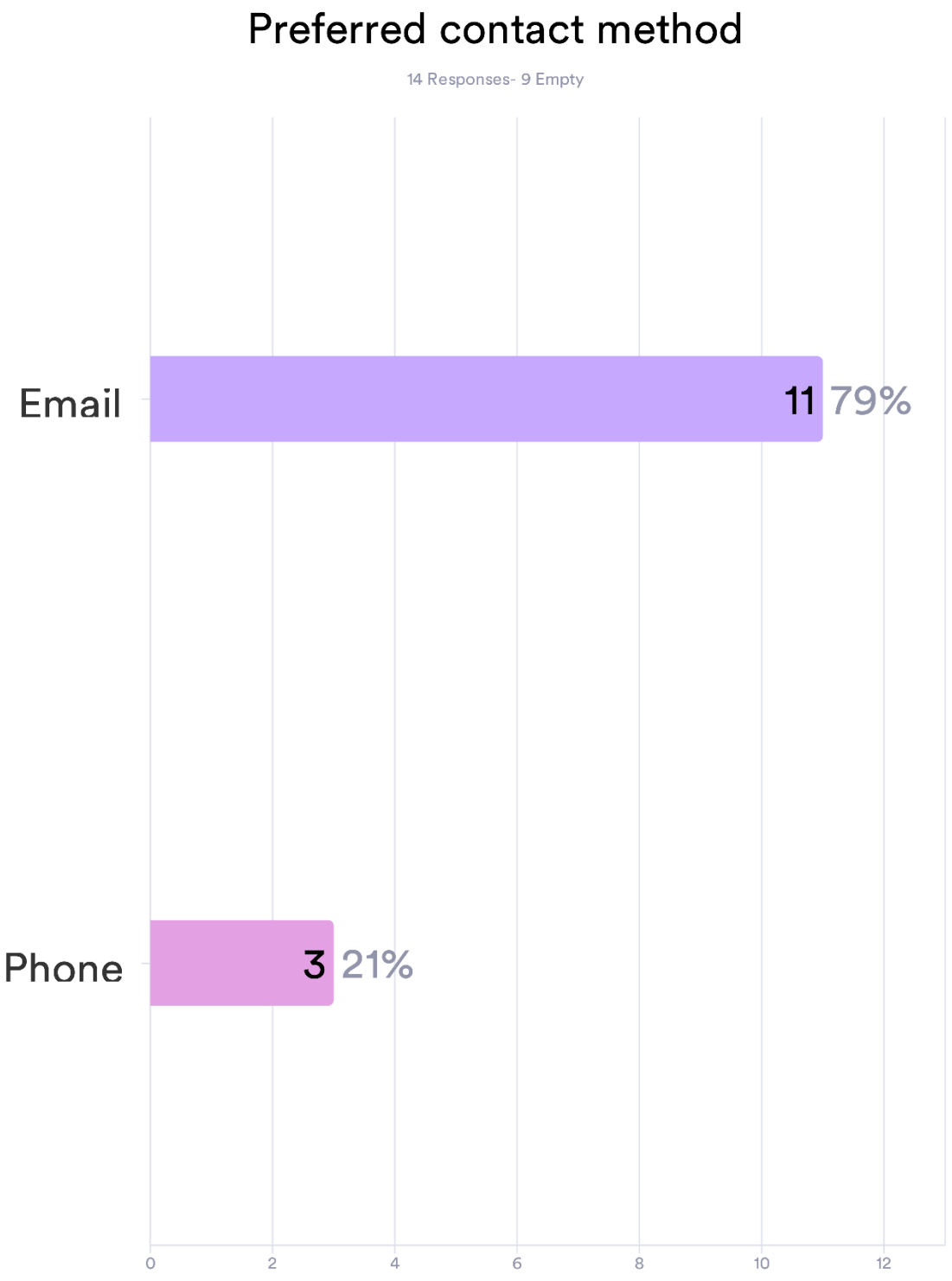
11 Responses- 12 Empty

Data	Responses
As a general statement, our firm is seeing this initiative progressing in various other states and incorporating best practices (or collaborating initiatives) would be ideal. It is assumed that ADOT will be engaging others. We are excited to see how this progresses. I'm certain my firm will successfully adapt as we are already providing these services in Arizona to some capacity, and elsewhere in greater capacities.	2
Pilot projects that would be shared with the design and construction community would be beneficial. Detailed and comprehensive survey would be critical to the accuracy of a 3D design - this will cost more. 3D representation of existing utilities will need to be discussed. Additional SUE effort may be required to show buried facilities in a 3D design.	1
We are suportive of digital delivery as the future of the industry, there are many benefits to be realized by consultants, agencies, and contractors. From a consultant perspective, if we can spend more of our budget/effort on refining the design and models instead of drafting often redundant information onto physical sheets, the resulting designs will be of a higher quality and avoid conflicts by enabling better clash detection.	1
Alternative delivery methods for the first few projects would be required to ensure contractors are on board (we have done this in Utah for 8 projects)	1
ADOT should use a Change Management expert to help engage the construction and engineering community as this is a big change in the way that business is done and there will be a lot of apprehension.	1
contact me by email or phoe 480-262-5237 robert.brantley@stvinc.com	1
Currently design models are produced and brought up to a 90% accuracy level. To achieve the last 10% accuracy often comes with a greater effort than the first 100%. Simple projects are easier to achieve greater accuracy, but complex projects do not seem to achieve the benefit over the cost.	1
ADOT is lagging behind other DOT's in the application of digital delivery and needs to refine and update standards and details, templates and requirements to establish a consistent delivery package that meets the needs of ADOT and protects consultants and ADOT from misuse and financial losses from contractor claims.	1
I think smaller firms will be at a big disadvantage in being able to compete compared to the medium and larger size firms.	1
As-builts by non-CAD users in the field seems like a pretty big hurtle.	1

Will you be willing to be contacted for a follow-up discussion?

21 Responses- 2 Empty




Preferred contact method
14 Responses- 9 Empty
Email
11
79%
Phone
3
21%
0
2
4
6
8
10
12

Appendix E. Model Use Cases

Prerequisite Model Use Cases

To use digital data in the project delivery process, there are two types of models that need to be developed: existing conditions and design models. These two types of models are required to use digital data for most of the ADOT model uses described in this section. Below is a description for each of these model types.

Existing Condition Modeling

A process to document the existing conditions of a project to form the basis of design and/or construction. Existing conditions may include the existing ground surface, roadway alignment(s), bridge structures and elements, surface features (e.g., edges of pavement), surface assets (e.g., signs, lighting, striping), land boundary information (e.g., right-of-way, legal boundaries, and property corners), subsurface utilities, structures, and subsurface features (e.g., ground characterization and the existing pavement layers). The digital data may include 2D and 3D geometry, GIS derived information, documents, images, and analytical models (e.g., geotechnical). Because elements depicted in existing condition models carry level of accuracy uncertainty about their location and characterization, it is important to define standards and requirements as part of the Engineering Survey Specifications and Practices Manual. Model users need to be familiar with the various confidence intervals for all depicted model elements, especially subsurface features.

Design Authoring (Roadway, Bridge, Drainage and Utilities)

The process of developing a model to define and document the design. Typically, each individual discipline (e.g., roadway, structures, and drainage) develops a discipline model using common standards for coordinate systems, levels of accuracy, and other modeling requirements. The individual discipline models are then referenced together into a single, federated model. This is an essential model use case to support many downstream uses, including model as the contract document. Element detail and information increases from conceptual to final design as the project is being designed.

Model Use Cases

During the life of a highway infrastructure project, there is a significant amount of information that needs to be exchanged between stakeholders and milestones during project development. Digital delivery is a modernized approach to project delivery processes and contract media that incorporates digital data. Simply stated, construction projects have the ability to be bid on using 2D and 3D technology and no longer only be delivered in a traditional construction plan format. The specific type of information needed by each model user to conduct their job tasks is described as a model use. Each model use is based on the needs of the recipient (model user), including model-based and other digital information exchanges. Details about the required model uses for digital delivery are described in this section.

Visualization

The process of creating visual representations of the project to communicate with technical and non-technical stakeholders throughout the project lifecycle (e.g., scoping, NEPA, stakeholder involvement).

The digital data includes 3D model renditions, raster files, and video simulations. The graphical detail and information associated with these models is dependent on when the visualization products are created. If the visualization is to produce products for public information as the project enters final design, the base model may have a high level of detail, but little or no engineering information.

Design Model Review

The process of reviewing the design to determine compliance with codes and guidelines. Design review may include the use of software to analyze design models using a rule set that checks design criteria requirements, as well as the outputs of analytical design and 3D coordination. Design review is the responsibility of specific project stakeholders, such as the Engineer of Record (EOR) and a designated design reviewer. Often, the EOR and design reviewer are responsible for specific discipline models. There are additional design review procedures for federally funded projects. The digital data includes 2D and 3D geometry, analytical models, and documents (i.e., reports). The model elements may have variable levels of detail and information depending on when the design review is being performed.

Design Quantities

The process of taking off quantities from the design model according to a schedule of bid items and estimating a price for each bid item to estimate the construction cost. The model elements may have variable levels of detail and information depending on when the design quantities are being developed. However, the final design quantities and engineer's estimates for final deliverables are derived from a model with a high level of detail and information.

Temporary Construction Model

The process of developing a model for the design of temporary construction systems, such as staging, temporary utilities, excavation, or other engineered temporary construction systems. These models can be utilized during 3D coordination and clash detection to make appropriate construction decisions through detailed analysis. The model elements may have variable levels of detail and information depending on the level of need to make appropriate decisions.

3D Coordination and Clash Detection

The process of using software to analyze a combined model of all disciplines (commonly referred to as a "federated model") using rule sets to identify collisions between design elements. 3D coordination also includes performing a visual analysis to identify potential spatial design and staging issues. 3D coordination and clash detection may include comparisons between both existing conditions modeling and proposed models, and interdisciplinary design model coordination to proactively avoid collisions in the design authoring process. Analysis using existing conditions models needs to consider the accuracy of the model source data. The digital data includes GIS, 2D and 3D geometry and documents (i.e., collision reports). The model elements may have variable levels of detail and information depending on when the 3D coordination or clash detection is being performed. However, it is important to recognize that the more detail and information available, the better the reliability of the 3D coordination and clash detection.

Digital Delivery Contract Model (Letting Model)

The process of documenting the existing conditions, design intent, construction specifications, and engineer's estimate for the purposes of bidding and construction. Currently, the process uses documents such as plans, specifications, and spreadsheets. With digital delivery, most plans will be replaced with digital data, which may comprise of 2D and 3D model geometry and documents like spreadsheets with tables of data or 2D project PDF files (e.g., digital roll plots). The "letting model(s)" delivered as the contract document is at high level of detail and information.

Construction Inspection, Verification and Acceptance

The process by which a construction inspector uses the contract bid model to verify, document and accept construction outcomes.

Construction Planning

The process by which the contractor determines means and methods for constructing the project, which may include scheduling, workforce planning, equipment selection, etc.

Contractor Quantity Takeoffs and Estimates

The process by which the contractor extracts information from the design model to verify pay item quantities and to prepare bids, order materials, and schedule crews.

Construction Layout

The process by which the contractor extracts information from the design model to lay out the work on site, including setting local survey control points and the use of Automated Machine Guidance (AMG).

Shop Model (Drawing) Authoring

The process by which the fabricator develops and documents the fabrication information.

Shop Model (Drawing) Review

The process by which the Contractor and Resident Engineer provides shop model (drawing) and RFI submissions to ADOT.

Digital As-Built (Record Model)

The process of documenting any significant changes to the constructed condition compared to the contract (bid) model. With digital delivery, the design models and shop models could be updated to reflect the as built condition and may be supplemented with digital data represented in spreadsheets or other digital file(s). The digital data includes GIS attributes, 2D/3D geometry, documents, photographs and/or videos. This data model concludes the digital project delivery phase and constitutes the "handoff" model for post-construction operations.