KYTC Digital Project Delivery Phase 1 Summary

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Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

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Kentucky Transportation Center • University of Kentucky
176 Raymond Building • Lexington, KY 40506 • 859.257.6898 • www.ktc.uky.edu

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Research Report
KTC-26-21

KYTC Digital Project Delivery Phase 1 Summary

Rachel Catchings, P.E.
Program Manager

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

In Cooperation With
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16. Abstract
The Kentucky Transportation Cabinet (KYTC) launched its Digital Project Delivery (DPD) Initiative in September 2020 with the goal of expanding the use of digitally formatted plan and project information throughout the transportation asset life cycle, from project delivery through asset management. KYTC retained Kentucky Transportation Center (KTC) staff with expertise in construction and design to facilitate DPD implementation. This document summarizes DPD-related efforts undertaken by the Cabinet over the past five years. Key activities completed during this period include a survey of Kentucky Association of Highway Contractors members to document their perspectives on design file usage and preferences, coordinating multiple projects on which DPD was piloted, building robust communication networks to keep internal and external stakeholders updated on the initiative's rollout, collaborating with several transportation agencies (e.g., Federal Highway Administration, Caltrans), and establishing the Cabinet's Committee for Model-Based Design and Construction. Lessons learned during Phase 1 of implementation are discussed as well as long-term strategies for streamlining DPD adoption agencywide.

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1. Introduction

The goal of KYTC's Digital Project Delivery (DPD) Initiative is to increase the use of digitally formatted plan (or project) information throughout the transportation asset life cycle. DPD promises to increase the efficiency of all Cabinet user groups while decreasing costs. This report summarizes Phase 1 results of the DPD Initiative.

Prior to the formal inception of the DPD Initiative, Kentucky progressed toward more widespread use of digitally formatted project information. For example, the Cabinet required electronic engineering data (EED) deliverable files from the Division of Highway Design since 2006. These are shared with KYTC construction staff and eligible construction bidders. Even back in 2010, a reconstruction pilot project further explored the use of EED during construction. Details of the project and its use of digital terrain modeling were featured in a FHWA TechBrief (FHWA-HIF-13-049a). As technology and workflows advanced, KYTC asked the Kentucky Transportation Center (KTC) in 2018 to investigate construction-ready digital terrain models (DTMs), including potential DTM use within the Cabinet and the state's transportation construction industry groups. That report was published in May of 2020. Report recommendations included high-impact quick wins that would minimally disrupt existing processes.

Quick Win

Interviews and case studies revealed that PDF files received by contractors through the construction bid letting process did not fully conform to relevant KYTC CADD standards. The vendor managing KYTC's construction lettings had been routinely removing file accuracy. The vendor was not understanding user needs, and until KTC talked to contractors, the problem was overlooked. KYTC managers informed the vendor of the issue, and PDF file accuracy was restored to bidders within six weeks of KTC staff alerting KYTC to the problem.

The DPD Initiative formally kicked off in September 2020, when KYTC selected staff to lead the initiative. KYTC asked KTC staff with design and construction experience to assist with implementation. This group became known the DPD core staff and functions to critically maintaining the DPD Initiative's consistency and focus. DPD core staff remain embedded within their respective division structure (Highway Design, Construction, CADD Support, and GIS) but each contribute to the implementation success. With the DPD Initiative beginning during COVID-19, most early meetings and collaboration were conducted virtually. The core DPD staff continue to use virtual options in combination with in-person, on-site project meetings as needed to continue efforts.

2. Where We Started

While a full transition to DPD throughout the Cabinet's workflows and policies remains the agency's long-term goal, KYTC agreed upon a targeted approach to implementation, especially given resource limitations. Following a targeted approach prevents implementation efforts from being spread too thinly or inconsistently across multiple stakeholder groups. Carefully building foundational pieces of DPD for construction will also yield dividends integrating DPD and asset management, especially since construction and maintenance roles are both assigned to Section Engineer (SE) field offices at KYTC.

The first goal tasked of the DPD core staff was to:

Help construction staff integrate digital advancements from design software into their construction management responsibilities. Use a small group of pilot projects to support and grow the increased use of the available electronic engineering data (EED).

Figure 1 highlights these initial targets of DPD within the lifecycle of Kentucky's transportation assets.

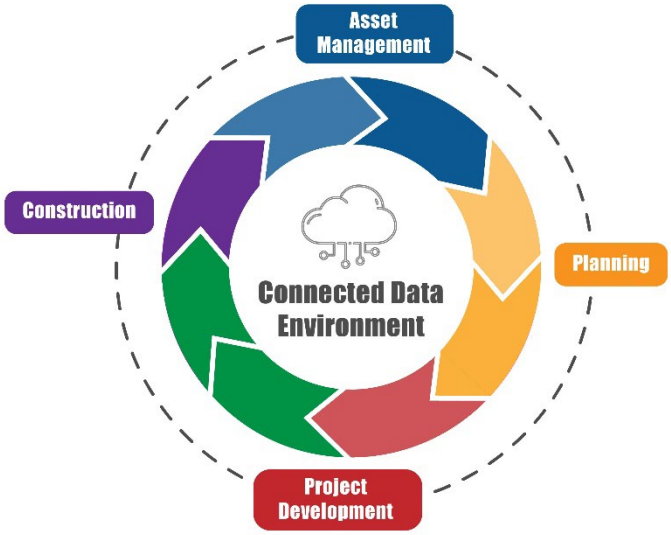


Figure 1 Lifecycle of a Transportation Asset and Kentucky's Initial DPD Targets (Green)

3. What We Accomplished

3.1 Communication with Industry

The Kentucky Association of Highway Contractors (KAHC) and American Council for Engineering Companies of Kentucky (ACEC-KY) have discussed with their members opportunities for advancing digital processes on a national and statewide scale. To gauge where KAHC members stand on issues related to design file usage and preferences, we administered an online survey. Many respondents provided contact information and indicated they want to stay engaged in the DPD Initiative. Survey participants held KYTC contract prequalifications in several fields, with a majority prequalified in grade and drain construction. Appendix A summarizes results of the KAHC survey. Key findings are provided below.

KAHC Member Survey Response Highlights

- *Supplemental file information is unreliable. Required files are not consistently delivered through the letting process, and their quality varies between designers.*
- *Final design changes are most often made on the sheets instead of the digital model. As a result, supplemental files seldom match the PDF cross sections and plan sheets. The proposed surface (DTM) should match the PDF cross-section sheets.*
- *Features most useful to have in digital form are disturb limits, construction phasing, and right of way lines.*
- *Denser template drops should be used in areas of transition and curves. Bolstering the quality assurance checks of proposed DTMs would improve safety and ensure sufficient right of way is available for diversions and temporary conditions.*

Furthermore, DPD core staff attended professional conferences and presented details on the DPD Initiative to attendees whenever possible, including the Kentucky Society of Professional Engineers Convention, KYTC Project Delivery and Preservation Conference, and the KYTC/FHWA/ACEC Partnering Conference. These efforts also remain ongoing.

3.2 KYTC Internal Communication

DPD core staff remained in contact with KYTC Highway Design and Construction staff and prioritized communication with personnel involved in pilot projects. A virtual roundtable in February 2021 was hosted for district Design staff to discuss barriers to fully implement OpenRoads Designer (ORD) software. Core staff also kept KYTC leadership up to date on DPD efforts and held a meeting in September 2021 that included all CDEs, division directors, and the KYTC State Highway Engineer's office (see Appendices B-F for materials presented at this meeting). Cabinet staff had the opportunity to attend many informational meetings offered by software vendors and consultant engineers with expertise in digital delivery concepts.

To further bolster internal (and external) communication, Core staff developed and maintained webpages for the DPD Initiative. Other materials produced to facilitate communication and maintain consistent messaging include graphical tools, a frequently asked questions list, and a one-page summary document (see Appendices G-K). The one-page summary is a living document and is updated routinely. A mailbox[1] for DPD questions was established and shared with internal and external stakeholders.

3.3 Collaboration with Peer Agencies

In April 2021, Missouri DOT and KYTC staff spoke about field processes (e.g., construction inspection and surveying using electronic engineering data). DPD core staff also participated in a regularly held CALTRANS Peer-Exchange Program, collaborating on topics like construction inspection using innovative solutions. KYTC hosted an FHWA Virtual Peer Exchange for Digital Delivery at the end of April 2021. Multiple states, including Utah, Pennsylvania, and Michigan shared their experiences with DPD, including barriers to implementation and solutions. Collaboration between external partners remains at the forefront of the initiative.

3.4 Model-Based Design and Construction (MBDC) Committee and DPD Subcommittees

In January 2022, KYTC's Committee for Model-Based Design and Construction held its first meeting. This committee includes the directors of the following divisions: Highway Design, Construction, Maintenance, Planning, Structures. Several staff from the State Highway Engineer's office also participate on the committee. DPD subcommittee groups that met during the initiative's first year include Design, Utilities, Survey, Environmental Analysis, and Right of Way. Chairpersons have been designated for each group.

> *Level Naming: One example of Cabinet-wide impacts from DPD Subcommittee collaboration resulted from detailed discussion about user groups outside Design relying heavily on level naming and line styles as they glean information from EED or supplemental files. As a result, KYTC CAD staff have begun work to condense the levels KYTC uses for its plans and applying naming conventions that are more universally understood. This effort remains a work in progress,*

[1] kytc.dpd-qanda@ky.gov

though the pace necessarily changes according to external influences like software versioning and KYTC-specific resources.

3.5 Pilot Projects

In November 2020, a formal invitation to participate and submit a project in the DPD Pilot Program was issued using the Professional Services bulletin system (Appendix L). For each pilot, approval of the responsible KYTC project manager was a prerequisite for proposal submission. In January 2021, KYTC vetted pilot project proposals and sought Construction staff input at each Section Engineer office anticipated to manage the candidate projects. The first eight DPD pilot projects were selected in February 2021.

Pilot Project Workshops for two projects (Item 6-446, *Pleasant Valley Road*, and Item 4-8954, *Leitchfield Bypass*) were held in April and May 2021 (Appendices M and N). Central Office and district staff responsible for developing and constructing these projects shared their perspectives and ideas through facilitated virtual group discussions. The potential of DPD was readily apparent to participants, who gave suggestions for connecting as-designed data to as-built data. Many participant questions and comments underscored the importance of critical features of the DPD Initiative that have already been put in motion. Pilot Project Workshops are critical for the communication of information and data.

Recommendations from Pilot Project Workshops

- *Shore up the integrity and functionality of existing processes before implementing major process updates.*
- *Find useful model viewing tools for non-CAD users.*
- *DPD will benefit from routine messaging and more interdepartmental communication.*

The Project-Level Implementation Plan Template was completed in August 2021 (Appendix O). Implementation Plans summarize project goals, points of contact, milestones, and other DPD-related items. Project-specific implementation plans were drafted for the two projects nearest to construction letting (Item 4-8954, *Leitchfield Bypass*, and Item No. 9-228, *KY 7 in Sandy Hook*) (see Appendices P and Q). Project staff selected project objectives from the list in the template. DPD core staff followed up with project staff on every pilot in November 2021. During these meetings, DPD core staff gave updates on the DPD Initiative while project staff provided updates on project scheduling.

4. What Worked

- *Identified core staff who will lead the DPD effort*
  - KYTC and KTC designated point of contact persons and classified their DPD responsibilities as a primary duty. They represent the DPD Initiative at conferences, webinars, and peer-exchanges.
  - This small group met frequently and used a task list to track progress and to maintain focus. An example of this tracking tool is in Appendix R.

- *Combatted misunderstanding by developing consistent messaging for internal and external stakeholders*
  - Created easily referenced and sharable files and made them readily available (e.g., one-page summaries, FAQs, presentations), which are available publicly on KYTC's DPD website.
  - Committed to recurring communication with industry partners so their perspective is heard.

- Prioritized communication with pilot project staff and maintained communication across standard operational divisions.
- Consistently offered progress updates to KYTC leadership and short-format email summaries to continue to garner high-level management support.

- *Avoided overly prescriptive pace for implementation of DPD*
  - Unrealistic and unnecessary constraints inhibit deliberative vetting of the process. Given that DPD is closely tied to software adoption, independently prescribing the pace of implementation is not possible. Core staff continually evaluate barriers and opportunities, and the DPD Initiative's pacing is aligned with the capacity of agency resources, software, and staff. This targeted approach is well defined and disseminated to all stakeholders.

Agencywide change takes time and strategic focus. While it is important to develop long-term goals, intermediate steps are equally critical, but also tough and unglamorous. Implementing major changes in policy and process occurs gradually and it is important to keep in mind how everything will eventually fit together. Keeping focused on how current activities fit within the larger puzzle is crucial. Later, pieces can be identified and planned around while the immediate focus stays targeted.

Barrier to Implementation: A Lesson Learned

Pilot Project Design staff with outdated hardware could not run OpenRoads Designer to perform quality checks of the EED at first. After this barrier was identified, staff needs were prioritized within the equipment replacement schedule.

- *Embraced transparency (e.g., make file folders accessible to all internal employees)*
  - Listen to staff concerns. Create spaces in which staff can voice concerns without fear of retribution or ridicule.
  - Before making changes, consult with staff. This can help prevent staff from being surprised or frustrated when new processes are introduced.

- *Identified and eliminated barriers that prevent staff from giving honest feedback or voicing concerns*
  - If a meeting does not generate open dialogue, brainstorm and implement strategies to reach groups or staff who come from different backgrounds (even if this happens outside the meeting). Once their ideas have been collected, present them to the original group. Develop methods for the group to vet ideas so attendees do not have to bring ideas to core staff outside the group setting. This preserves open dialogue after the DPD core staff exits.

- *Forged and maintained relationships built on trust. Recognized when relationships had to be mended and put in the necessary work to do so*
  - KYTC Construction staff learned the file data for their projects was inconsistent to the PDF plan set materials, which hold contractual authority. As a result, the DPD initiative must first address this inconsistency and

build trust in the deliverables that project development produces. The research into construction-ready DTMs outlines findings from a sampling of project EED for quality metrics.[2]

- *Dissolved barriers between traditional disciplinary silos to facilitate cooperation*
  - Establishing a common language can be challenging. DPD core staff have experience in multiple disciplines and worked to implement a common vocabulary in all communications.

- *Judiciously evaluated requests for staff time*
  - Avoid having staff inundated by standardized vendor presentations.
  - Preserve as much of the staff's time as possible.
  - Adopt flexible formats to present information. Adjust formats based on staff learning preferences. Consider local project-specific software testing and demonstrations, with on-site support as needed.

- *Assessed existing barriers (e.g., technology availability, staffing limitations)*
  - Operating within existing constraints serves as a feasibility test to determine how easily DPD processes can be integrated into project delivery workflows. If the agency can invest additional funds, the benefits will multiply. For the initial DPD effort, no new hardware was purchased strictly for DPD pilot projects and staff felt less anxiety about learning new methods and tools.

- *Proactively planned for staff turnover*
  - Expect that some staff movement to other positions to occur. KYTC will also onboard new employees. Prepare for this by focusing on documentation and building robust communication lines with more than one member of a project team. New staff members should receive a "debrief" on DPD at KYTC.

- *Expected and adjusted for normal project changes, delays, and politically expedited actions*
  - For example, a railroad with right of way on a DPD pilot project site has no incentive to accommodate a project manager wanting to advance a project to letting so they can work on DPD objectives in the active construction phase as early as possible.
  - One pilot project experienced a multi-year delay from a complicated right of way acquisition process.

- *Sought reliable help*
  - Take advantage of the Cabinet's contract with KTC. The Center can field questions, research topics, and troubleshoot problems.
  - Some help from vendors is cumbersome and becomes sales oriented. The DPD core group vetted offers for software carefully.

- *Recognized patience is a virtue*
  - Some people need more information and time to wrap their arms around a major change like DPD. Anticipate this and adjust the rollout in response to staff needs. Experience, roles, and duties will impact each persons' view of DPD differently.

- *Emphasized the importance of documentation*

[2] *Construction-Ready Digital Terrain Models* https://saalck-uky.primo.exlibrisgroup.com/permalink/01SAA_UKY/ija67f/cdi_uky_uknowledge_oai_uknowledge_uky_edu_ktc_researchreports_2708

- Tracked funding sources, limitations, and need estimates. First-year funding was allocated to: (1) KTC staff contract to support DPD, (2) Design effort changes due to ORD and DPD Pilot Project, and (3) Training.
- Meeting attendees, pilot project staff, committee membership are examples of details tracked using shared Projectwise folders.
- The Pilot Project Implementation Plan structure served the tracking needs during the progress of the pilots. The Implementation is a "living" document which goes through versioning as needed and is accessible to all stakeholders.

○ *Looked for small wins and valued their contributions.*

- Providing GIS (geospatial information systems) formatted files, specifically KMZ (keyhole markup language) files to Construction was a quick win for DPD.
- Giving Construction a list of files that should be provided when the construction phase starts lets their staff know what is reasonable to expect and when to ask for missing materials. KTC staff incorporated this information into presentations and training opportunities. KYTC Highway Design delivered messaging for consultants and designers ensuring they understand the emphasis on the EED.

5. What's Next – New Targets and a Long-Term Cabinetwide Implementation Plan

As DPD moves toward more efficient sharing and consumption of digital data, guidance and policy will build on what has been accomplished during Phase 1. Figure 2 indicates expansion from Figure 1 targets into the phases of the asset lifecycle shown green below.

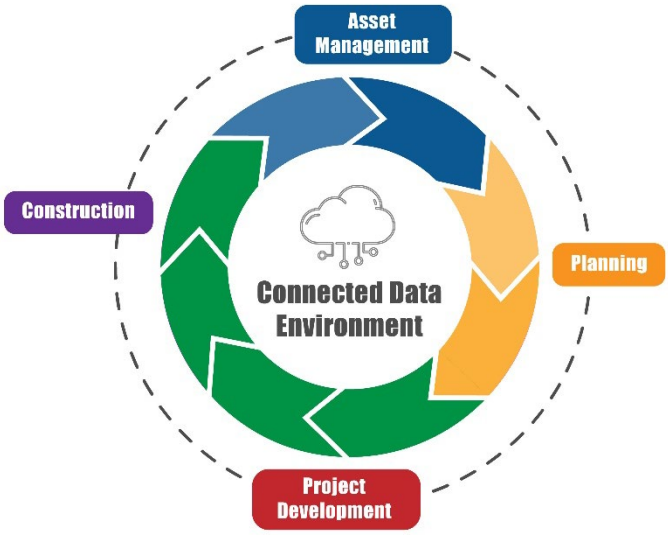


Figure 2 Expanded Digital Project Delivery Efforts in KYTC's Next Steps

Next steps, which will further build on our accomplishments and generate more lessons learned, are reviewed below.

○ *Pilot Projects support and follow through*

- Project-level Implementation Plans will be drafted, updated, and finalized for the remaining pilot projects in coordination with project staff.
- Timelines for the projects will be prepared as details of each biennial Six-Year Highway Plan become available from the Kentucky Legislature.

- *Opportunities for DPD involvement on more projects will be sought.*
  - An experiment that is not live can be valuable as it removes risk and the pressures of a schedule. DPD tools can be tested in ways that do not impose risk to existing contracts and still support KYTC construction management responsibilities. For example, a mock Final Joint Inspection meeting may be held using DPD tools without impacting construction letting.
  - Case studies of past project data will review opportunities where DPD might have reduced costs and improved schedules

- *Continued collaboration with industry stakeholders*
  - DPD core staff will continue to attend and present at the KYTC Project Delivery and Preservation Conference and the FHWA/ACEC/KYTC Partnering Conference.
  - Industry collaborations with ACEC of Kentucky and construction industry partners will continue.

- *Cabinetwide Implementation Plan Drafting will begin.*
  - The initial focus is creating guidelines. Drafting policy that encompasses the full life cycle of KYTC's responsibilities will ensue once guidelines are in place and functional. DPD core staff, in communication with impacted users, will prepare guidance for variable modeling requirements based on project type. All projects do not need full modeling and digital delivery. DPD will be used when appropriate and helpful. Collaboration with other DOTs will allow for consistency of DPD implementation across the nation. Resources made available by other states (including workplans, BIM Execution Plans, staff structure, etc.) may be utilized to further develop DPD at KYTC.

- *DPD core staff will budget time for ongoing learning and collaboration*
  - Informal and structured (e.g., conferences, trainings) collaborations are valuable. If the DPD core staff are overtaxed, members will not have time to study and integrate new ideas into practice.

- *A glossary of terms will be maintained. This can eliminate barriers that arise when stakeholders rely on different vocabularies.*

- *Development of the website and the DPD landing page will continue.*

KYTC faces the continuation of its DPD Initiative with the benefit of solidly built foundational work. Rather than focusing on philosophy and broad anthems, KYTC leans into its own staff for DPD implementation. Gaps in readiness continue to be met with grassroots solutions identified and applied by staff through solid communication and teamwork.

Appendix A Executive Summary — KAHC Survey on KYTC's Digital Project Delivery Initiative

Executive Summary — KAHC Survey on KYTC's Digital Project Delivery Initiative

Kentucky Transportation Center researchers surveyed members of the Kentucky Association of Highway Contractors (KAHC) about the Kentucky Transportation Cabinet's (KYTC) Digital Project Delivery (DPD) Initiative. The goal of the survey was to gather feedback from KAHC stakeholders that would help the Cabinet improve its efforts to develop and deliver more useful digital information. Responses are summarized below. The survey was open to responses from December 23, 2020 to February 21, 2021. For some questions, respondents had the option to select more than one answer.

Use of Digital Plan Information

- 38 of 67 respondents said their firms sometimes rely on digitally formatted representations of proposed project designs to facilitate completion of construction contracts. 19 respondents said they always use digital information, while just 10 never do (**Figure 1**).
- If a respondent's firm does not use digital plan information, they were asked to identify what prevents them from doing so. Common reasons were lack of CAD software, satisfaction with PDF plans, and finding no need to use them. **Table 1** lists all comments received.

Future Use of Digital Plan Information

- If a respondent said their firm does not use digital plan information, they were asked if the firm intends to do so in the future. 6 firms plan to use digital information in the future; 4 do not.

Areas in Which Respondent Firms Have KYTC Prequalification

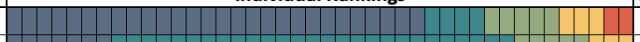
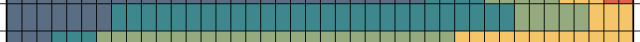
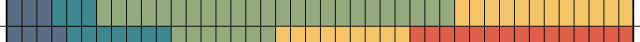
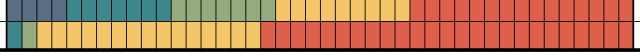
- Respondents selected all construction categories in which their firms are prequalified to perform work for KYTC (**Figure 2**). The most common selection was grade and drain (37). The number of selections for bridges of different characteristics and lengths ranged between 10 and 23, while 16 to 19 respondents said their firms are prequalified for asphalt or Portland cement concrete paving.

Project Areas in Which Digital Information is Used

- Participants selected areas of project delivery in which their firms use digital design information (**Figure 3**). Measuring for quantities was the most common response (38), closely followed by field staking and progress checks (34), cost analysis for initial construction bids (33), and developing a work plan (32). Earthwork (28) and drainage/pipe installation (25) also garnered a significant number of responses.
- Respondents could identify other areas that could benefit from digital plan information. Two respondents provided supplemental answers (**Table 2**).

Sources of Digital Plan Information

- Respondents were presented with five sources of digital plan information and asked to rank them from most common (1) to least common (5). The figure below presents the average score for each source. The column labeled *Individual Rankings* captures the number of respondents who assigned a particular score to each source. Cells are shaded to denote the ranking given. Respondents said the *Bid Package* is the most common source of digital plan information, closely followed by *KYTC (Post-Award)*.

Digital Plan Sources	Average Score	Individual Rankings	Ranking Color Code
Bid Package	1.74		1
KYTC (Post-Award)	2.10		2
Design Consultant (Post-Award)	3.07		3
In-House Development	3.57		4
Created By Design Consultant	4.52		5

Utility of Digital Features

- No clear favorite emerged for useful digital information features (**Figure 4**). Construction phasing details and disturb limits amassed the most selections (32), followed by right-of-way limits (31). All other features received between 25 and 30 selections, indicating most respondents find some utility in each category of features.

Spacing of Breaklines, Polylines, and Feature Lines

- Ten respondents submitted comments about point spacing for different line types. The consensus is that denser point spacing is preferable, especially around structures, curves, and intersections. **Table 3** lists all comments given by respondents.

Other Useful Features

- Respondents noted the following as useful features to include in digital plan information: surfaces, alignments, corridors, easements, rock and tree lines, details on permanent signs and striping, and property boundaries.

Most Useful File Formats

- DWG garnered the highest number of selections for most useful file format (29), followed by CSV (22), DGN (20) and KMZ (15) (**Figure 5**).
- Respondents listed several other useful file formats: PDF, XML, DTM, LandXML, and Georeferenced Aerials.

GPSS/GNSS Surveying Practices

- 15 respondents said their firms rely on in-house base stations for surveying, just 2 depend solely on Kentucky's CORS network, while 18 use a combination (**Figure 6**).

Potential KYTC Digital Project Delivery Focal Areas

- Respondents were presented with seven areas KYTC may focus on as part of its DPD Initiative. They ranked these areas from most helpful (1) to least helpful (7). The figure below presents the average score for each source. The column labeled *Individual Rankings* captures the number of respondents who assigned a particular score to each source. Cells are shaded to denote the ranking given. *Quantity Take Offs* and *Average End Area* clearly outranked other focal areas, while *Train/Support KYTC Staff* proved, in general, to be the least helpful focus area.

DPD Focus Areas	Average Score	Individual Rankings	Ranking Color Code
Quantity Take Offs	2.94		1
Average End Area	3.03		2
Feature Accuracy	3.91		3
Utilities	4.03		4
LOR/LOD Labeling	4.09		5
Field Changes	4.68		6
Train/Support KYTC Staff	5.32		7

- Respondents identified areas KYTC should work on to improve digital design information. Notable ideas included keeping plans and surfaces up-to-date (e.g., XMLs, DTMs), matching proposed digital surfaces to cross sections, partnering with industry stakeholders and update technology as needed, ensuring consistent surfaces across consultants, resize PDF plans, and focusing on producing accurate data. **Table 4** provides full responses.

Supplemental Information

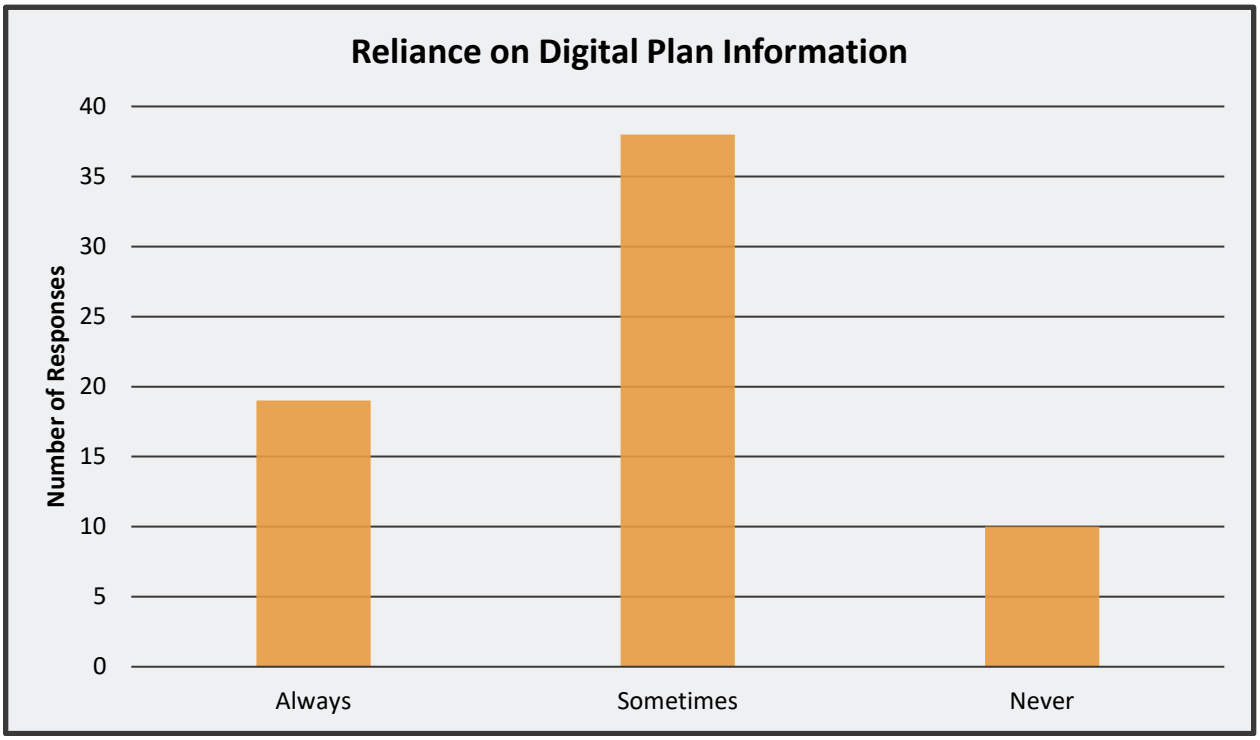


Figure 1 Frequency Digital Plan Information Use

Table 1 Issues that Prevent Firms from Using Digital Plan Information

• Not a requirement and the digital files are not yet reliable.
• No CAD program.
• We very seldom have a need for anything more than PDF.
• We do not currently have CAD software for use with digital format.
• Projects that I have been involved with have not needed the digital plans. We would possibly use them if it made the project easier to manage.
• We have never tried it. The PDF plans have always worked for us.
• Lack of technology and old school.
• We fabricate structural steel. The only information we have received from KYTC to prepare a bid is in PDF format. We are using detailing software that would allow us to incorporate more digital information, if it becomes available but thus far, it has not been available for our scope of work.
• Not equipped to use it.

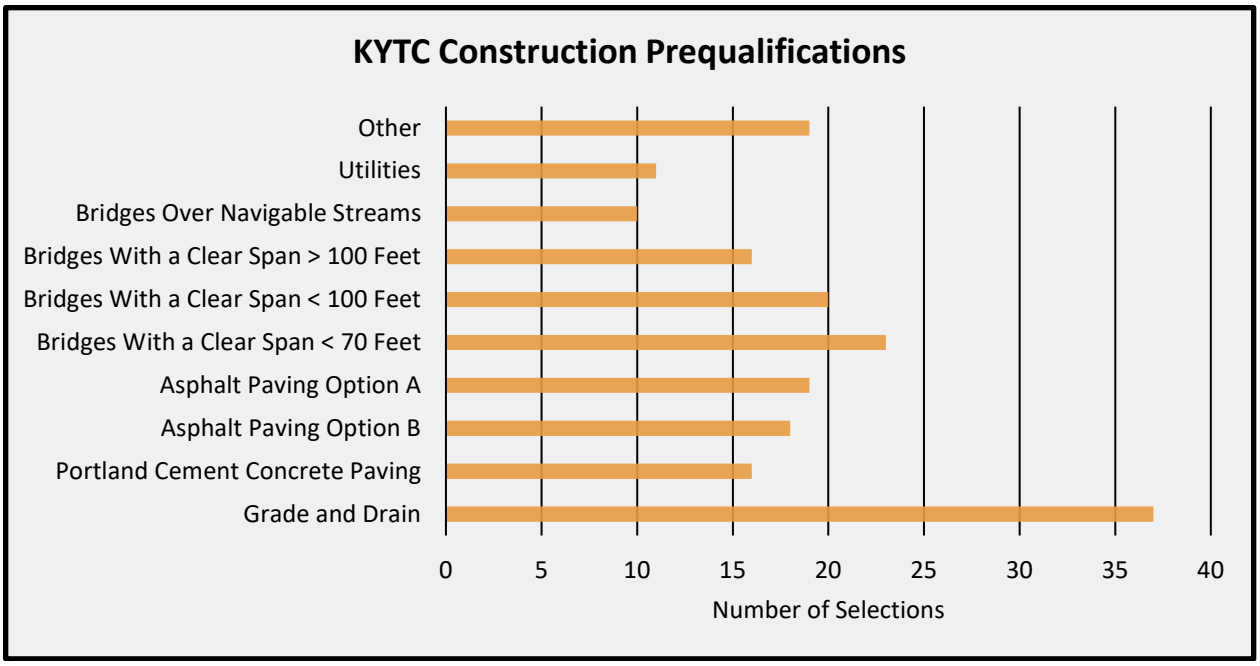


Figure 2 Firm Construction Prequalifications

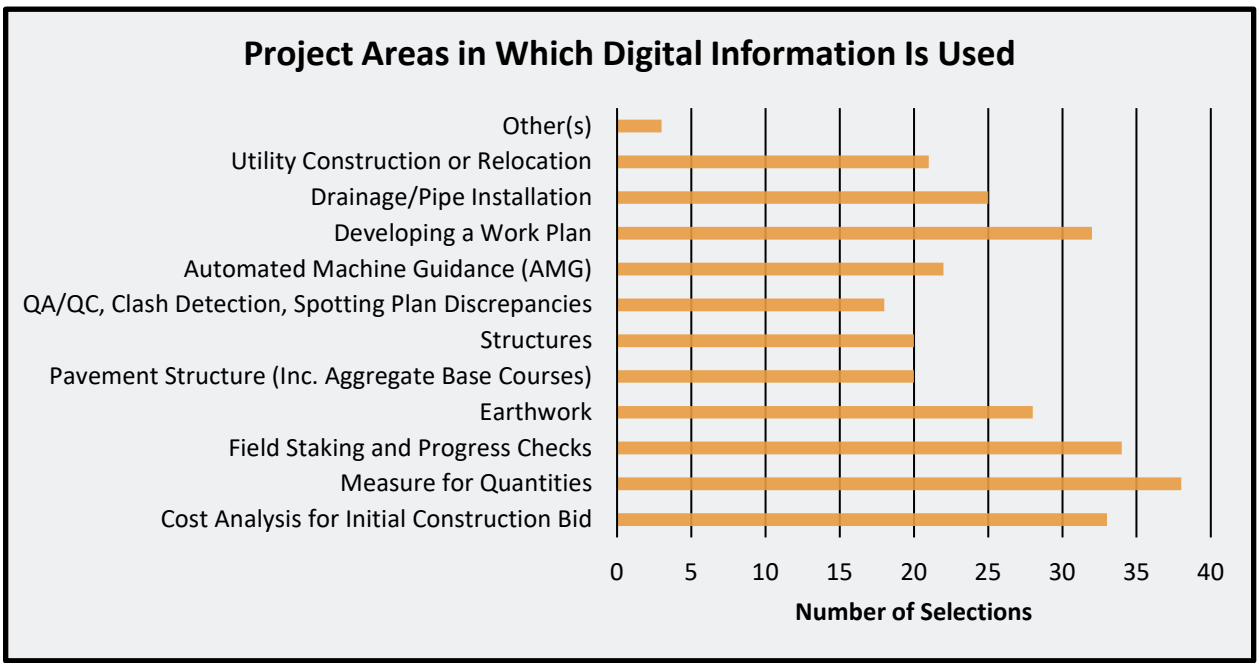


Figure 3 Applications of Digital Information

Table 2 Other Areas That Could Benefit from Digital Plan Information

• Right of way, easements, rock excavation quantities, property boundaries, creating KMZ files or plotting linework on other aerial photographs, clearing limits, checking subgrades, progress payment checks
• Right-of-way information, scope of work, identifying project variances

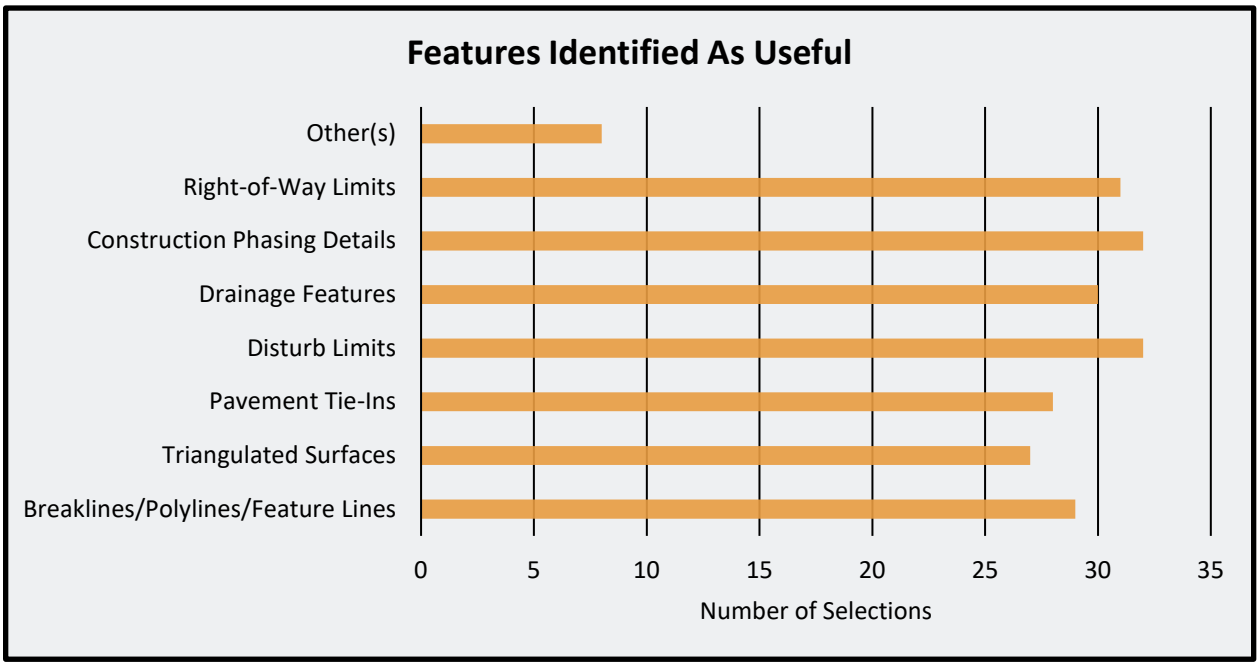


Figure 4 Utility of Digital Features

Table 3 Recommendations for Point Spacing

• Points at least every 50 feet, but you can never have too many.
• Denser point spacing is better around structures and bridges, in my opinion.
• 10 feet in tangent- 5 feet in radius, crest, and sag curves.
• On alignment, 100' and at all breaks (PC, PT). Denser at all transitions and in curves.
• Areas of transition — always.
• Denser point spacing is useful in curves. We have not had reason to look at ideal point spacing because in the recent past we have had no issues with point spacing in the digital files provided by KYTC.
• If I don't like it, I change it.
• Dense point spacing helps with layout.
• Points are only need where there are grade or directional changes. Denser point spacing is useful around radius of drives and intersections.
• Not sure I understand the question, but the points on a polyline should be the minimum needed to represent the line. I densify 3D lines if needed to get a better triangulation model.

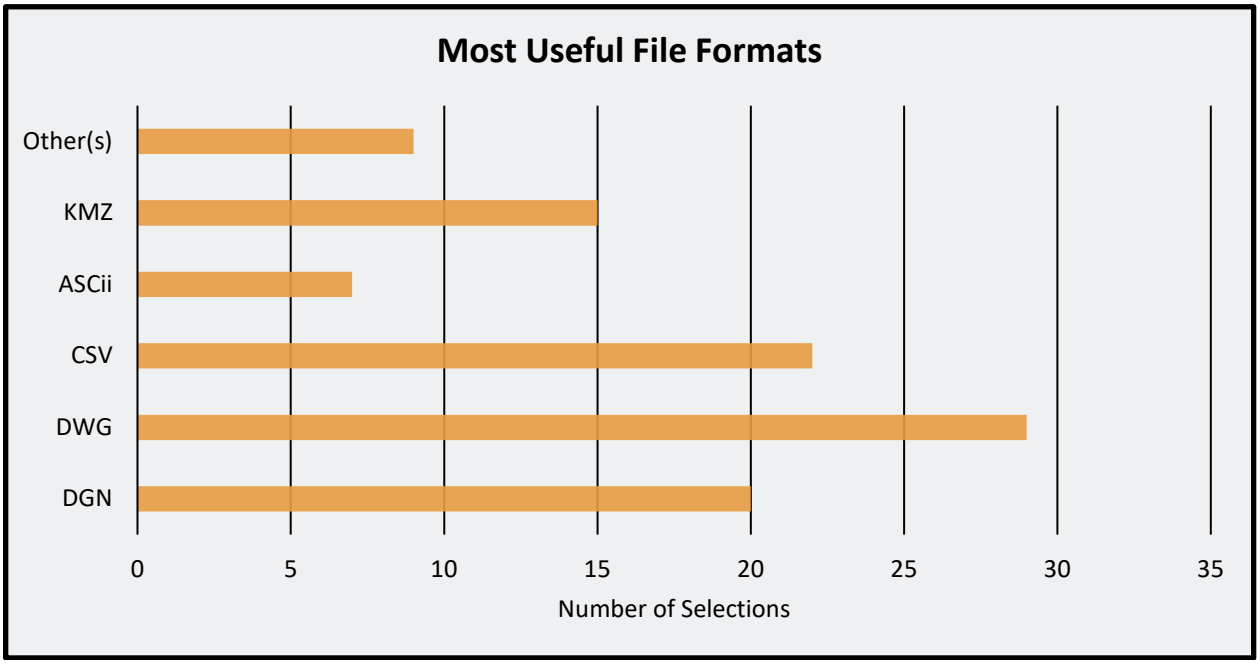


Figure 5 Preferred File Formats

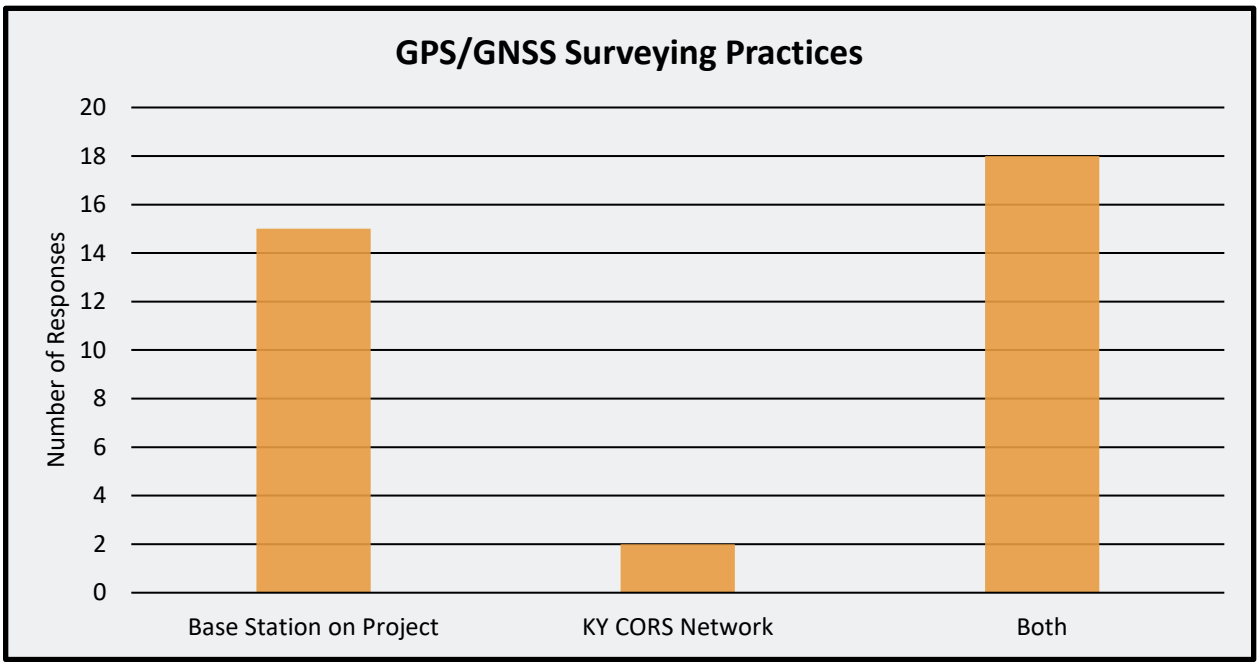


Figure 6 Surveying Equipment/Techniques

Table 4 Other Proposed Focus Areas for KYTC's DPD Initiative

• Need to update proposed/finish surface to reflect what is in the plans. Most of the time the plans are amended, but the surfaces (XMLs/DTMs) never are updated.
• Ensure that the Supplemental data contains an XML of geometry and any relevant surface. Ensure that the Supplemental data contain a CSV of the control point information. Consistency in the level of reliability of the proposed surface from one consultant to the next. A clearer means of proposing questions to the design consultant.
• Keep it simple. Convey intent. Include relevant data. Accurately tie in at construction limits.
• We answered *sometimes* to the first question in this survey because we felt it was the best choice of the 3 options to describe our use of digital information provided by KYTC. However, a more accurate response for us would be to say we always heavily use both PDFs and CAD/other digital files provided by KYTC on all projects. 2. It would be very beneficial if PDF plan files were developed by KYTC to print to scale on 11"x17" paper. Currently, KYTC plans print to scale using 12"x18" paper, but 11"x17" printers/paper are far less expensive and the most commercially available.
• Basically, have the proposed digital surface match the cross sections. If a cross section is hand modified, the model should be updated.
• Spec searches.
• Continue receiving feedback from the industry; make improvements as technology is updated.
• Accurate finished grade DTMs, bottom of rock roadbed DTMs, and subgrade DTMs. Paper/PDF plans are still important. Finished grade contours should be included in the paper/PDF plans. They provide a check on the accuracy of cross sections and show grading in areas where cross sections do not provide enough information. Make sure roadway plans are updated with final structure plan elements. In places where there are substantial differences in elevations between close cuts, provide enough right of way for access between the cuts (don't make large elevation changes in the right of way between close cuts). Use existing ground contours to help visualize how the right of way should be bought. Consult with construction experts to identify constructability concerns. More projects are reconstructions of existing highways. Designer should use intermediate DTMs to verify whether there is enough room to construct temporary diversions and phasing and safely accommodate traffic.

Appendix B DPD Status (December 17, 2020)

Digital Project Delivery

STATUS

December 17, 2020

KENTUCKY TRANSPORTATION CABINET

UK UNIVERSITY OF KENTUCKY
Kentucky Transportation Center

Digital Project Delivery

1. Pilot Projects
2. OpenRoads Transition
3. Industry Outreach
4. Roadmap
5. What ELSE is happening?



Leadership Decision



Win

Pilot Projects: Professional Services Notice

- Invitation to participate in DPD Initiative through an *existing* consultant contract (posted on Professional Services' website 11-18-20)
- Submittal deadline: January 1st
- Submittals *require* Project Manager support and final pilot project invitations will be issued *through* the Project Manager



Selection process for Pilots?
Submittals will be initially received through Kevin and Rachel. Catherine can help with reaching out to Section Offices.

Pilot Projects: Candidates

#1 9-9015 Fleming: KY 11 at KY 559 Intersection improvement

#2 6-0446 Boone: KY 237 (Pleasant Valley Rd) through KY 842 (Hopeful Church Rd) to Mall Rd/I-75 Interchange

#3 12-8703 Floyd: Improve Access to KY 80 at Garrett

#4 1-9018 McCracken: I-24 Acceleration Lane for the Eastbound on Ramp at Exit 4

#5 ??

#6 ??

Pilot Project Candidate #1

Fleming Co - **Item No. 9-9015** - KY 11 at KY 559

Districtwide Support for Pilot Effort

- TYPE: HSIP Intersection Safety Improvement
- PLAYERS: D9 Project Development, D9 Construction, HSIP Staff, Gresham Smith Partners
- LETTING SCHEDULE: Fall 2021
- OBJECTIVES FOR PILOT:
  - **Construction Inspection Support Needs**
  - Digital Plan Review Tools Test



Critical D9 staff training and equipment needs have already been identified and will require resources.

Pilot Project Candidate #2

Boone - **Item No. 6-0446** –
KY 237 (Pleasant Valley Rd) through KY 842 (Hopeful Church Rd)
to Mall Rd/I-75 Interchange

- TYPE: New Connector
- PLAYERS: D6 Project Development, Central Office CAD staff design
- LETTING SCHEDULE: Construction is outside the biennium
- OBJECTIVES FOR PILOT:
  - DPD coordination through Project Development Process
  - Construction Inspection Support Needs

Pilot Project Candidate #3

Floyd Co. - Item No. 12-8703 – Bridge Replacement

- TYPE: Bridge replacement with earthwork and retaining walls
- PLAYERS: D12 Project Development (in-house design), D12 Section Office
- LETTING SCHEDULE: Construction funding in FY 2022
- OBJECTIVE FOR PILOT:
  - Support Construction Inspection Staff Responsibilities with DPD



Contractors in this region already use Automated Machine Guidance (AMG) with proficiency

Pilot Project Candidate #4

McCracken – Item No. 1-9018 – Ramp Improvement

- TYPE: HSIP Acceleration Lane for EB Ramp at Exit 4
- PLAYERS: D1 Project Development (in-house design), D1 Section Office
- LETTING SCHEDULE: Construction funding in FY 2021
- OBJECTIVE FOR PILOT:
  - Support Construction Inspection Staff Responsibilities with DPD

More Candidates

- Submittals through Professional Services invitation are due January 1
- Multiple conversations with consultants who are preparing submittals, in most cases more than one project will be submitted



Should Progressive Design/Build or Alternative Delivery Methods be used for any Pilot Projects?

OpenRoads Transition

- Primary committee represents: CO CAD, District Design, District Construction
- Active sub-committees for Surveying, Utilities, DEA
- Recommendations have been unanimous across divisions



Kentucky is the second state in the US to implement Bentley OpenRoads Designer

OpenRoads Transition

- Recommendations include:
  - 1:1 vertical scale on entrances
  - grayscale contours and existing features
  - bookmarks replace station range on sheets to assist pdf plan use



Bookmarks display issue found as a result of committee discussion. Addressed through ePlanroom and Lynn Imaging.



What level of approval is needed for recommendations?

KAHC/ACEC Conversations

- Build on SPR 19-576 interviews
- Multiple consultants and contractors presenting their DPD experiences to KYTC

  (Recordings available as a resource)
- Held joint KAHC/ACEC introductory meeting (December 8th)
- Meetings since DPD kick-off include:
  - 5 other DOTs and FHWA
  - 5 contractors and KAHC
  - 9 consultants and ACEC
  - 6 vendors
- Follow-up survey to contractors (KAHC membership) under review



SPR 19-576 identified PDF quality issue that was corrected through ePlanRoom.



Send any survey edits to Rachel by 12-18. How long to accept survey responses?

Roadmap for 2021

- Training for KYTC Construction staff - staff for Pilot #1 request training be targeted for delivery *just prior* to active need and tailored to any software/hardware piloted
- Continue coordination with ORD Conversion Sub-committees (Utilities, R/W, DEA…)
- Continue communication with internal and industry stakeholder groups (including KYBOELS)
- Pilot # 1 to Construction Letting
- Selection and delivery of additional DPD Pilot Projects
- Phased Implementation Planning Recommendations

What ELSE is happening?
KYTC CAD

- OIT Discovery Request to evaluate CAD to GIS solutions
- As-built pilot effort using drone captured data
- Experiment with review tools for non-CAD decision makers – including 3D PDF with Blubeam, Bentley iTwin review tool, and Keyhole Markup (KML or KMZ) files with Google Earth



The “CAD to GIS” OIT project has far-reaching implicationsto aid information sharing and needs leadership support

What ELSE is happening?
Nationally

- Industry Foundation Classes - AASHTO decision to adopt IFC
- BIM for Roadway – FHWA pooled fund research (KYTC participation begins 2021)
- BIM for Bridges and Structures – FHWA pooled fund research
- Peer Exchange through FHWA (Spring 2021)
- Highway Engineering Exchange Program (HEEP) Special Interest Group (SIG) for Survey – DOTs comparing ideas and solutions
- NCHRP Synthesis 20-05 “3D Models as Highway Construction Documents”

NEXT UPDATE MEETING

January?

KENTUCKY TRANSPORTATION CABINET

UK UNIVERSITY OF KENTUCKY
Kentucky Transportation Center

Appendix C State of DPD at KYTC (July 2021)

State of Digital Project Delivery at KYTC

Tim Layson, Director, Highway Design
Catherine Keathley, CAD and DPD Group

Rachel Catchings, Research Engineer

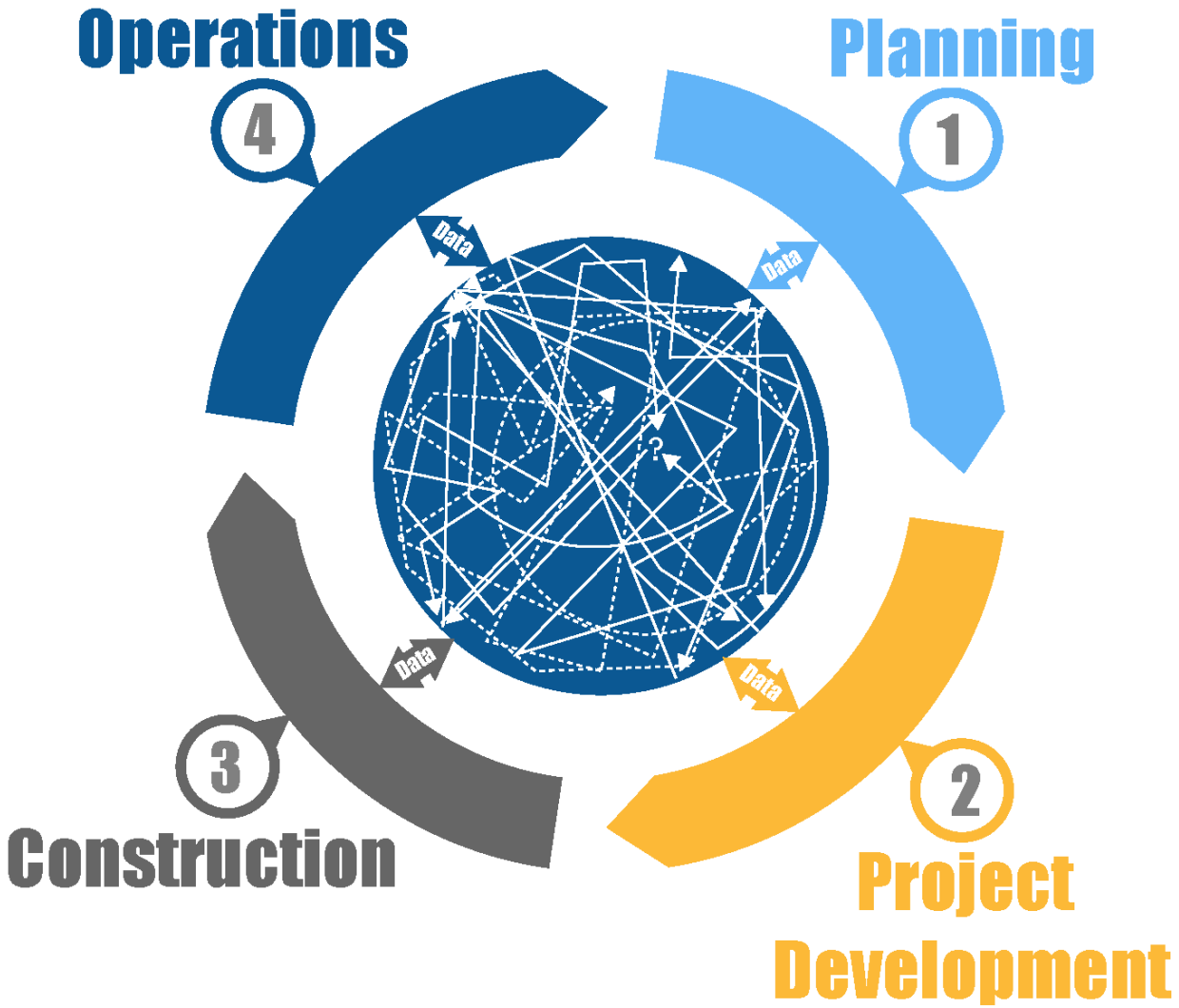
July 2021

Digital Project Delivery (DPD):

KYTC’s transition to making use of Engineering Data within design, construction, and asset management processes

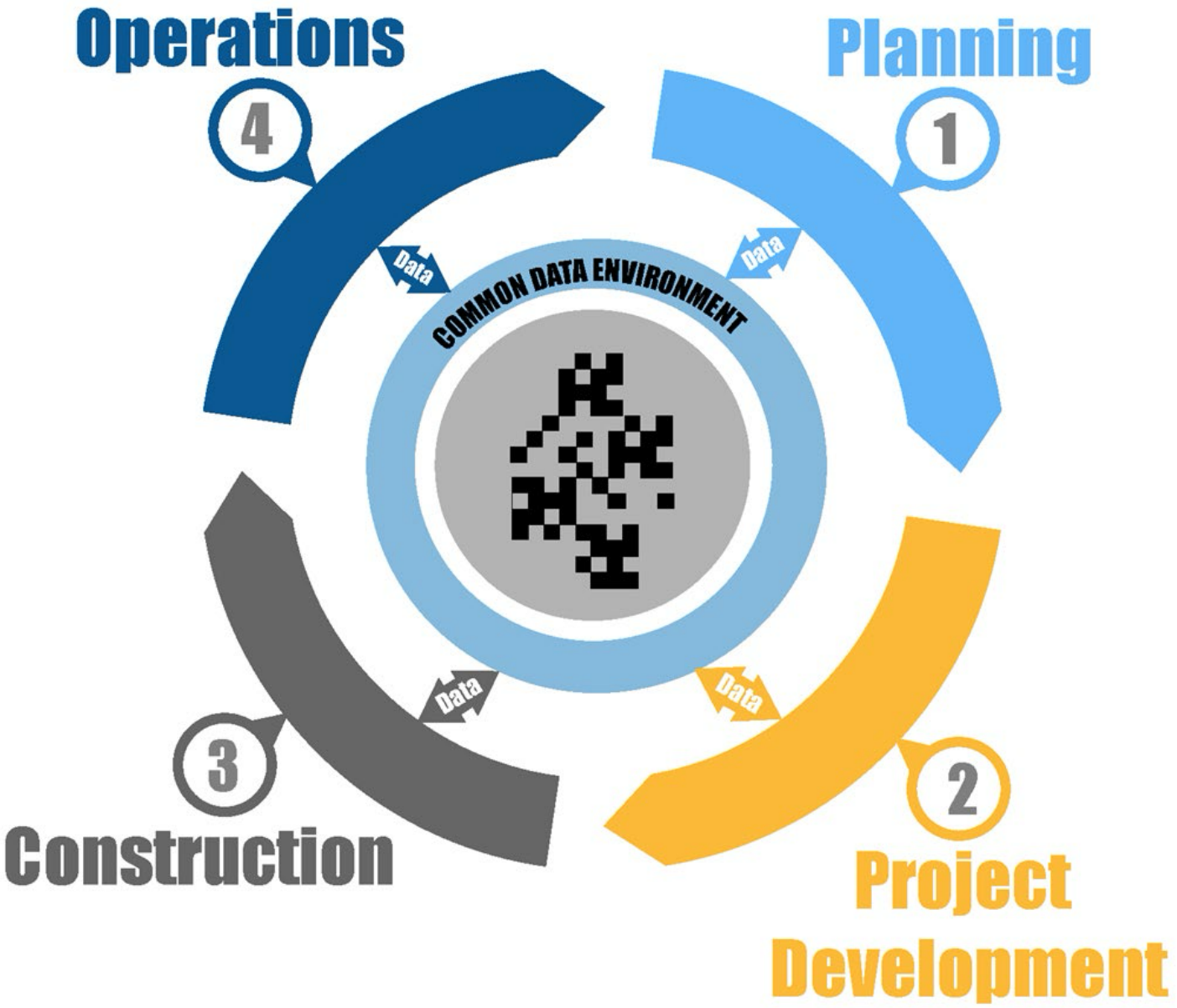
Digital Project DELIVERY

Information Exchange During the Lifecycle of an Asset



Information Exchange During the Lifecycle of an Asset

With Digital Delivery



Digital Project DELIVERY

1 2004 KYTC CADD Standards V2.0

(KYTC becomes an industry leader by requiring Microstation & InRoads files as design deliverables and providing them as non-contractual, supplemental information to construction bidders.)

2 2010 First Pilot Project

(Construction begins on Kentucky's first pilot project with Model as Legal Document (MALD) and for which the model was used for construction inspection.)

3 2019 Construction-Ready Digital Terrain Models (DTMs)

(Cabinet funds two-year research project to improve the usefulness of design data to construction project management.)

4 2019 OpenRoads Designer (ORD) Adopted

(Bentley's model-centric workflow highway design software OpenRoads Designer (ORD) adopted for all new projects per CAD Standards.)

5 2020 Digital Project Delivery Initiative

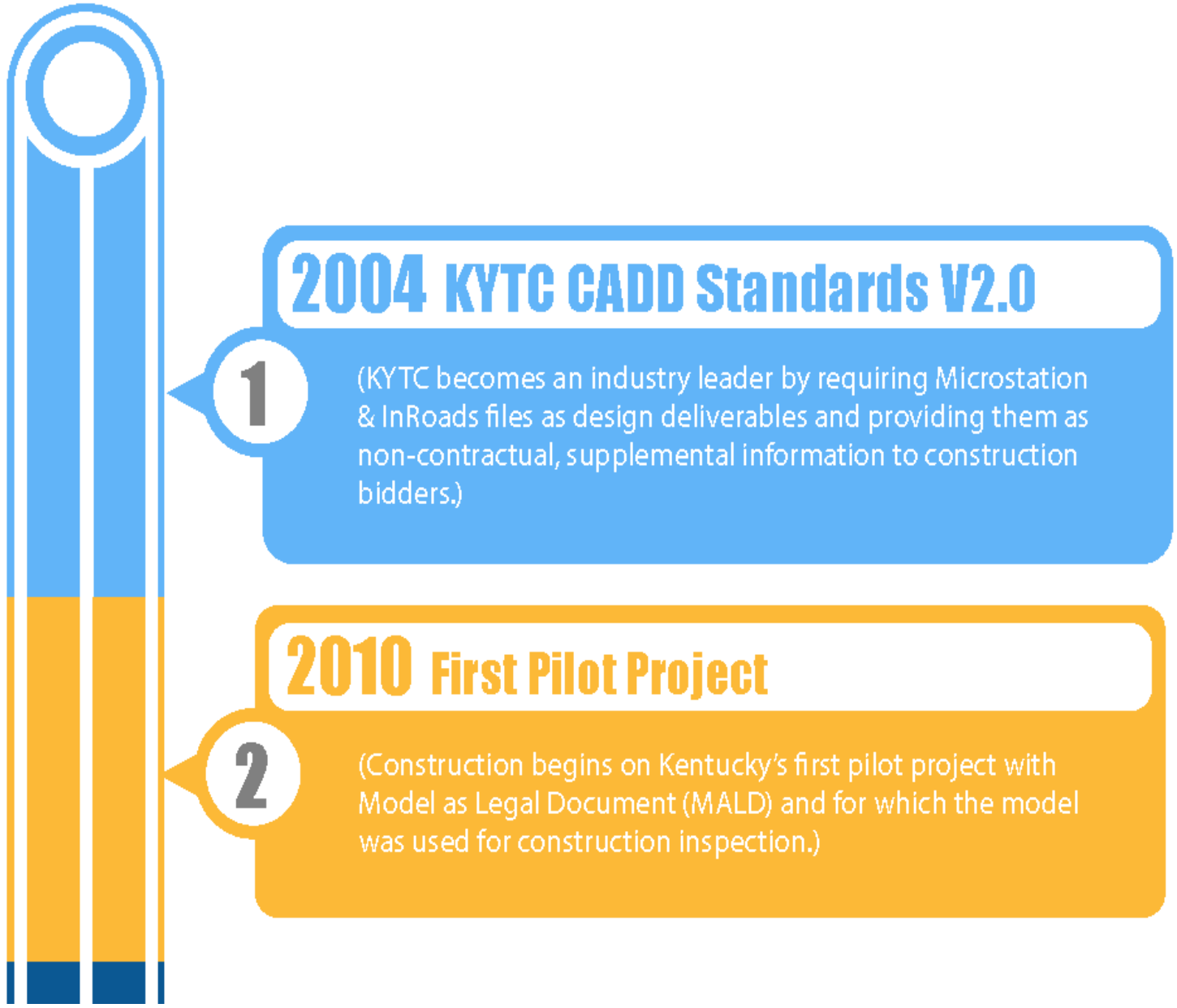
(DPD introduced to industry at the FHWA/ACEC/KYTC Annual Partnering Meeting.)

6 2021 New Pilot Projects Selected

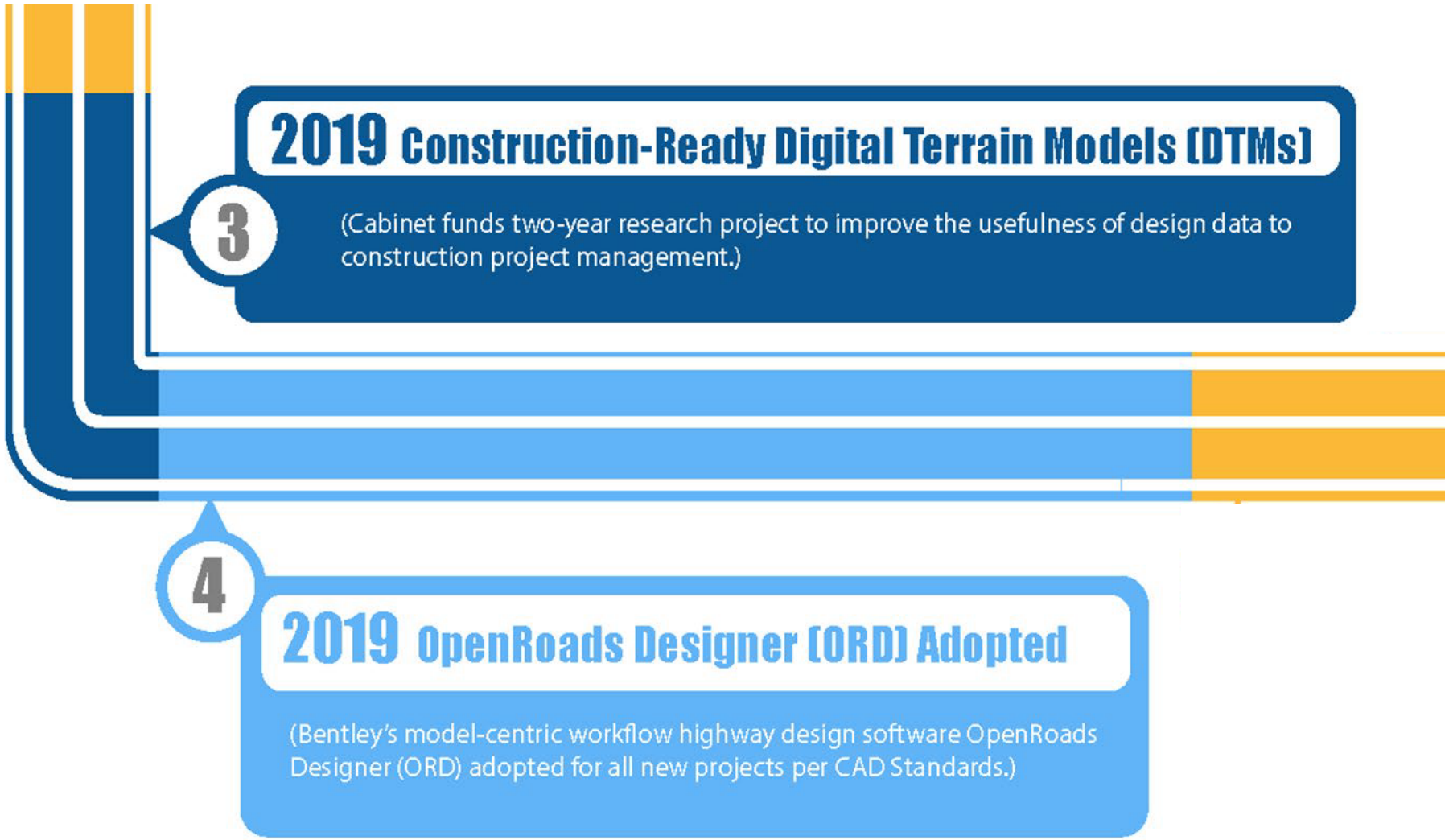
7 2022 Pilot Projects

(Pilot projects move toward Construction.)

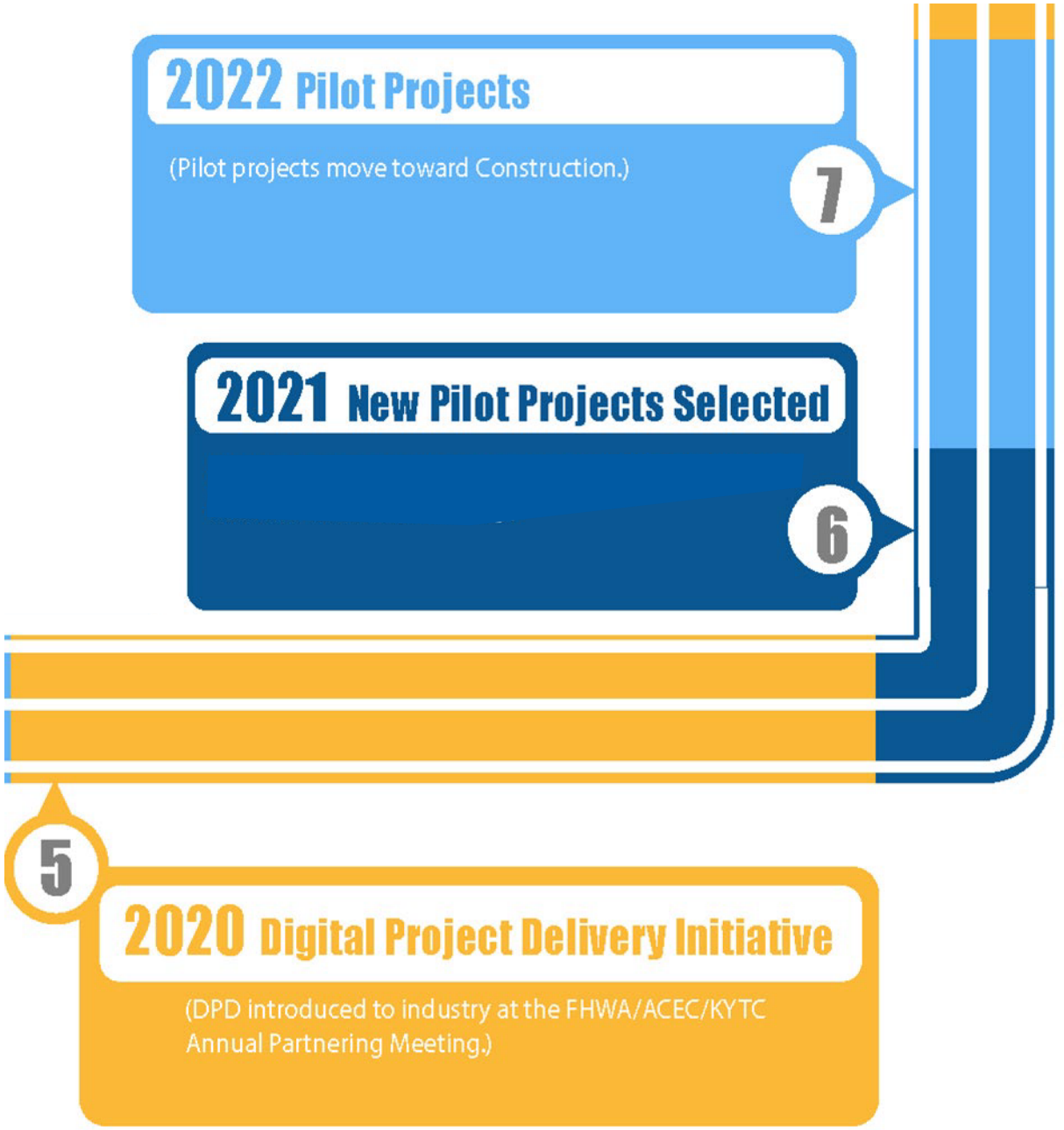
KYTC Digital Project Delivery Timeline



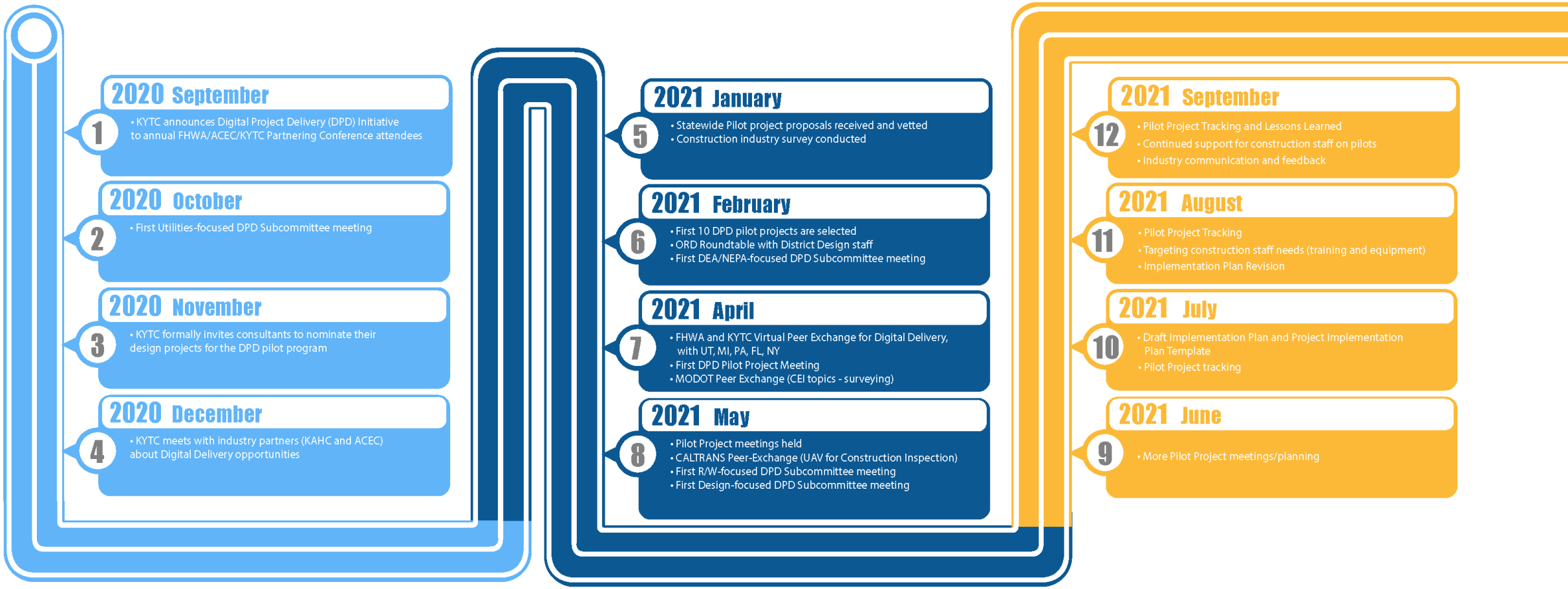
KYTC Digital Project Delivery Timeline

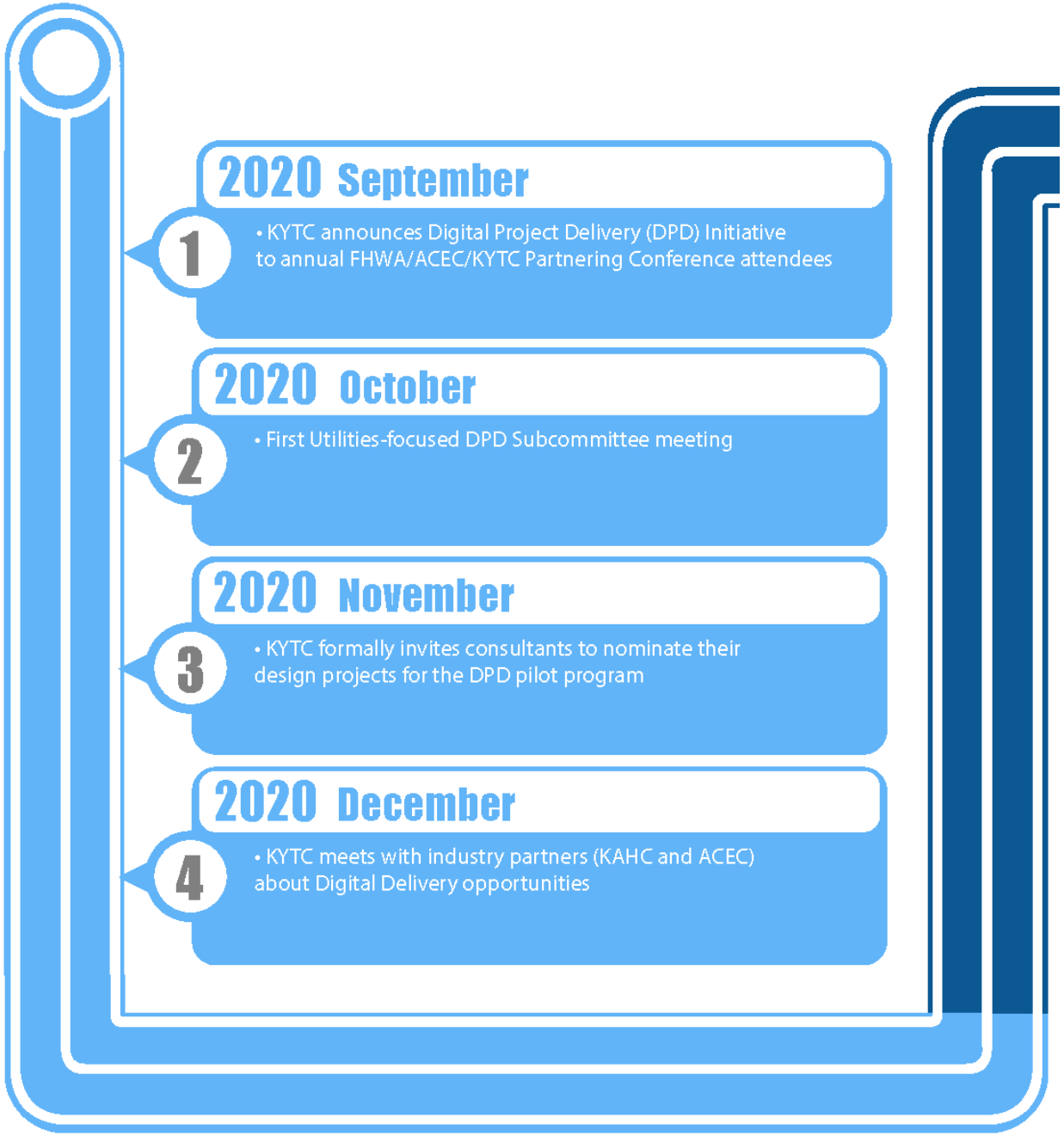


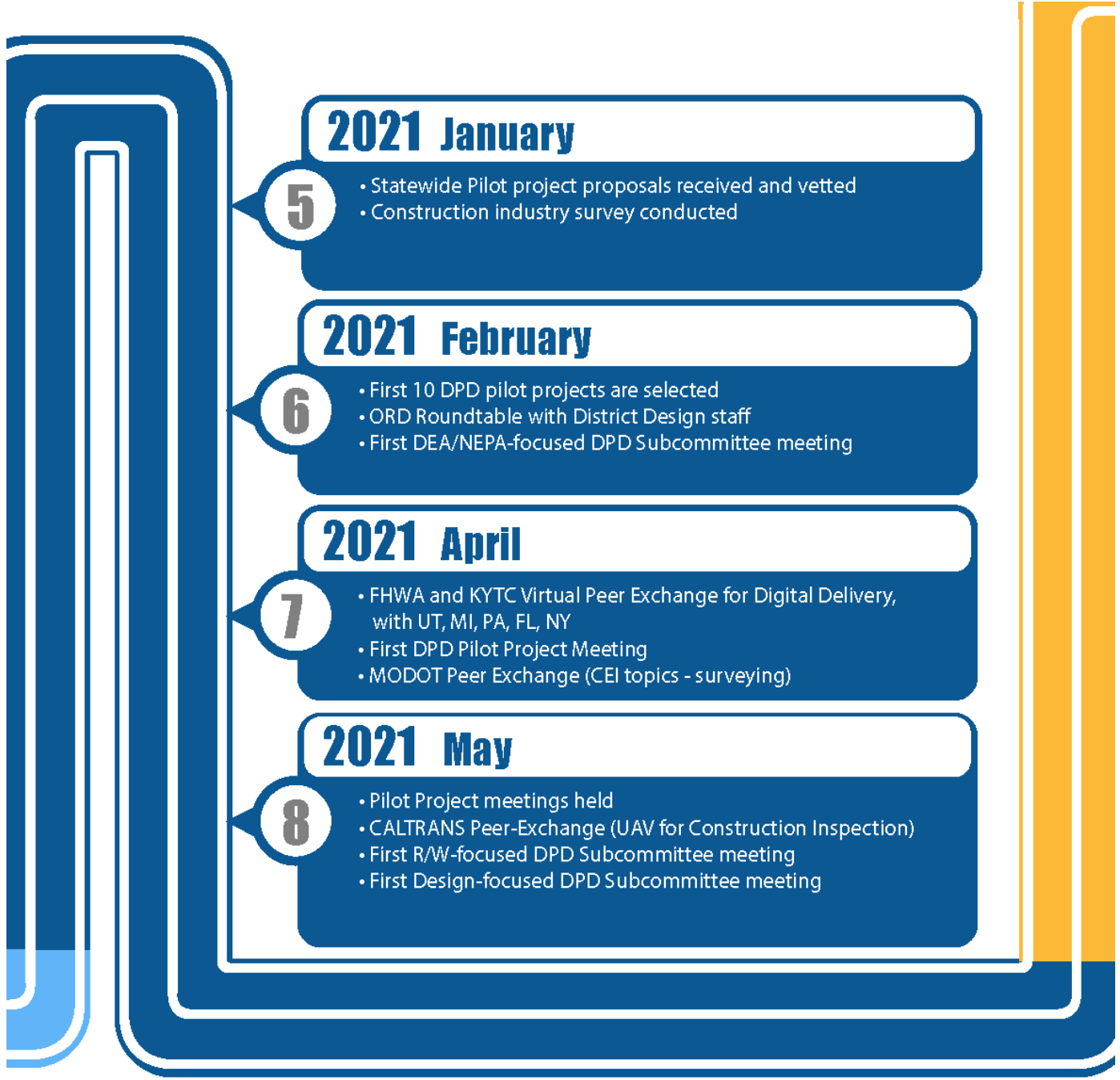
KYTC Digital Project Delivery Timeline



Inside DPD's First Year




2020 September
1
• KYTC announces Digital Project Delivery (DPD) Initiative to annual FHWA/ACEC/KYTC Partnering Conference attendees
2020 October
2
• First Utilities-focused DPD Subcommittee meeting
2020 November
3
• KYTC formally invites consultants to nominate their design projects for the DPD pilot program
2020 December
4
• KYTC meets with industry partners (KAHC and ACEC) about Digital Delivery opportunities


2021 January
5
• Statewide Pilot project proposals received and vetted
• Construction industry survey conducted
2021 February
6
• First 10 DPD pilot projects are selected
• ORD Roundtable with District Design staff
• First DEA/NEPA-focused DPD Subcommittee meeting
2021 April
7
• FHWA and KYTC Virtual Peer Exchange for Digital Delivery, with UT, MI, PA, FL, NY
• First DPD Pilot Project Meeting
• MODOT Peer Exchange (CEI topics - surveying)
2021 May
8
• Pilot Project meetings held
• CALTRANS Peer-Exchange (UAV for Construction Inspection)
• First R/W-focused DPD Subcommittee meeting
• First Design-focused DPD Subcommittee meeting

2021 September

12

- Pilot Project Tracking and Lessons Learned
- Continued support for construction staff on pilots
- Industry communication and feedback

2021 August

11

- Pilot Project Tracking
- Targeting construction staff needs (training and equipment)
- Implementation Plan Revision

2021 July

10

- Draft Implementation Plan and Project Implementation Plan Template
- Pilot Project tracking

2021 June

9

- More Pilot Project meetings/planning

Staying ahead of the curve

- ORD Conversion
- Industry Perspectives
- Short- and Long-Term Planning
- Pilot Projects – Testing
- Training and Support Systems

Digital Project DELIVERY

Staying ahead of the curve

- ORD Conversion
- Industry Perspectives
- Short- and Long-Term Planning
- Pilot Projects – Testing
- Training and Support Systems

Digital Project DELIVERY

Staying ahead of the curve

- ORD Conversion
- Industry Perspectives
- Short- and Long-Term Planning
- Pilot Projects – Testing
- Training and Support Systems

Digital Project DELIVERY

- Deliverables from OpenRoads Translated into Usable Formats for Construction Inspection and Contractor Use
- Clash Detection (e.g. MOT, Constructability, Utility Location)
- Geospatial Format Tested for Construction (e.g. KMZ in Google Earth with layers and features)
- Construction Inspection Training and Support
- Design Availability into Construction Phase (e.g. formal feedback at 15-25% contract completion, minimum)
- Construction Software Test (e.g. BluBeam, AutoDesk-PlanGrid, HCSS Plans, BIM360, OnStation, Synchro...)
- Establish Modeling Guidance for Construction Work Types (e.g. earthwork, drainage, paving)
- Model as Contract Document
- Structural Design - Bridge Design Modeling First Steps
- Represent Geotechnical Report Details in Modeling
- Underground Facilities Location Mapped

BlueBeam (limited existing availability to Section Offices)
Bentley: OpenRoads Navigator (decommissioned – prior tests through Utah DOT)
Bentley: OpenRoads Designer
OnStation
Trimble: Trimble Business Center (TBC), Quadri, DatuMate
Synchro
AutoDesk-PlanGrid
HCSS Plans
BIM360
Rugged Tablet – Microsurvey, Field Genius
AASHTOWare Mobile Inspector
Nearmap



Tim.Layson@ky.gov

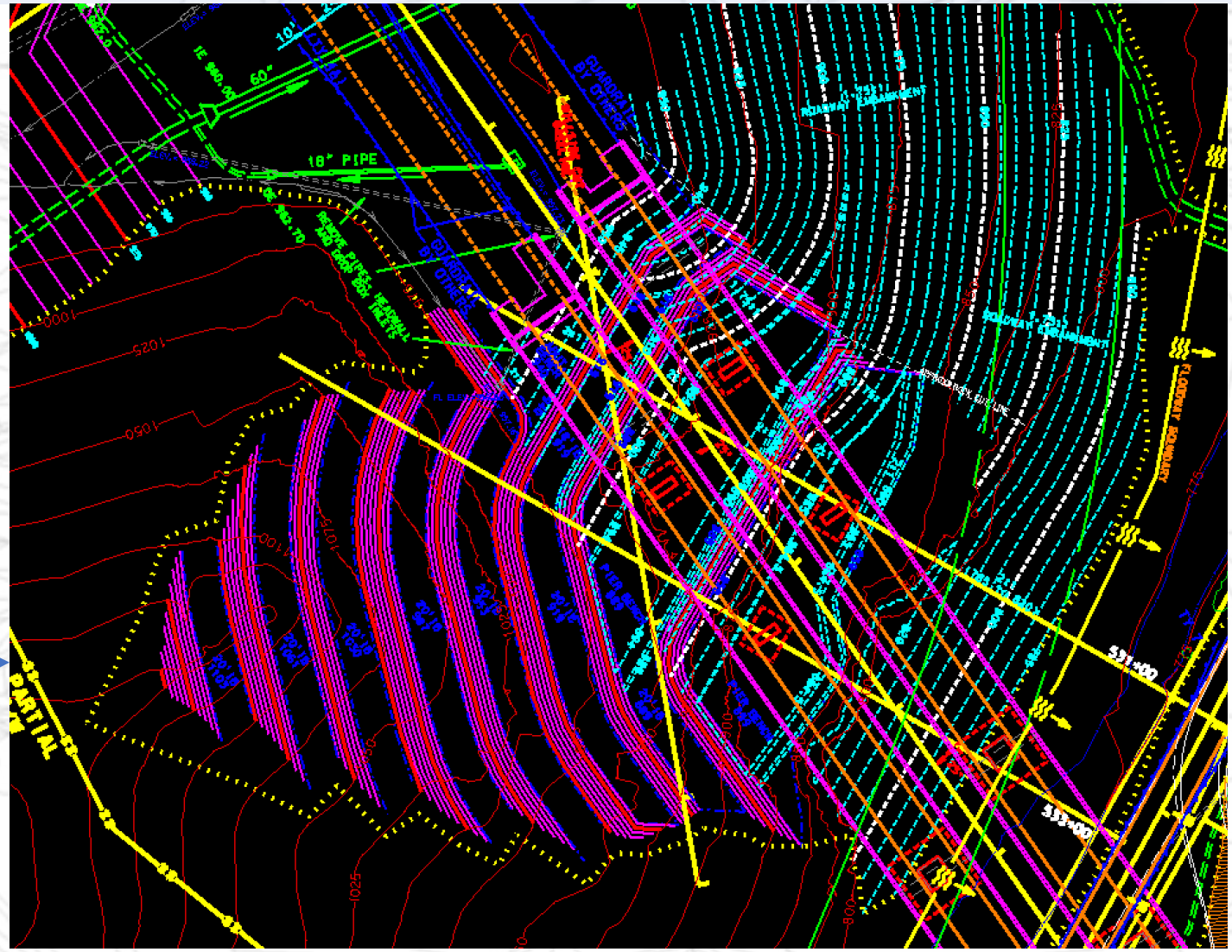
Catherine.Keathley@ky.gov

Rachel.Catchings@uky.edu

SPR Research Project: 19-576 “Construction-Ready DTMs”

Case Studies: 1. *CAD Standards* Evaluation

Likely that the work is being done to varying degrees, but isn't being included in the supplemental folder, as required.



Cut slope and embankment benching is extensively modeled and can be viewed in the 2D manuscript file, but **no 3D manuscript or proposed surface file is provided** for this project.

Recommendations: Focus Areas

- Strengthen the Quality of the Electronic Engineering Data
- Professional Services Contracts
- Staff Training and Support
- Continuous Information Exchange with Industry Representatives
- Cost Implications

Recommendations

1. Review the EED Quality at Construction Contract 25% Completion
2. Implement CAD Standards Specific to Project Type
3. EED Submittals Increased Within Existing Plan Review Processes
4. Update Shelved and Aging Projects' EED to Most Current Software
5. Revise Production Hours and Descriptions to Modern Workflow
6. Establish Support for Construction Surveying

Recommendations

Quick Wins:

1. Reinforce the EXISTING CAD Standards using existing organization structure (Project Team, District Survey Staff, QAB, Plan Processing)
2. Consistent Rate of Template Drop
3. Deliver Breaklines in Point File Format
4. Deliver KMZ Formatted Files of Proposed Manuscript Data
5. Train EED Reviewers
6. Train Construction Staff
7. Consistent Information Exchange with Industry Representatives
8. Track and Measure Case Studies for Links Between EED Quality and Costs
9. Evaluate Alternative to Average End Area Method – given that the software offers much more accurate means

Recommendations

Longer term:

9. Review the EED Quality at Construction Contract 25% Completion
10. Implement CAD Standards Specific to Project Type
11. Deliver Breaklines in Point File Format
12. EED Submittals Increased Within Existing Plan Review Processes
13. Update Shelved and Aging Projects' EED to Most Current Software
14. Revise Production Hours and Descriptions to Modern Workflow
15. Establish Support Tailored to Construction Surveying



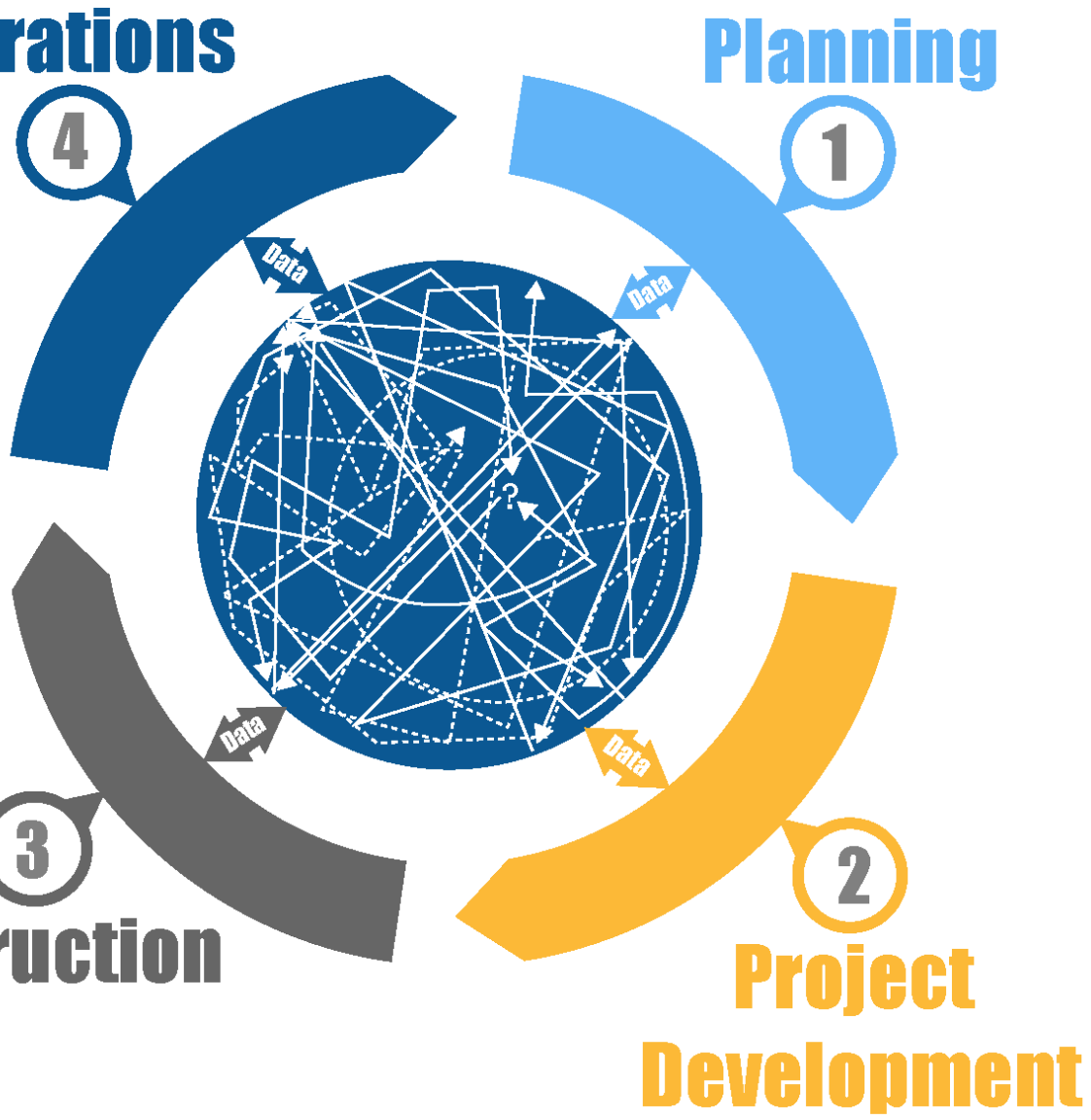

instant
Sanka
97% CAFFEIN FREE COFFEE
WT. 8 OZ.

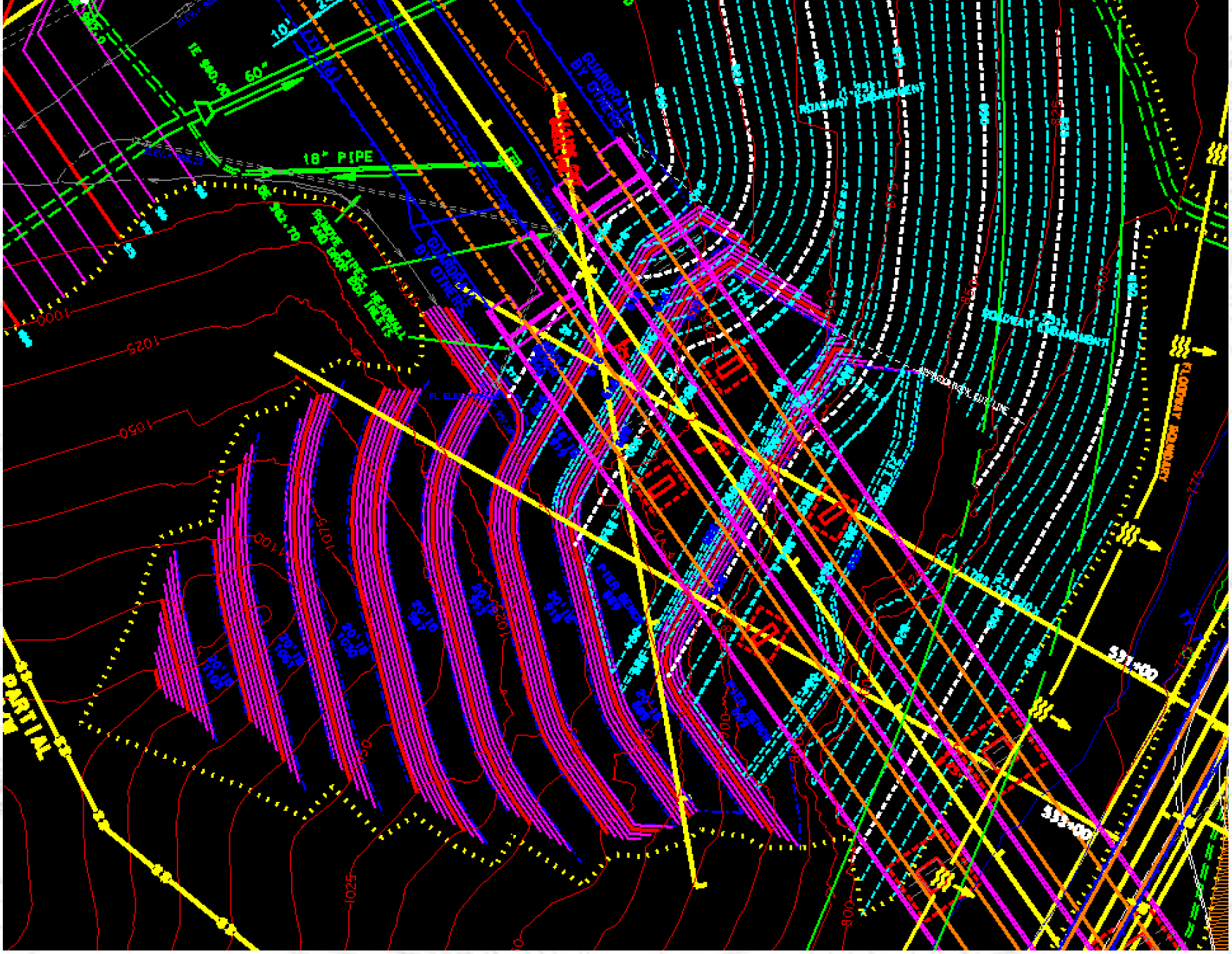


Appendix D DPD Overview (September 2021)


Digital Project
DELIVERY

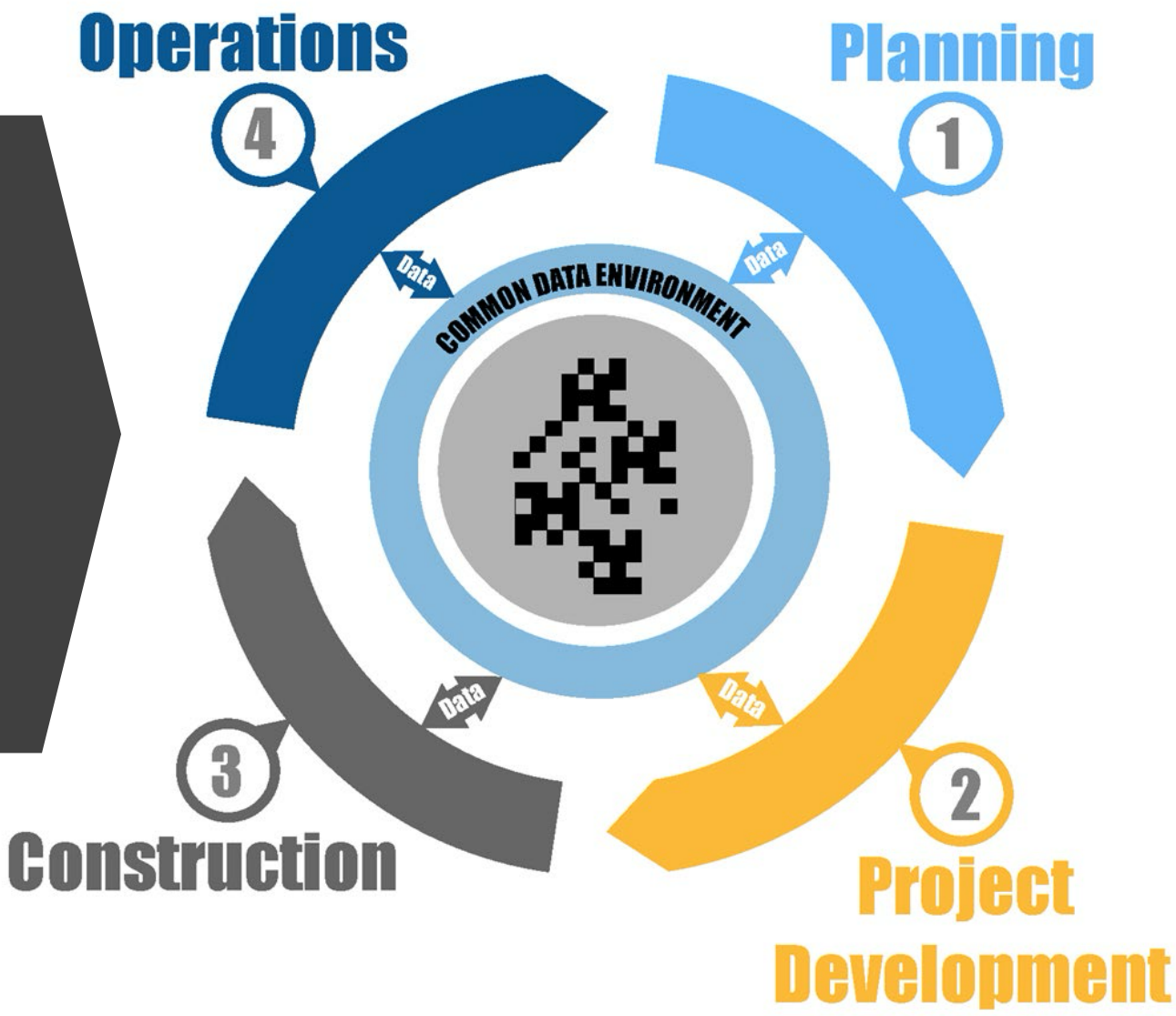
Information Exchange During the Lifecycle of an Asset




18" PIPE
60"
PARTIAL
FLOODWAY BOUNDARY
PROPERTY LINE
EASEMENT
BY OTHERS

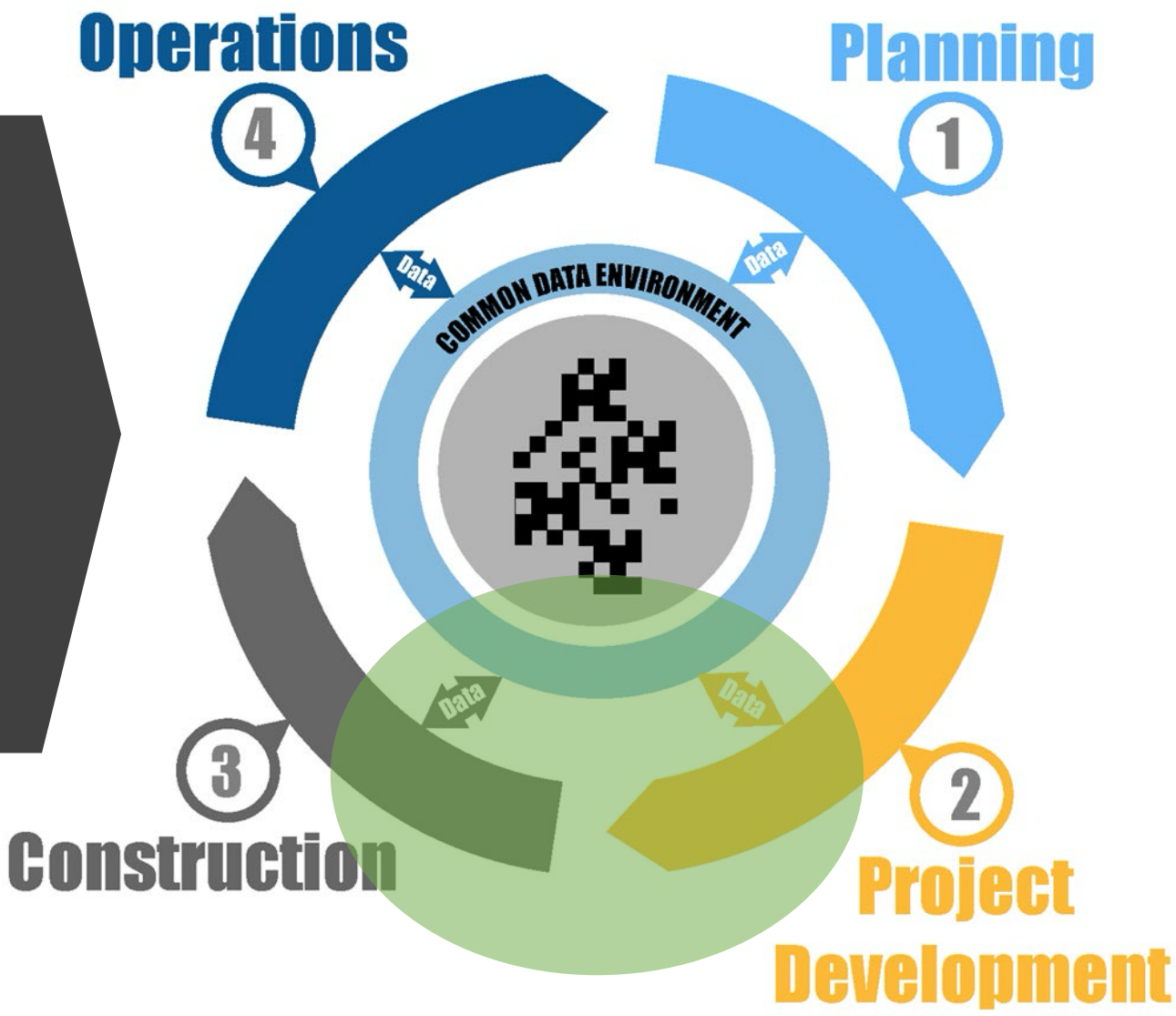
Information Exchange During the Lifecycle of an Asset

With Digital Delivery



Information Exchange During the Lifecycle of an Asset

With Digital Delivery

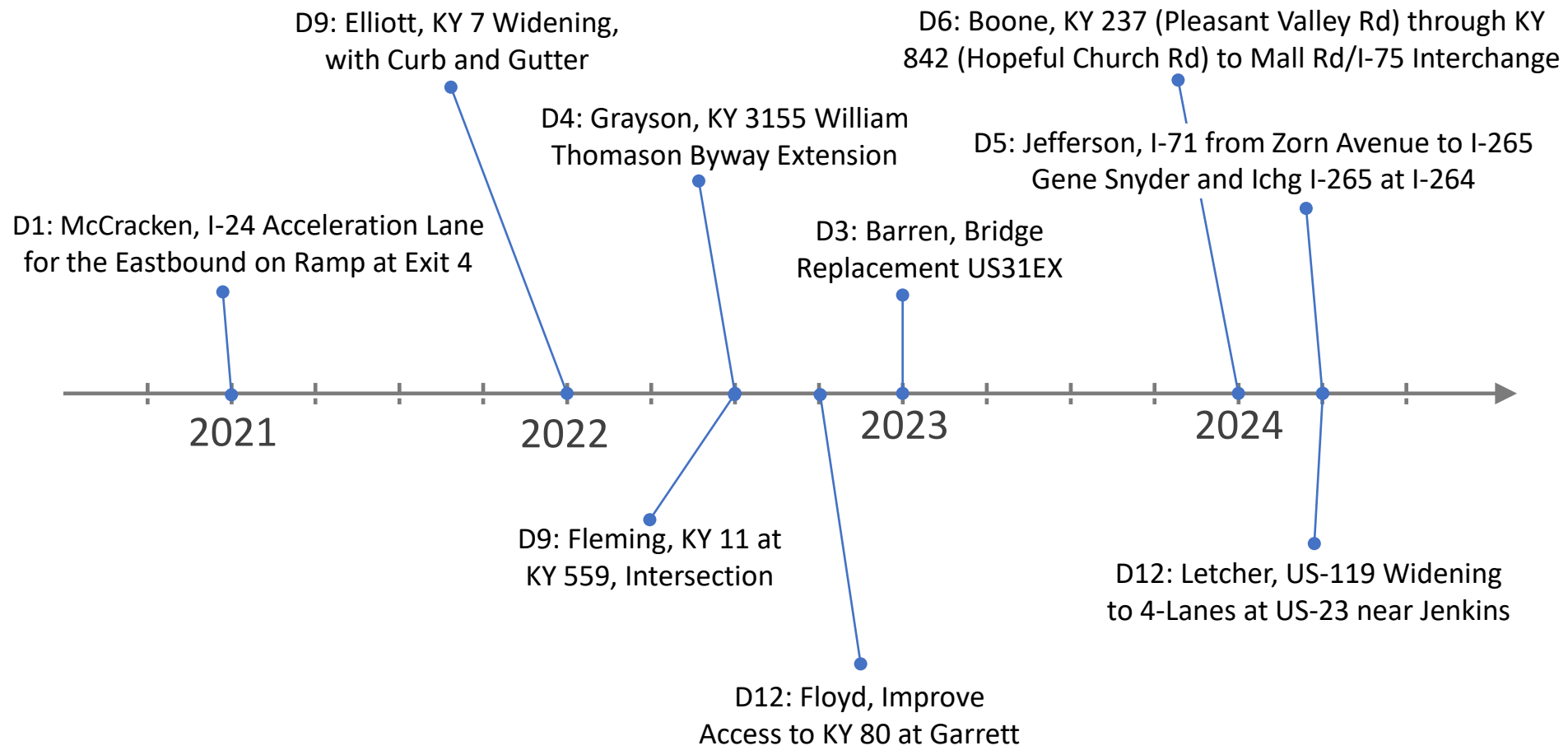


DPD PILOT PROJECTS

How were the projects selected?



DPD PILOT PROJECTS

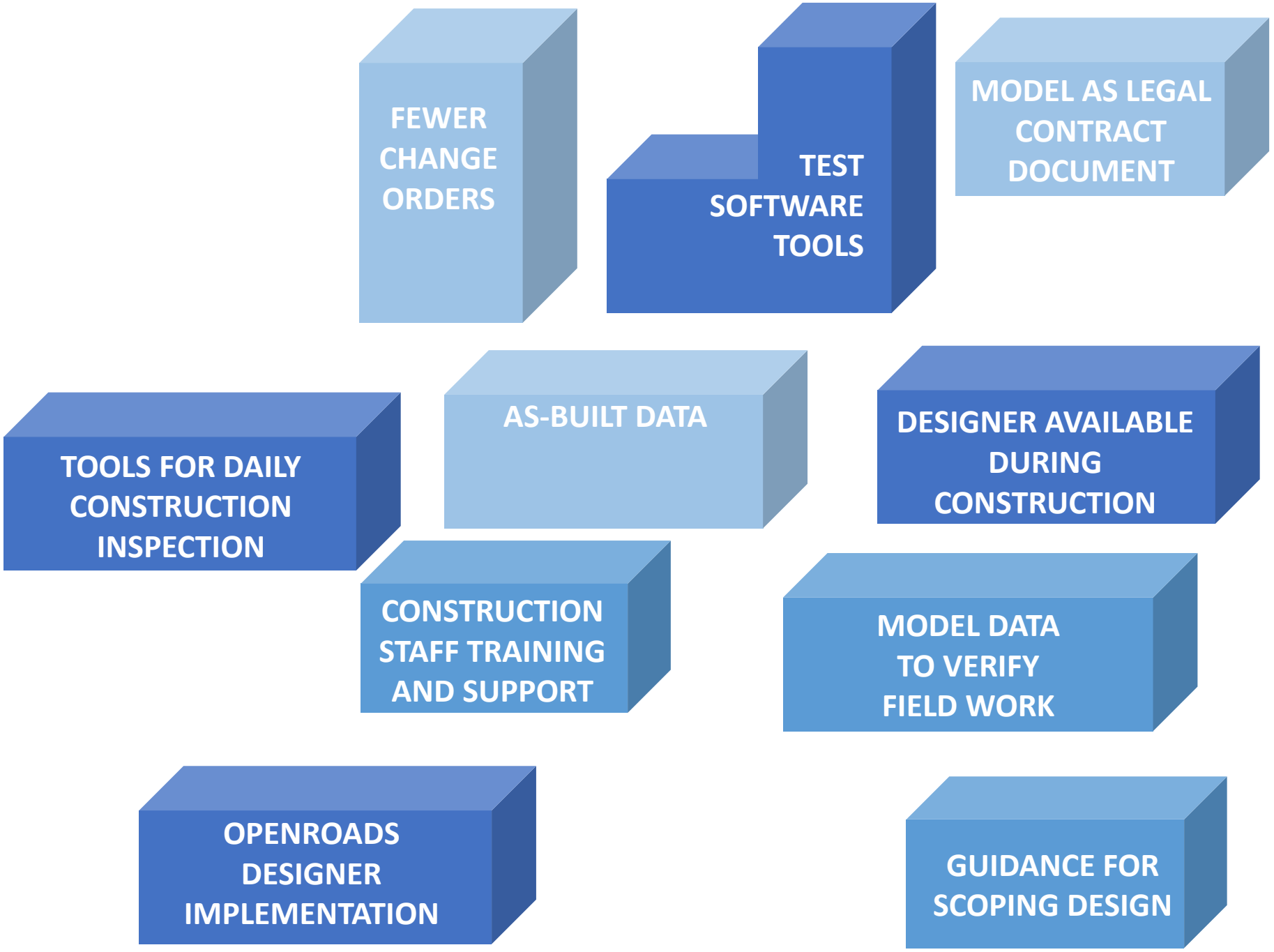


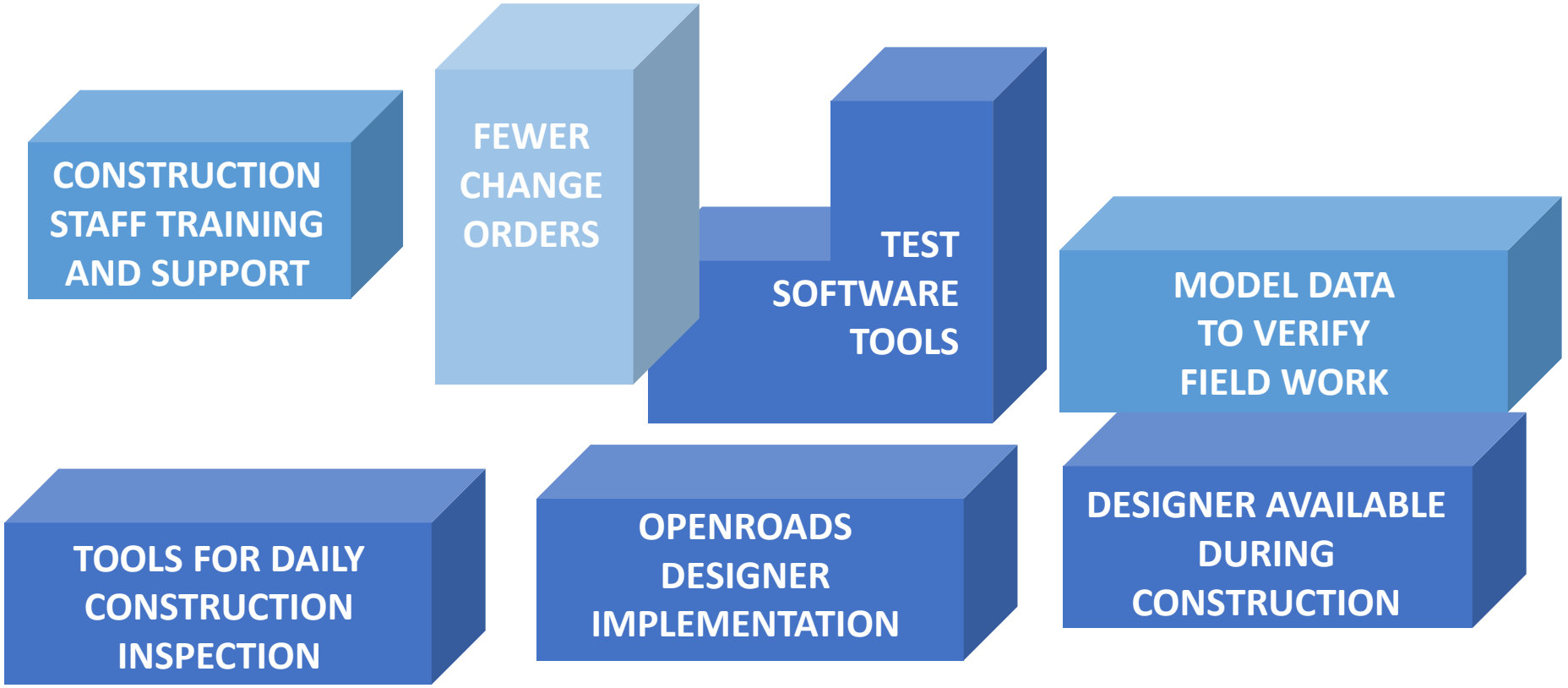
Anticipated LETTING DATES as of September 2021

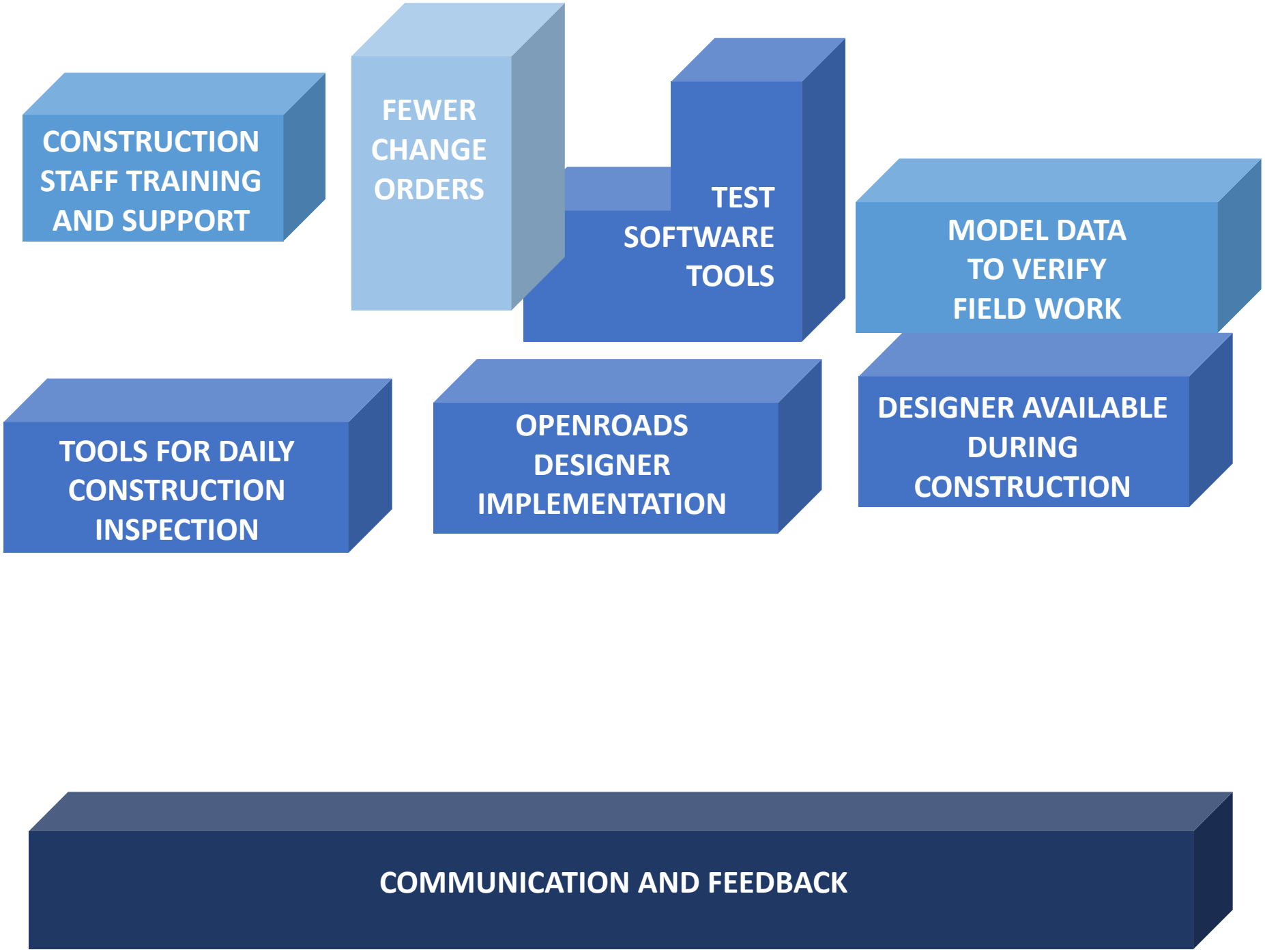
What's specifically being tested on the DPD Pilot Projects?

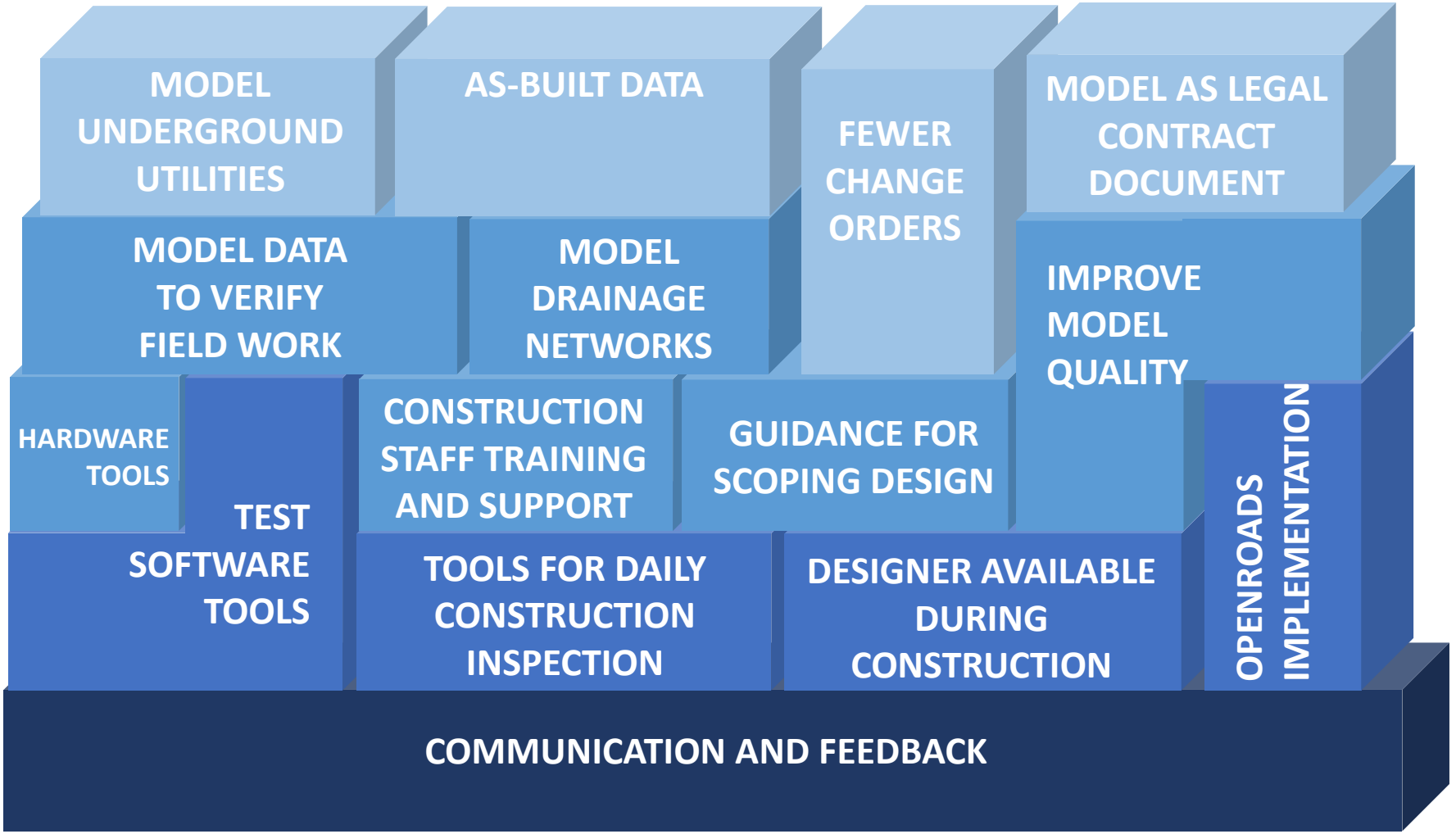
How have internal KYTC stakeholders and industry been engaged?

What are KYTC internal staff saying about Digital Project Delivery?


FEWER CHANGE ORDERS
TEST SOFTWARE TOOLS
MODEL AS LEGAL CONTRACT DOCUMENT
TOOLS FOR DAILY CONSTRUCTION INSPECTION
AS-BUILT DATA
DESIGNER AVAILABLE DURING CONSTRUCTION
CONSTRUCTION STAFF TRAINING AND SUPPORT
MODEL DATA TO VERIFY FIELD WORK
OPENROADS DESIGNER IMPLEMENTATION
GUIDANCE FOR SCOPING DESIGN


CONSTRUCTION STAFF TRAINING AND SUPPORT
FEWER CHANGE ORDERS
TEST SOFTWARE TOOLS
MODEL DATA TO VERIFY FIELD WORK
TOOLS FOR DAILY CONSTRUCTION INSPECTION
OPENROADS DESIGNER IMPLEMENTATION
DESIGNER AVAILABLE DURING CONSTRUCTION


CONSTRUCTION STAFF TRAINING AND SUPPORT
FEWER CHANGE ORDERS
TEST SOFTWARE TOOLS
MODEL DATA TO VERIFY FIELD WORK
TOOLS FOR DAILY CONSTRUCTION INSPECTION
OPENROADS DESIGNER IMPLEMENTATION
DESIGNER AVAILABLE DURING CONSTRUCTION
COMMUNICATION AND FEEDBACK


MODEL UNDERGROUND UTILITIES
AS-BUILT DATA
FEWER CHANGE ORDERS
MODEL AS LEGAL CONTRACT DOCUMENT
MODEL DATA TO VERIFY FIELD WORK
MODEL DRAINAGE NETWORKS
IMPROVE MODEL QUALITY
HARDWARE TOOLS
TEST SOFTWARE TOOLS
CONSTRUCTION STAFF TRAINING AND SUPPORT
GUIDANCE FOR SCOPING DESIGN
OPENROADS IMPLEMENTATION
TOOLS FOR DAILY CONSTRUCTION INSPECTION
DESIGNER AVAILABLE DURING CONSTRUCTION
COMMUNICATION AND FEEDBACK

Digital Project DELIVERY

Questions?

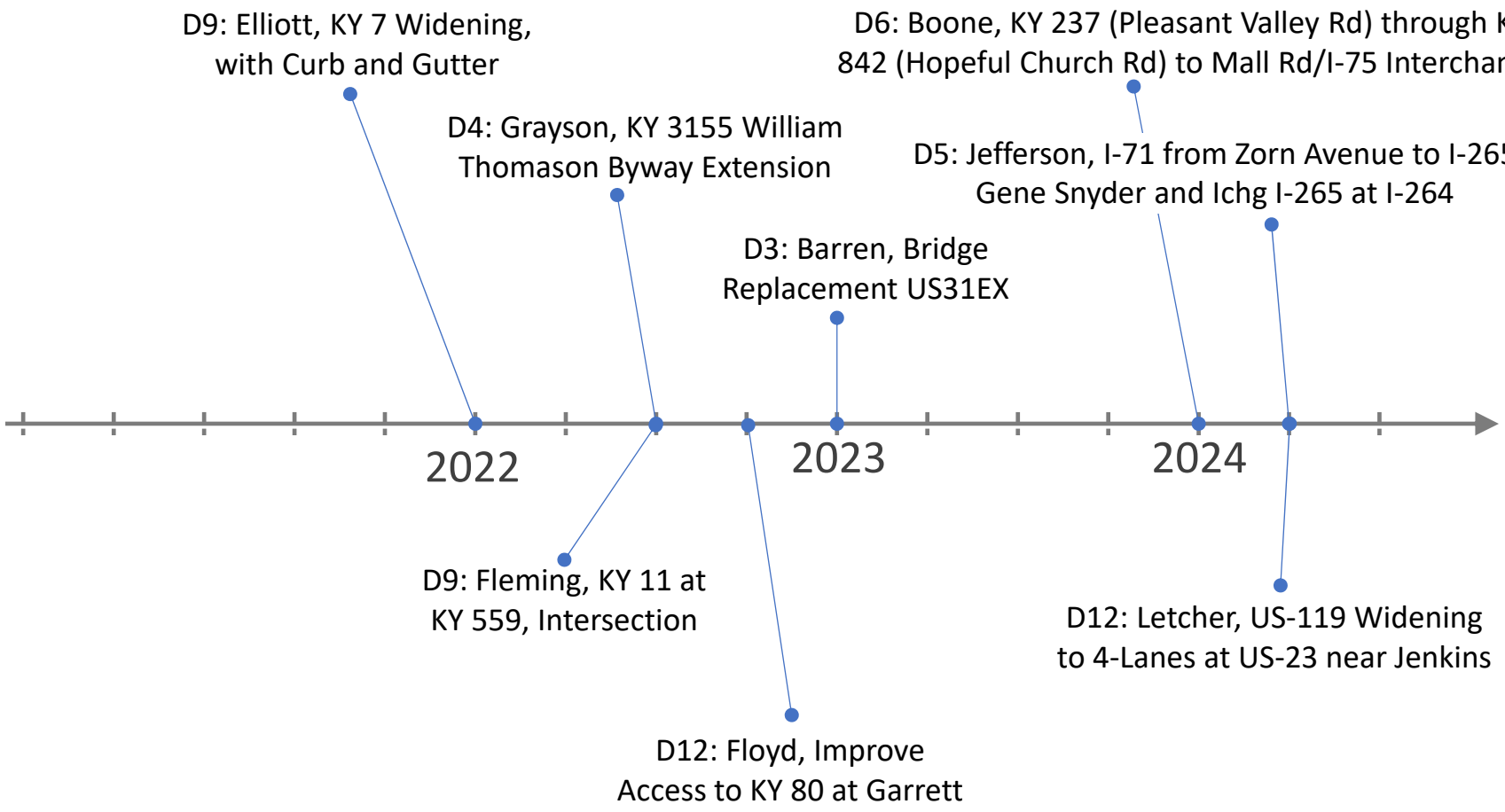
KYTC-DPD-QandA@ky.gov

Catherine.Keathley@ky.gov

Rachel.Catchings@uky.edu

Appendix E DPD Pilots Timeline

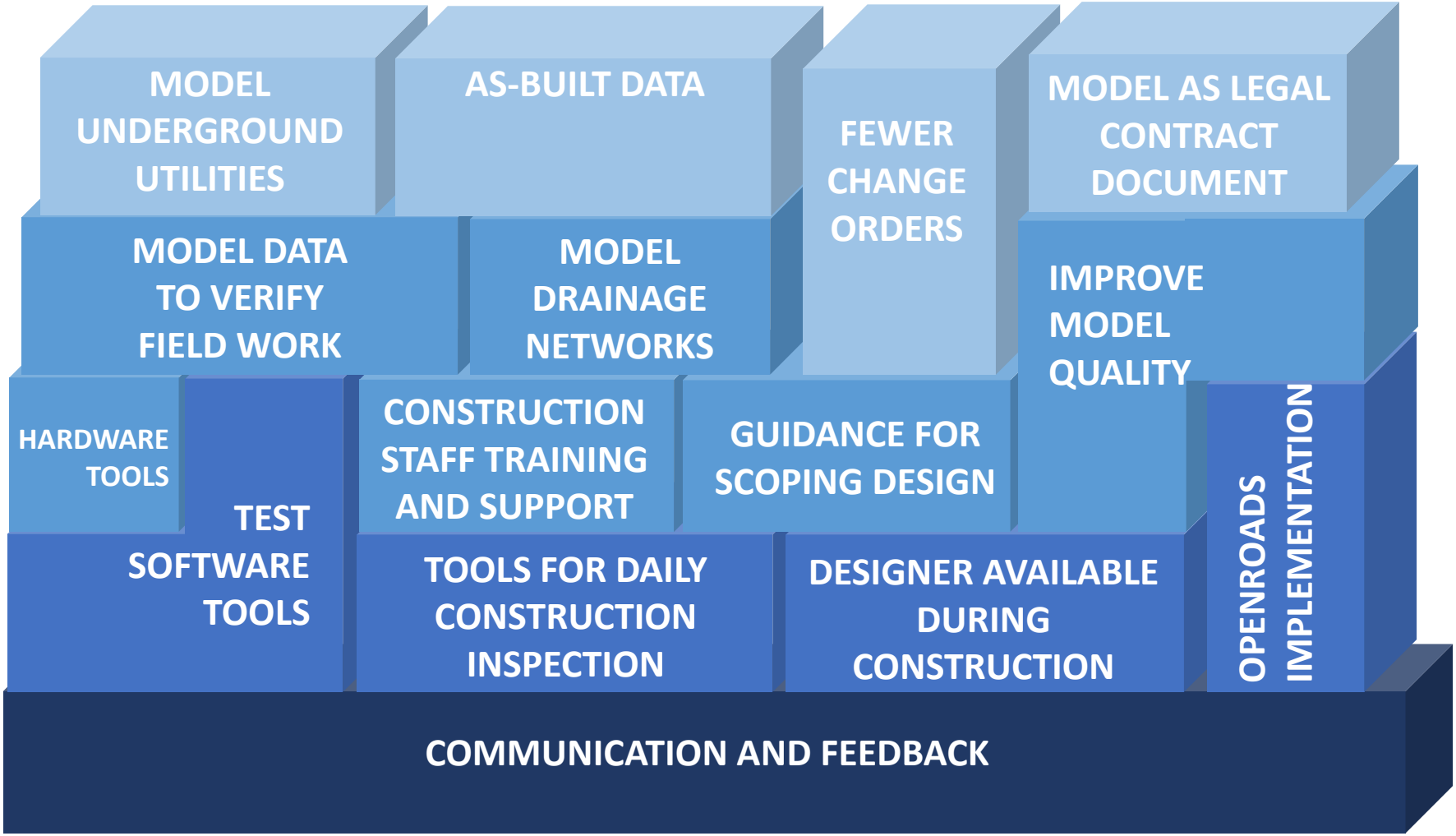
DPD PILOT PROJECTS



Estimated LETTING DATES – for Internal Use Only

Appendix F DPD Building Blocks

DPD Building Blocks



Appendix G DPD Frequently Asked Questions (October 2021)

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When is the design model "good enough" for construction? In other words, how detailed should a designer make the proposed design model? 3

Digital Project Delivery (DPD) – General

What digital design information is available to construction?

KYTC's CAD Standards provides a complete list of required design deliverables. It can be accessed at: https://transportation.ky.gov/CADD-Standards/Pages/default.aspx

For example, after design is complete and final plans are ready to submit for letting, the designer generates an electronic LandXML file (.XML) from the design (*proposed corridor*). LandXML files are open source and can contain geospatial data on a project's design. The LandXML file is just one of the digital products KYTC requires.

How were the first round of Pilot Projects selected?

KYTC selected eight pilots based on:

- Design Project Managers' approval
- Construction staff input
- Cabinet leadership endorsement
- Consultant responses to KYTC's invitation posted through the Division of Professional Services

The pilots are critical for understanding how information is exchanged and working toward agencywide implementation of DPD.

What are the DPD Pilot Projects testing?

Project-level implementation plans describe testing details and review how the unique needs of each project team have been addressed. Examples of key pilot testing concepts include:

1. Training and support for Construction staff
2. Tools for using 3D models during construction, including software products from two software vendors and multiple model viewing options
3. Designer availability during construction
4. Construction perspectives providing feedback to design model development

How do the pilot projects move KYTC toward more efficient use of digital data?

The pilots are working to (a) resolve obstacles that hinder more widespread use of digital data and (b) increase data functionality during the construction phase of project management. Strong collaboration and feedback between Highway Design and Construction personnel are essential for addressing these challenges. When the designer is available during construction, feedback from construction field staff can help the designer incorporate model details construction values. Pilot project testing will highlight where modeling effort returns the greatest benefit. Improvements in overall digital data quality will follow.

KYTC Construction staff will continue to verify the work using 3D model data and up-to-date surveying methods. Support and training are a part of the pilot program. Software KYTC is testing gives Construction staff a single source of digital design information that reinforces daily project management.

Has KYTC sought input from consultants and contractors?

KYTC is working with industry stakeholders through partnerships with the American Council of Engineering Companies of Kentucky (ACEC-KY) and the Kentucky Association of Highway Contractors (KAHC). Along with formal meetings and member surveys, industry representatives are serving on committees and participating in pilots.

Consultant engineers and contractors can stay up to date on DPD by subscribing to CAD updates at https://transportation.ky.gov/CADD-Standards/Pages/default.aspx, submitting questions by emailing KYTC.DPD-QandA@ky.gov, and talking to their KYTC counterparts about ways to get involved.

Is DPD just for Construction and Design?

Design and construction data generated through full implementation of DPD will support the life cycles of infrastructure assets. Achieving full implementation requires long-term planning, and KYTC's DPD program will help Kentucky craft a digital delivery policy tailored to its unique context. KYTC is focusing on Construction and Design components with the initial DPD efforts, but other disciplines are engaged and will continue to be involved. Experts in KYTC's Central Office and in district offices are participating and giving feedback. KYTC staff participation and feedback remain a priority.

Are there plans to replace PDF plans with the design models?

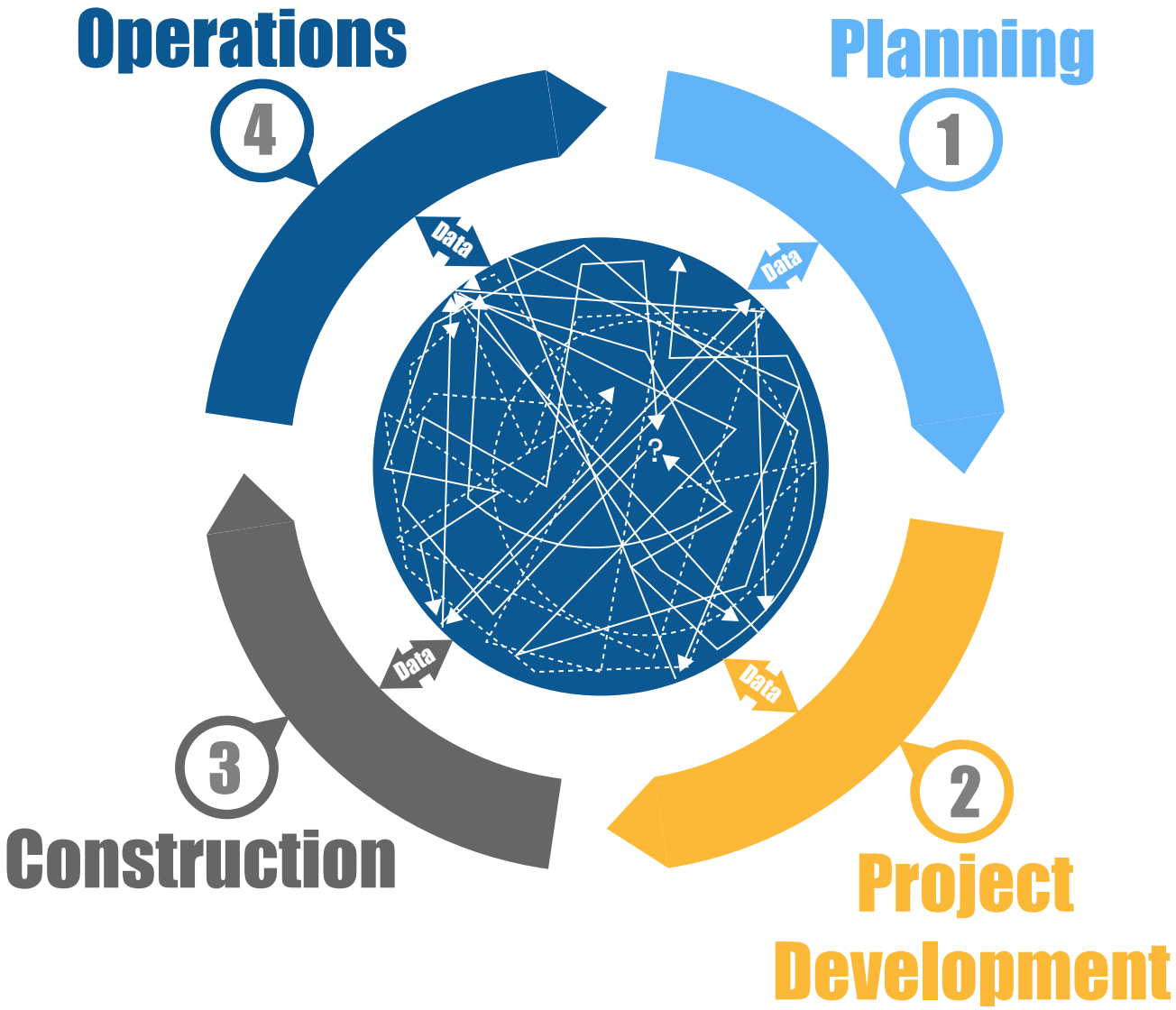
Currently, digital design information is treated as supplemental to primary contract documents. These documents include a hierarchy of resources (e.g., PDF plans, standard specifications, special notes, standard drawings, the proposal). Pilots testing use of digital design data will generate PDF versions of the plans for construction reference. KYTC anticipates that eventually the 3D model and digital design files will serve as the project plans. Currently, there is no target date for that shift because many complexities must be resolved first.

When is the design model "good enough" for construction? In other words, how detailed should a designer make the proposed design model?

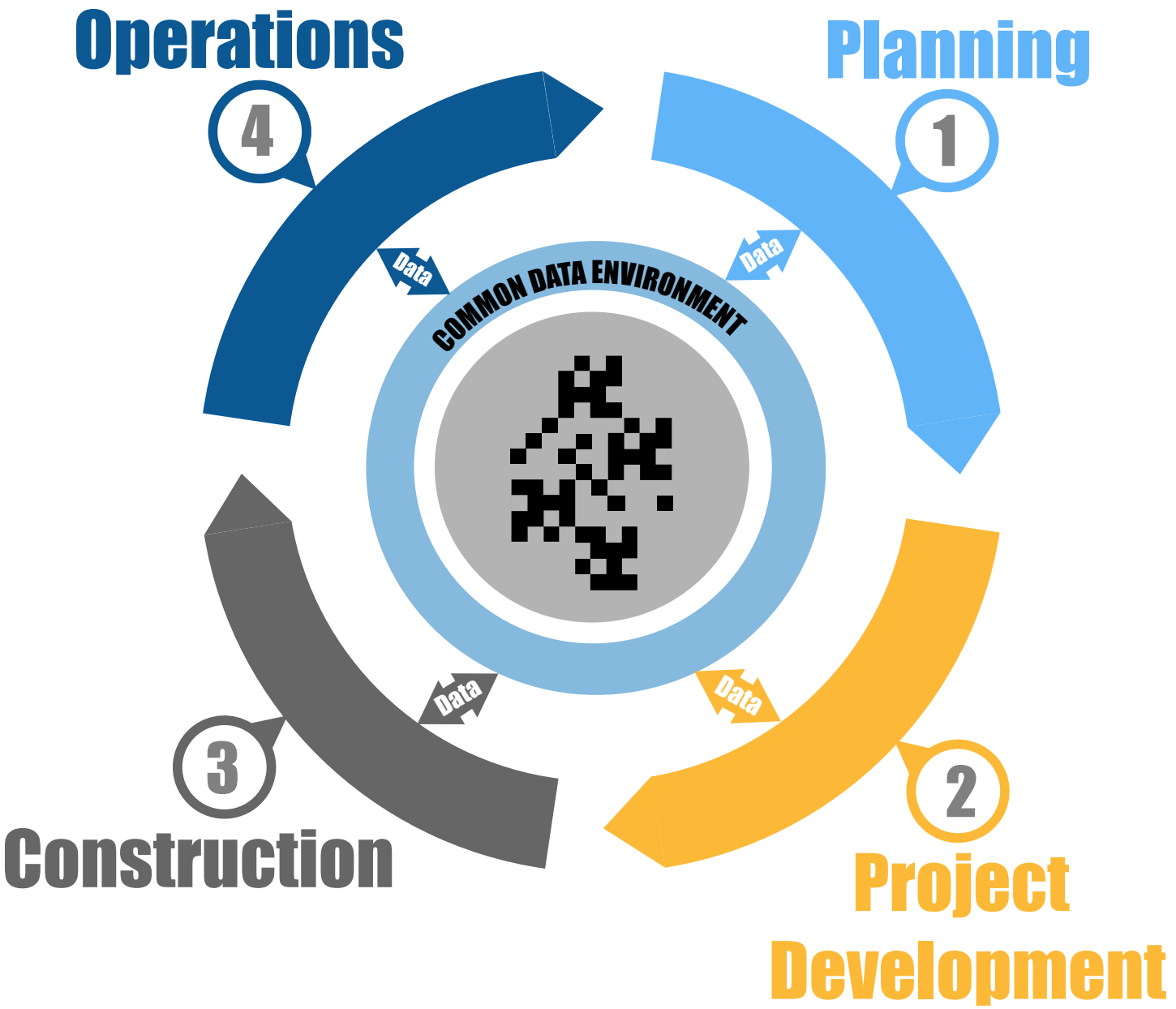
A model is good enough when it is sufficient to guide project construction. When modeling a project, designers should work with project managers as they scope their level of effort. KYTC's CAD Support staff can assist with these discussions on a project-by-project basis. Ultimately, Cabinet guidance will aid decision making related to the completeness of digital design files and content. This guidance will depend, in part, on ideas from construction staff participating in pilot projects.

Appendix H DPD Models

Data Exchange within the Lifecycle of an Asset

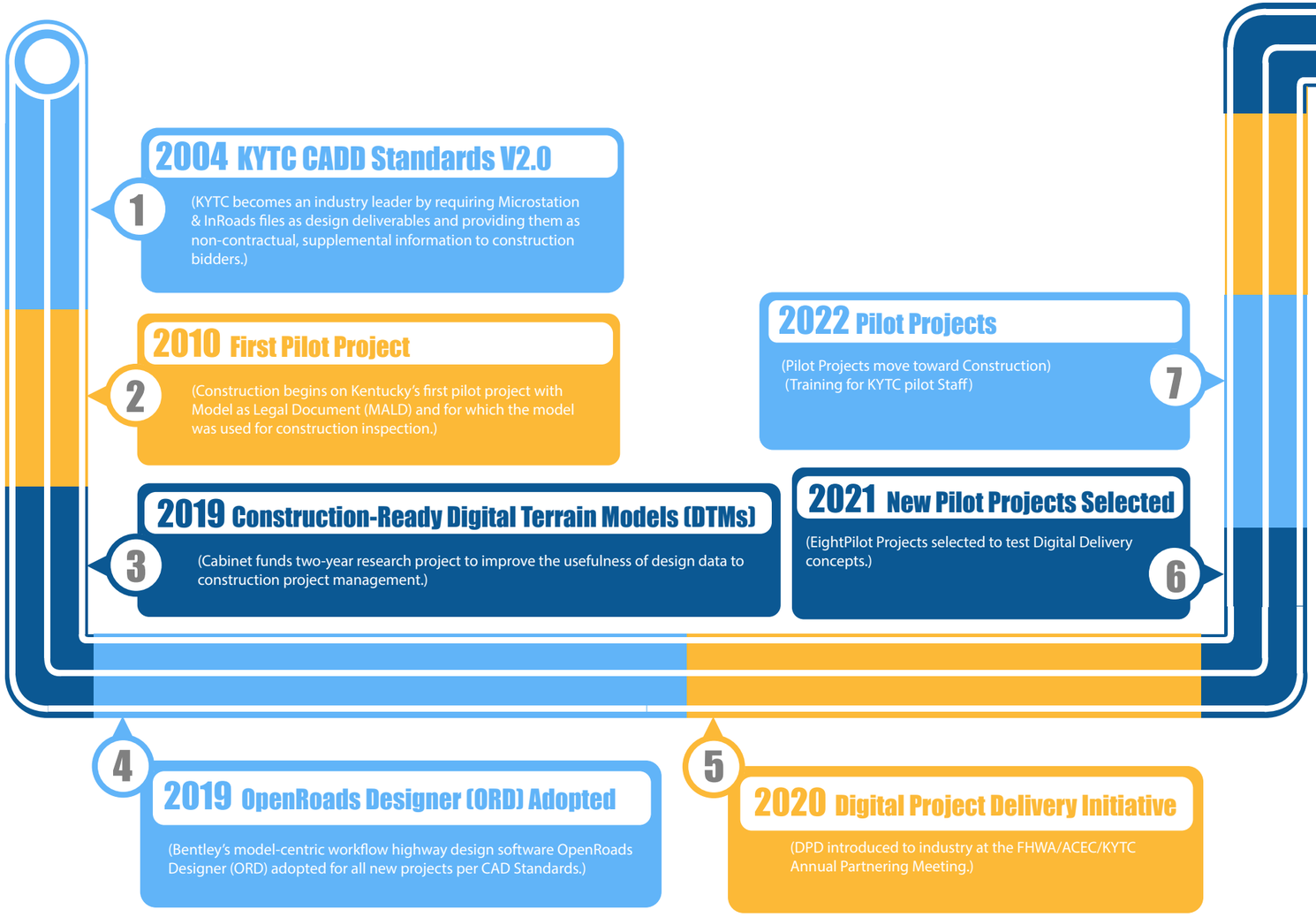


Data Exchange within the Lifecycle of an Asset



Appendix I DPD Yearly Timeline

Digital Project Delivery Timeline - Yearly



Appendix J Project Delivery Model One Pager (November 2021)

Digital Project DELIVERY

NOVEMBER 2021

Fundamentals

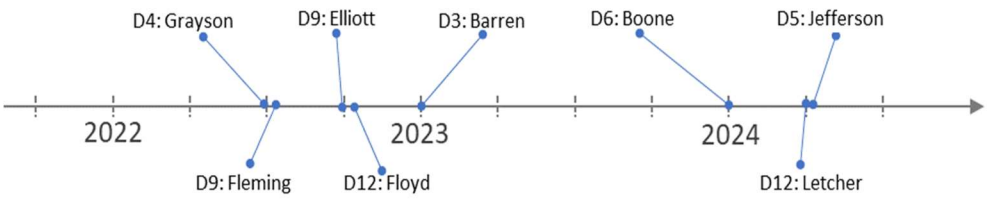
KYTC took a noteworthy step toward digital project delivery (DPD) in 2004 with the agency's requirement that supplemental project design files from Design be passed to construction bidders as a part of CAD Standards V 2.0.

Full Implementation

When DPD is fully implemented, design and construction data will be better able to support the entire life cycle of infrastructure assets. Achieving full implementation requires long-term planning and KYTC's DPD program will help Kentucky craft a digital delivery policy tailored to its unique context.

Pilot Projects

Eight pilot projects are testing how 3D design models can support construction project management. Products from two software vendors (Trimble and Bentley) are being evaluated, along with multiple model viewing options (e.g., GIS, PDF). An implementation plan has been developed for each pilot that describes the scope of testing, specific objectives, and project stakeholders. These projects are critical for understanding how information is exchanged and working toward agencywide implementation.



Construction Timeline for Pilot Projects

Training and Support

KYTC is developing training resources and support systems for construction and design staff. Construction feedback will underpin design modeling guidance.

External Partners

KYTC's external partners include ACEC and KAHC members, utilities, peer states, and FHWA. DPD is helping the Cabinet advance multiple FHWA Every Day Counts initiatives. What distinguishes Kentucky is its strong industry partnerships. DPD is leveraging these relationships to facilitate collaboration between diverse stakeholders. KYTC's partners stay engaged in DPD through pilot projects, surveys, interviews, committee involvement, and email subscription.



Digital Data Sharing and the Lifecycle of Infrastructure Assets

8 Pilot Projects

Testing **2** New Software Options and Revisiting Existing Options

15 Objectives

3 DPD Core Staff

8 Section Offices

10 Designers

Contact:

Catherine Keathley

Submit questions to:

KYTC.DPD-QandA@ky.gov

KENTUCKY TRANSPORTATION CABINET

Appendix K DPD Notice Through KYTC Professional Services

Digital Project Delivery, Coordination with ACEC – Open Invitation to Consultant Engineering Firms

NOTICE:
As a part of KYTC's Digital Project Delivery (DPD) Initiative, the Cabinet is inviting Consultants and Project Managers to participate in a limited pilot program using existing KYTC projects and active consultant engineering contracts. This notice ***does not*** constitute a Request for Proposals for a Professional Service Contract.

Objectives:
- Demonstrate DPD innovation within existing KYTC processes using an existing project, with an emphasis on transferring design intent and project control from Project Development to Construction.
- Identify opportunities for updating design and construction workflows to improve efficiency.
- Explore tools that facilitate information exchange, collaboration, and the administration of design and construction projects.

The outcomes of pilot projects will influence KYTC policy changes and the agency's future implementation of Digital Project Delivery/BIM for Infrastructure. Interested consultants should prepare a two-page (A4 size) project summary that includes the following information:

1. Project Identification
    - Item Number, county, route, and project type.
2. Letting date (if one has been established)
    - Fall 2021 letting is preferred, but this criterion for pilot selection is flexible.
3. A statement of the current project status
4. KYTC Project Manager's (PM) name and a statement from the PM verifying that they support using the project as a pilot
    - Without PM support, pilots ***will not*** be considered for selection.
5. Experience with delivery of digital projects
    - Indicate level of experience on delivering digital projects.
    - Explain how the proposed project will be a good pilot for the Cabinet.
    - Discuss how the pilot exemplifies the use of proposed (as designed) Electronic Engineering Data (EED) to support construction project inspection and contract management.
6. Proposed scale of pilot work
    - Explain how the scope will be determined and if the work can fall under the scope of the current design contract.
    - If additional costs are anticipated, provide an estimate of the scale of that cost.
7. Recommended plan for pilot coordination and project-level implementation
    - Provide a brief implementation proposal for the project.
    - How will the pilot capture any challenges met and recommended solutions?
    - What level of proficiency will be needed among likely bidders - so they can successfully use the digital project data to fulfill their construction contract on this KYTC project?

Please send all requested information to Kevin Martin (Kevin.Martin@ky.gov) and Rachel Catchings, Kentucky Transportation Center (Rachel.Catchings@uky.edu), by **January 1, 2021**. Submissions will be reviewed by a KYTC interdisciplinary team. The team will then make project selections. KYTC has not established the number of projects that will be selected, but depending on responses, up to six are

anticipated. The KYTC PM will notify consultants if their project will be used as a pilot. Virtual meetings will be held with the selected pilot project teams to flesh out additional details.

Appendix L DPD Model Workshop 1 Summary — Boone County

Digital Project Delivery (DPD), Workshop 1 Summary

Pilot Project: Boone Co. Item No. 6-446 KY 237 (Pleasant Valley Rd) through KY 842 (Hopeful Church Rd) to Mall Rd/I-75 Interchange

KYTC Project Development and Construction staff identified techniques for using DPD tools and methods to manage the Boone County pilot. Due to high interest in DPD, 26 staff took part in the workshop (13 were originally invited).

Workshop Takeaways and Recommendations

Perspectives offered by workshop participants will be valuable for completing the Boone County pilot and guiding Cabinetwide DPD implementation. The participant comments have been fully catalogued at the end of this summary. Here are key takeaways and recommendations.

Many participant questions and comments underscored the importance of critical features of the DPD Initiative that have already been put in motion. Examples include:

- *Early and ongoing industry dialogue*
  - Idea exchanges between KYTC and industry partners (engineering consultants and contractors) began early and will continue throughout DPD implementation.
- *Discipline-specific dialogue*
  - DPD subcommittees have been established in three divisions: Right of Way and Utilities (two subcommittees), Highway Design, and Environmental Analysis. Committee members come from district offices, Central Office, and industry. Highway Design's CAD Section is identifying and addressing complications associated with switching to the model-based workflow of OpenRoads Designer. Committee recommendations for incrementally moving toward DPD implementation have and will continue to be forwarded through the Director of Highway Design to the Assistant State Highway Engineer.
- *Training and support*
  - This remains a focus of DPD. Training and support for KYTC staff have thus far included:
    - OpenRoads classes (enrollment open to KYTC and its partners)
    - Peer exchanges (interagency and internal)
    - OpenRoads modeling training specific to drainage features
    - Opportunities for software demonstrations
    - Formal presentations by digital delivery experts
- *Model viewing tools for non-CAD users*
  - DPD staff continue to seek viable solutions to this obstacle. Pilot projects will test different software options. KMZ files will become a required project development deliverable, offering a simple 2D geospatial option viewed readily with GIS software such as Google Earth.

Explore policy changes through specialized workshops to facilitate DPD implementation across KYTC divisions and business processes

- In the short-term, hold workshops focused on (1) the Division of Construction and (2) the Division of Highway Design's Plan Processing Branch and Construction Procurement Division (including the Estimating Branch).
- As DPD Implementation progresses, more KYTC Divisions can benefit from facilitated brainstorming to identify and plan for shifting to more digital processes.

DPD will benefit from routine messaging and increased interdepartmental communication.

- Before the event, we invited participants to reflect on the meeting objectives and brainstorm questions. They received web links to nationally recognized DPD resources from the FHWA and Utah DOT. Introductory meeting remarks included a DPD overview. Despite communicating DPD concepts directly to participants, some misconceptions persisted. Knowledgeability and understanding of DPD varied among participants. DPD staff addressed participant questions and concerns, but this delayed brainstorming and group discussions.

Shore up the integrity and functionality of existing processes before implementing process updates.

- Participants are frustrated with several data sharing and management systems:
  - Data Sharing — Participants find housing of project files in Projectwise inconsistent and cumbersome.
  - CAD Standards — For projects that reach construction, the quality of project files varies. Construction and field survey staff are uncertain of how much they should rely on data contained in the files.

Cabinetwide DPD implementation will yield full asset lifecycle management efficiencies.

- For some participants, the potential of DPD was readily apparent. Participants gave suggestions for connecting as-designed data to as-built data.

DPD implementation requires modifying affected Project Development processes.

- Professional Services contracts and standard production hours should be evaluated and updated for DPD workflows. Project size and scope are relevant to the updated scope and contract terms.
- Project Development milestones (e.g., Preliminary Line and Grade, Final Joint Inspection) need to be adjusted so the project team can review plans in 3D format. The traditional meeting format must be modernized.
- Plan Processing staff will need training and support if they are to mark up project files that are no longer available as PDFs.
- Designers must be engaged during the Construction phase. This represents a departure from standard policy and professional services contracting.

Contract details found in PDF plan sets will have to be accommodated elsewhere in the final contract documents.

- Participants cited examples such as Q&A from the letting process (which becomes contractual after letting), bid items and quantities, plan notes.

Workshop Structure and Question Prompts

To accommodate the large number of attendees, the workshop was divided into two sessions. Both were held virtually and took place on April 13 and May 11, 2021. Sessions opened by reintroducing DPD and reviewing key project details. Participants were divided into three discussion groups. Each group tackled different questions looking at the intersection of DPD and project delivery. One group examined DPD from a design or Project Development perspective. The second group answered questions related to Construction Procurement and letting, and a third group focused on Construction phase project management.

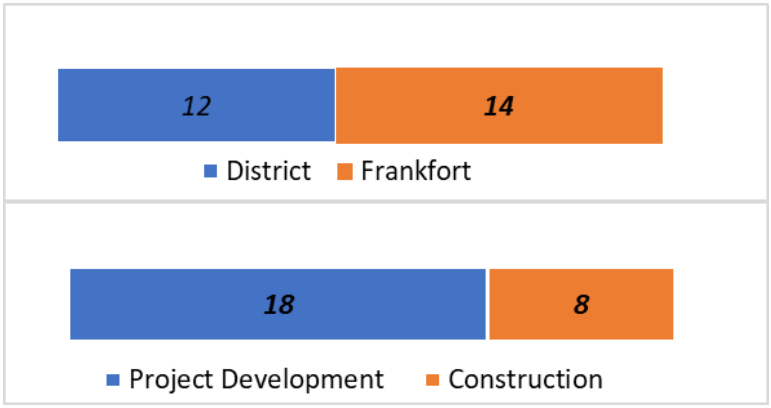


Figure 1 DPD Workshop Demographics

Participants were given question prompts:

(Project Development Breakout Group)

1. What policies and process need adjusting to implement Digital Project Delivery in design/construction procurement/construction?
2. What activities are necessary for Project Development to deliver digital plans on this project?
3. How much detail should the 3D model have, whether in general or specifically for this project? (What are the best practices related to this project type or construction work items specific to this project?)

(Construction Procurement Breakout Group)

4. What does it look like when the contractor is responsible for the delivery of a project with only digital versions of the plans?
5. How does the Construction Procurement Process change for this project?
6. How does the Electronic Plan Room need to accommodate Digital Plan Delivery for this project?

(Construction Breakout Group)

7. What do KYTC inspectors need for daily inspection on this (digital) project? (For example: specific types of data, opportunities for peer exchange or formal training?)
8. What do KYTC inspectors need when field verification of the work requires survey-level accuracy?
9. How will KYTC staff process field changes when working from digital plans?
10. How do construction progress meetings change with the implementation of digital plans? (For example: Should the designer be involved?

Participant Data

Questions and ideas for DPD implementation submitted by workshop participants are categorized into nine thematic groups:

1 Business Services and Contracts
2 Field Survey Data (Existing and As-Constructed)
3 Conveying Design Intent Without Conventional Plan Sets
4 Process Changes
5 Data Organization and Storage
6 Data Sharing
7 Software/Hardware
8 Training and Support
9 Field Implementation During Construction

Questions asked by participants that relate to DPD solutions already being implemented are included and formatted as follows: (NOTE: __)

1 Business Services and Contracts

- Contract and Contract Hours for consultant design—more work to start, but eventually less. What are we asking and how we are asking them to do it?
- What deliverables are we requesting from our consultants? Specifically:
    - What do our contractors need to build this item? Is this model enough? Is the list of items enough to bid the project? What do the contractors need from the designers?
    - What are we expecting the consultant to give us during Phase 1 and/ or Phase 2 – what is their deliverable?
- Work with Professional Services to define scope for DPD project.
- Can 3D models become the legal construction contract? (Currently supplemental information for bidders)
- File types- industry input; what would help them? (NOTE: DPD and KAHC have and continue to communicate regarding the DPD initiative.)
- Will KYTC lose out on DBEs by taking the automated route as they may not have this equipment?
- Construction and design contracts are very different, but what about using contract language like the time-dependent penalties in construction contracts in order to ensure the designer is available for the lead-up to letting as questions are fielded and last-minute changes are made? (NOTE: This is a change that could be independent of DPD. For the DPD pilots, KYTC leadership has committed to providing a means for the designer to be involved within the Construction phase.)
- What to do with potential changes to design files after the consultant submits them? Legality of versions should be addressed. (NOTE: DPD group has and will keep talking with ACEC about this issue.)

2 Field Survey Data (Existing and As-Constructed)

- What will we require for surveying of existing ground? Lidar? More accurate data if we are depending on data to build a model. Need a wholesale look at existing terrain. Level of surveying accuracy is also important.

- Drone surveying capabilities in each district will be needed for construction inspection. (NOTE: Drones are currently being explored within KYTC as a construction inspection tool and a tool to gather as-builts.)
- Would this focus on survey crews or designers? In-house expertise varies between districts and section offices.
- Is KYTC willing to pay for training to help staff obtain drone licenses? — Consider how often staff will be using drones in the field (daily, weekly, monthly) when discussing this question. (NOTE: Training and support are priorities of the DPD effort and planning is underway.)
- How will as-built drawings be prepared? Is this something the designer will assume responsibility for? — This option might be the best fit to complete work. (NOTE: KYTC is presently testing Digital As-builts on several pilot projects.)

3 Conveying Design Intent Without Conventional Plan Sets

- Need to make sure that we have the correct data, plan, and profiles. The plan data must be accurate and free from anomalies, such as errors between stations or problematic tie-ins.
- When a contactor bids on a project they rely on plans — some prices could depend on accurate identification of, e.g., low clearances — how are these integrated into 3D plans?
- Minimize items that are put on plan sheets, are construction notes necessary on the plan sheet? Put them on a side report rather than on the plan sheet.
- How is the MOT conveyed and presented through this process? — Designer would potentially be able to run a new MOT scheme to determine whether it will work
    - Need to know that work can be phased properly, and traffic maintained (how is this depicted in digital plans?) — may need different models/layers for different construction phases
- Notes with plan set that can't be captured in the model, must be in the proposal. The proposal becomes even more important to capture nuances.
- Material listing is in Excel (bid item listing) presently. (NOTE: Within DPD, this will remain necessary to support AASHTOWare functions.)
- MOT cross sections (3D) are extremely helpful; can vary based on project type.
- KMZ files are useful to convey design intent. (NOTE: DPD has identified KMZ files as a useful tool and DPD Subcommittees recommend the KMZ become a required deliverable of Project Development.)
- How will "Do Not Disturb" areas be delineated when using digital delivery? Will these areas be annotated within the 3D model or elsewhere? (NOTE: Right of Way and DEA Subcommittees have the same concern and DPD offers solutions within Electronic Engineering Data, or EED.)
- Are they (contractors) supposed to move back and forth between digital and paper (pdf) delivery products? (NOTE: Until DPD is fully implemented, some pdf formatted plan information will be necessary as a supplement to the EED.)
- Consideration of a format for mid to smaller size contractors and DBEs - Provide supplemental info in 2D to potentially alleviate this issue.
- Questions and Answers during advertisement are also critical information that becomes part of the contract with the highest precedence. This contractual information will have to be included within DPD contract documents.
- Hierarchy of contract documents (from spec book) will need to include DPD files. For example, Q&A at letting take precedence over standard drawings.
- How would contractor bid on 3D documents? (NOTE: Industry has been and continues to be engaged in the DPD Initiative.)

- A proposal document will still be needed for notes, permits, ROW certs, etc. that would not be part of 3D models.
- Where will the General Summary and Typical Sections be located? These are often the focus of Plan Processing markups. These would likely be separate documents from the 3D design files.
- What will be included in a digital bid package?
- How will estimating quantities and takeoffs performed by the KYTC Estimating Branch be handled?

4 Process Changes

- Design Executive Summary (DES)- do we still have to document the engineering process? (NOTE: DPD implements a common data environment…changes automatically update and so does the documentation. Still need a mechanism for approval and legal purposes.)
- Projects typically designed and then moved to plans — How does the current PD process need to change to allow for reviewing projects in a digital format?
    - What type of learning curve is involved for those with differing levels of expertise in CAD software?
    - Will it be more difficult to pick out design flaws? How will the review process differ from current process (looking at a 2D plan set)?
    - Process changes will have to occur within Project Development — this is a new method of accomplishing tasks.
- Can envision larger projects being better suited to digital delivery than smaller projects, which tend have a lot more nuances and potentially more environmental complexities.
- Think about how the Cabinet will handle questions from property owners and stakeholders (e.g., Traditionally, staff print out plans or details to show property owners. How will this work with DPD, using a 3D model?)
    - Need to communicate clearly with those stakeholders.
    - Project managers note success using GIS and KMZ (Google Earth)
- Difficulties in establishing and maintaining a feedback loop from construction staff to designers; keep PM engaged throughout construction. (NOTE: With KYTC leadership support, DPD provisions will include contractual means of holding consultant designers' contracts open into construction for this reason.)
- Bridging gap among internal KYTC; design staff being involved in construction procurement process (& construction) has helped in KYTC design-build projects.
- Construction Procurement (CP) is already electronic; that shift was made complete within the last year.
- CP most generally passes files received from Plan Processing directly to Lynn Imaging for the Electronic Plan Room. This could continue for DPD with little change.
- Assuming that Digital Project Delivery means new file types would be added, compatibility of file types would only be an issue if the files had to be opened within CP.
- Will contractors have to download entire new file sets when any change is made? Currently they just retrieve affected pdf plan sheets.
- How can changes be noted within a 3D plan file – what is the comparable means to the present use of a red cloud around addenda changes?
- How do we deal with last minute changes? (big question) CP sees the largest hurdle being the lead time for making changes and addenda to the bid documents. This is extremely time sensitive. For DPD, the designer would need to be especially (contractually?) accessible and able to adjust the digital plan information within a prescribed timeline that supports the letting

process. This is also a major question and concern for Plan Processing because they often find themselves asked to adjust the plan documents (pdf plans or cross sections). DPD needs to manage questions and last-minute changes so that those are integrated into the plans (files) and released in a timely fashion.
- Mark ups are generally on bid items, typical sections, and notes. Will check prints and mark-ups be done on the proposal documents only?
- Need for high quality in digital design plans for this to work. Where within KYTC will that quality be checked? Currently wide variations in project type and plan quality exist.
- How will this work with bridges? (NOTE: OpenBridge Modeler is Bentley's answer to the software component for structures. This will be piloted through cooperation with the Division of Structures.)
- Estimation staff assign prequalification types for bidders. They currently do this by review of the plan information, such as for bridge span lengths. How would this be done through DPD?
- To make this work, we need to understand and resolve the "nuts and bolts" issues of how this will transition from design to CP and so on.

5 Data Organization and Storage

- Archive the engineering process in ProjectWise—connect the as-designed data to the as-built data.
- Archival of data—where is this data going? Storage and what does that storage look like are issues to resolve.
- Consistent file-naming conventions will aid implementation of DPD and minimize confusion.
- How will data within DPD be searchable? For example, historical bid info is traditionally catalogued and retrieved based on categorizations like type of bridge or span length. This affects the Estimation Branch directly, as well as other project estimating functions.

6 Data Sharing

- Consultants, Project Managers and SMEs need to have a central data folder to work in. Currently, no sharing.
- How will data get into ProjectWise from consultant for internal use by KYTC staff?
- How do Design Project Managers get data to Subject Matter Experts -SME's?
- How do we communicate with utility companies? Other outside partners? (NOTE: A Utilities Sub-committee for DPD is active and includes utility company representation. Challenges to DPD implementation are being identified so that solutions may be developed.)
- Value in utilities (not only horizontal, but vertical as well) as part of the model to save costs
- Lack of timely information on utilities is problematic and could affect how much detail can be included within the digital plan information (unless adjustments can be made to the current process.)
- Different utility companies with different plans often occur on the same project; have to integrate multiple plans and often end up with conflicts between utility companies. This challenge would also be faced within DPD.
- Currently only 1 utility consultant using 3D.
- Potential to end up with multiple plan sets for utility relocations.
- Utility companies allowing road design to complete their plans; makes 3D more feasible
- Problems with utilities using their own consultants; using MicroStation for now (NOTE: KYTC doesn't have means of dictating software or utility design methods of utilities.)
- 3D potential among utility companies may vary across district (and even counties)

- What about overhead utilities? Usually not in plans, relocations done ahead of time only included for contractor info
- Water, sewer, and gas potential for 3D to improve processes and efficiency. (NOTE: Appropriate modeling of underground resources is a focus of the Utilities Sub-committee for DPD.)

7 Software/Hardware

- Participants who manage projects would like to have the benefit of a single, comprehensive app that can be opened, views digital files, and is used to carry out all work related to construction management. (NOTE: Presently, AASHTOWare doesn't offer this compatibility, but this objective is still valid.)
- Quick navigations between plan sheets and cross sections would be helpful. (NOTE: A 3D model essentially displays both, simultaneously.)
- Ability to view adjacent sections quickly (e.g., 49, 50, 51). (NOTE: Viewing digitally formatted projects, including adjacent projects, is basic functionality common to several software options currently under consideration by KYTC.)
- Ability to pull quantities for the day's work (e.g., quantities for cross sections; earthwork quantities in a table relating to the construction accomplished within a given day would benefit those required to track this).
- Software apps that easily communicate with one another would be ideal. (NOTE: Several software options are under review.)
- Simplified user experience for inspectors in the field (e.g., iPads). (NOTE: Equipment inventory and needs have been a focus for DPD and will continue to be tracked. Initial deployment of resources may correlate with pilot projects before statewide needs can be addressed.)
- Method for flagging changes that are made in the field (in an app).
- Clear and seamless file-sharing method within any application/software for field use.
- Barriers that currently exist to using GPS rovers include:
    - Staff training/support is needed to aid with file conversion/getting information in a usable format for field survey equipment, in addition to loading the information into the rover
    - GPS not currently being used as a survey-level device by the Cabinet
    - Field survey staff are often uncertain about which files within ProjectWise are intended for construction use and which are outdated.
- Hardware availability/logistics in the field (accessible to large portions of the crew)

8 Training and Support

- Identify training needs for platforms that are adopted (NOTE: Training and support will be offered for software piloted and/or adopted through DPD.)
- Will inspectors be kept up to date? — Need to get them on board. Some in-house inspectors will require training. (NOTE: Training programs and vehicles for supporting field staff are important components of DPD that have been identified and remain one focus of the DPD group.)
- Design engineers may need training on some of the techniques for automated machine guidance (AMG)
    - Lack of knowledge on how it is implemented in the field
- How do you know that they person opening a file won't mess up the model??? What level of training and access do people need to access Bentley OpenRoads Designer (ORD) or OpenBridge Modeler (OBM)? Methods other than CAD software are needed for non-CAD users. (NOTE:

Options for non-CAD users are under study and KMZ files offer one solution that is user-friendly.)

- Will DBE's be put at a further disadvantage? KYTC will need to keep them in mind as they select a vendor to manage the data. (NOTE: DPD staff remain in communication with KAHC. Smaller and DBE contractors' perspectives remain a focus.)
- Training and access to OpenRoads Designer (ORD) will be needed by Plan Processing and Estimating staff. Or these staff need reviewer tool that allows reviewing the design outside of MicroStation and ORD. (NOTE: Several such tools are under review for piloting.)

9 Field Implementation During Construction

- Develop a list of items that will be implemented in the field (not all contractors will have the same capabilities)
- Will this be a huge change for a crew leader or superintendent, who will have to look at these materials on a laptop/tablet?
    - Larger contractors are moving in this direction — foreman, superintendents use rovers for checks. Also want to move away from staking. Paving operations not there yet — still traditional in their approach.
- Challenges with utility companies working on relocations (NOTE: The Utilities Sub-committee for DPD is tasked with oversight of this subject. Utility owners' feedback and process improvements will remain a focus of this multidisciplinary group.)
- Potential learning curve with building structures from 3D models.
- Training and access to Open Roads Designer (ORD) will be needed by Plan Processing and Estimating staff. Or these staff need reviewer tool that allows reviewing the design outside of MicroStation and ORD.

Appendix M DPD Model Workshop 2 Summary — Grayson County

Digital Project Delivery Workshop 2

Pilot Project: KY 3155 William Thomason Byway Extension, Item No. 4-8954, Grayson County

This meeting was held June 8, 2021 (via Zoom)

Project Details:

The new route has been designed with a rural, cross-country template except for one section near KY 259 which will include curb and gutter with storm sewer systems. Truck volumes are anticipated to be high at this location. The project includes work to provide a grade separated crossing for an existing T&L Railroad at-grade crossing. CSX is aiding T&L with the plan review and coordination. The railroad alignment is being moved to allow continuous rail use during construction as well as the new crossing configuration. The railroad will install its own rail after the structure has been constructed via KYTC construction contract. The structure design is KYTC (Earl Downey) via OpenBridge Modeler (OBM). The project is presently scheduled for February 2022 letting, but Brad advises that a later 2022 letting is more feasible.

Project Development Questions

1. Should CAD standards vary depending on project scale and/or construction work item?
    a. How do we define new CAD standards?
    b. How do we define a new scoping policy?
    c. What is the Level of Development (LOD) required from Design?
    d. What are the best practices related to the project type or construction work item?
2. What type of changes will be needed for design end-products or the deliverables that are handed off to construction?
3. What activities are necessary for Project Development to deliver digital plans?
4. How was the ground survey completed/compiled? Has it been verified and rectified? Is it accurate enough for DPD?
5. How "developed" is the design model? RR Bridge Model? Will this project be MALD or some hybrid (needed for consultant scoping right off the bat)? If MALD, what will be the method for signing and sealing the design files (data)?
6. What, when and how are the deliverables handled? Will the FJI for the project be formatted differently to allow for model review? Is the current Electronic Engineering Data (EED) policy sufficient to address this part of the consultant contract?
7. A Connected Data Environment is to be piloted on this project (Quadri) and will impact the way data is exchanged. What processes and staff needs are of concern as this software is tested?
8. Who are the Project Development Stakeholders that will need to leverage the design data? (e.g., Railroad, environmental)
9. How does the consultant contract and Project Development process need to adjust to retain active designer involvement within the Construction phase?

Group Discussion, Project Development (PD):

Brad Bottoms

Jason Littleton (AEI)
Patrick Stone
Patrick Perry
Derrick Dennison
Kevin Hodge
John Sudduth
Kevin Martin

Survey

1. Existing survey is a mix of aerial LiDAR (Quantum Spatial) and GPS survey (AEI). Project Team feels the survey needs to be verified in an area just west of the landfill, where trees may have obscured the ground. Reports of how the survey was collected and associated confidence level will be provided pre-bid.
2. Based on what other DOTs do in practice and what is recommended for digital delivery projects, it is recommended that during pre-construction meeting the contractor's surveyor and a surveyor representing the DOT shall meet and review the existing ground survey and agree on the quality/accuracy.
3. D4 Construction recognizes that when they are inspecting with GPS rovers, they are not using the same software as the Contractors. This pilot should stipulate that Trimble Siteworks will be used on D4 GPS controllers to be equal to the contractor.

Project Development Collaboration

1. Stakeholders that will need access to model data prior to the Letting will be exclusive to Utility companies and their Engineering consultants. The PM will coordinate a utility meeting to discuss the pilot project and the Quadri CDE so the level of engagement with the utility companies in the digital environment can be determined. AEI has offered to mentor their consultants to get 3D utility model data.
2. AEI agreed to also create a drainage and utility model, incorporating the proposed drainage with the existing and proposed utilities.
3. Quadri shall be the piloted Connected Data Environment (CDE). AEI will store the design files of record on their servers but will provide "delivered" files (models) in the Quadri environment for final inspection and procurement. These files shall reside on AEI's servers through Construction until KYTC shall physical ownership of the data for an as-built.
4. The engineers for the RR (P&L/CSX) have already received structure plans from the Division of Structural Design. Brad Bottoms will try to reach out to the engineering consultant that works for the RR and schedule a coordination meeting to discuss what digital information they can access to do their review. But at this time, the review is being done from the R/W Plans.
5. R/W Plans were submitted using SS2 and PDF plans set. These shall remain as such. After there are no more R/W revisions, AEI will convert the project to ORD and ensure the model is detailed enough. See next section for LOD information.

Level of Development

1. AEI has designed the project using InRoads SS2. After it is determined that there should be no more changes due to R/W Revisions, AEI shall convert the project to ORD.

2. The Level of Development for the roadway model was discussed.
    a. Template drops shall be:
        i. 10’ spacing in tangents
        ii. 2’ spacing in curves and more detailed areas such as intersections
    b. Care shall be taken to develop the model for approach roads and their subsequent intersections.
    c. Entrances do not need as much modeling detail.
    d. As previously stated, AEI has agreed to take the beta Drainage & Utilities configuration (or the current delivered configuration at time the model is created in ORD) and build an underground model for clash detection during the final inspection. This shall also involve existing and proposed utility data to an appropriate Quality Level. This may be C or B if the proposed utilities are not designed in 3D.
    e. Earthwork and paving quantities, at a minimum, will be calculated using component volumes as opposed to End-Area Method. AEI agrees to use the new beta configuration of ORD that contains Item Types and test out Quantity Harvesting using the model and associated Feature Definitions.
    f. A final estimate shall still be provided using Estimator.
3. The Railroad Bridge has been designed by the Division of Structural Design. A bridge model was created using Bentley’s OpenBridge Modeler software. Further discussion with the Division of Structural Design will scope the LOD for the bridge. It is the desire of the DPD Team to achieve LOD 500 and use the models for fabrication.

<u>Deliverables</u>

1. The Project Team has decided that the bulk of deliverables for both the final inspection and the Letting shall be DGN files that follow current CAD Standards for file naming and federation of data.
2. The DPD Team shall investigate various means and methods for signing and sealing the DGN files.
3. Proposal information shall still be required in PDF format as usual and will be linked in some way to the Quadri environment. Continuing to work with Trimble on details.
4. The Project Team recommends to not supply traditional plans. If something can be communicated in 2D without being in the model (simple traffic control, notes, Erosion Control), AEI will supply large format PDFs with minimal detail and annotations.

<u>Model as the Legal Document (MALD)</u>

1. AEI and the Project Team agree that the project shall utilize the model as the legal contract document. Anything less is not in line with DPD.
2. Structural Plans shall be investigated for MALD but will be left up to the Division of Structural Design to decide what will govern contractually.

<u>Consultant During Construction</u>

1. The Project Team recommends that a further discussion with Division of Professional Services be held closer to the Letting to determine how to mod the contract with AEI to provide consultant services during construction.

2. The Project Team recognizes that due to the difficulty in scoping hours for Construction Revisions, a cost-plus approach may be better.
3. Closer to the Letting, AEI shall propose a plan for addressing any changes during construction, including but not limited to:
    a. Time to correct the model for a design error or omission.
    b. Time to correct the model for a VE proposal.
    c. Protocols for communicating changes and updates to field staff for the Contractor and KYTC inspection.

Construction Questions

1. What data would improve inspection of contractor activities for KYTC Inspectors? The new design workflow offers much more accessibility to design details than pdf plansets. Without holding to traditional plan details, consider what data might support daily inspection.
   Follow up: What level of detail, or accuracy is needed for each of these data sets? Within DPD, this is termed "Level of Development (LOD.)" This accuracy level would be conveyed within the bid documents for bidders' information.
2. What tools (software and/or hardware) would improve inspection of contractor activities for KYTC Inspectors?
3. Are there any gaps in construction inspection due to reduced personnel and/or lack of experience that could be improved by technology?
4. What data/tools/training would improve a construction engineer's ability to oversee a project?
5. How could this project serve as a pilot for "Model as the Legal Document (MALD)" or some hybrid (needed for consultant scoping right off the bat)? If MALD, what will be the method for signing and sealing the data? How will the hierarchy of contract documents be managed?
6. How will the Digital As-Built be collected and archived? Who should be responsible for this effort?
7. A Connected Data Environment is to be piloted on this project (Quadri). What processes and staff needs are of concern as this software is tested? Who should the 25 pilot licenses be assigned to? (contractor, AEI, etc)

Group Discussion: Construction

Paul Sanders
Bow Warren
Chris Smith
Kevin Pierce
Ryan Gossom
Therese Wimsatt (AEI)
Peter Overmohle (AEI)
Adrien Patane (Trimble)
Catherine Keathley
Rachel Catchings

Bow raised concerns about availability of GPS when satellites are out of range. Kevin Pierce, an inspector with survey experience, has found that reference points are necessary for occasional inconsistencies with the survey experience. He asks for updated GPS equipment prior to construction. Tools that allow for viewing the full model would be helpful. Ryan suggests lidar and a drone for monthly checks would be helpful. Bow suggests apps that work from an iPad are not accurate enough

for field verification that is under tighter control and for which acceptance tolerances are required. Peter offered AEI could provide lidar during construction via drone. Chris Smith suggested photogrammetry could be used as well, and this would offer cut/fill progress checks. (NOTE: The PD breakout also discussed this, and Kevin Martin wants to make sure construction has what they need. Brad stated that they have received commitment that resources will be provided to field staff.)

Construction staff request that model information offer related specifications and requirements as the field staff called up data from the model. Linking to reference documents is a goal and will be considered with Quadri. Standard Forms and paperwork being linked would be a great help. One example form is the Piling Report. Ryan suggests one-drive/ProjectWise and construction resource center page. He has 40 GB on his account. Catherine notes that some pdf forms have been made fillable. Ryan uses Bluebeam on his iPad and uses it for marking up 2D plans. His account is paid personally. BlueBeam on desktop is available to Construction. iPad compatible BlueBeam software is separately obtained and not widely available to construction staff at this time. (Ryan purchased his with personal funds.)

Ryan has seen some consultants offer details within separate tables and that has been helpful. (NOTE: Component quantities will be used to develop quantities for bid items directly from model information as much as possible. Structure design will be further discussed with KYTC Structural designers.)

Bow asked how MOT would be conveyed and how phasing would be considered if the project is entirely within a model. Peter thinks pdfs will still be necessary. Temporary ditches and slopes are drawn by hand. (NOTE: From PD group – phasing sheets for this project should be sufficient, but US 62 where part width construction occurs will be modeled. An MOT review will occur and will use Quadri. Training via HDR for 3D model review is being developed. Bow agrees that for the most part, the more complex areas would need to be modeled. May want KY 259 English Street or KY 54 temporary widening detailed. AEI will forward some right of way plans for a determination on which areas Bow/Construction wants modeled.)

Bow agrees that consultant needs to be available throughout construction and AEI will have to have contract capability to do so. Ryan said that Michael Baker was kept on and available on “the bridges” project. Bow said Peter was used to being available, because of a prior DB project.

Catherine noted that section staff buy-in is important. Ryan suggests that Rent-a-Tech consultants be consulted about QC/QA with DPD. He encouraged reaching out to Tim Adams to see what else is being done by contract inspection firms nationwide.

Chris noted LandXML format is used by contractors, and he notes a known issue with triangulation for Trimble and Bentley. Kevin was concerned whether state and contractor would be using the same information. Catherine asked Adrien if he could address this question. Adrien stated that parts of the model can be locked. He says legal document can be locked but sharing and commenting is available to users. Prior to bid, questions can be fielded and addressed. Triangulation is always different between packages. He calls out differences in accuracy and densification that exist and will not be corrected with Quadri. (NOTE: Template drops were handled in PD breakout. Jason notes that site versus corridor mentality works best for appropriate modeling workflow. Peter notes that contractor methods during paving relate to these issues.)

Kevin Pierce asked about equipment available to field staff. Catherine explained the D1 project staff receipt of surveying equipment upgrades. She highlighted some Bluebeam limitations. D4 has a two GPS setup R10 and a R8, in addition to a handheld. Kevin wants to know how much live information will be available to him onsite. One example is drainage feature details – Chris states that drainage modeling is pretty far along. Peter says currently they don't model drainage but would be willing to do that. The group discussed Level of Development concepts as they relate to digital delivery and the level of effort put into parts of the design. Bow is concerned about a loss of design accuracy in moving from pdf plansets to digital delivery.

Peter brings up relocated utilities as a question of modeling level of accuracy. Bow thinks relocated utilities should be required to provide model-level detail. Bow believes different areas are more critical than others, such as utility poles that are in critical locations. (NOTE: This topic was also discussed within the PD group and the composite group. Peter asked about AEI assisting with utilities. Brad says he doesn't know at this time whether utilities will be included in the roadway contract. Brad may set up a meeting with underground utility engineers to see if they could work with AEI to integrate their information. Brad states any relocation is conducted ahead of construction needs good as-builts. Bow suggests that the greater impacts a utility error makes to the roadway, the greater the need to return that cost to the utility.)

Kevin asks about liability and doesn't want to be held responsible for limitations of staffing. He would like to have a rover at all times to be able to verify construction. Kevin states that reference control points are too far apart nowadays and is uncomfortable using the GPS for consistent accuracy. Kevin wants to make sure the GPS doesn't negate the tolerances that are required per specifications. They generally use a base station, instead of the CORS network. Peter reminds the group that monumentation must be established on a project through the design contract. Ryan states that a Shelbyville project he had did NOT have a base station on the project. He believes that a base station ought to be set up on each project. Kevin says that a base station is available to use on this project. He states that battery problems are occurring and may need to be addressed.

Kevin states onsite training would be helpful, as would a means of peer exchange of information. Bow suggests a laminated cheat sheet for survey steps. Derrick has helped Kevin by making his own step by step instructions for inspectors. Catherine offered a refresher could be a good method. Ryan would like to see the drone used increasingly. Two per district could be a good number, in his estimation. Licensing was a barrier that Chris identified. Catherine noted the D8 project for drone use is underway to compare some drone software methods/tools.

Ryan suggests specialized tablets may be a good solution. Bow notes that using the model on existing hardware, even in the office, is a concern. Hardware limitations exist, have been identified and will be brought to leadership's attention.

Peter questions what is required for an as-built? Catherine asked Ryan about any existing guide for as-built information. Bow refers to the construction guidance manual for requirements. Catherine wants to know what information is gathered and best practices for how the information is captured. Mark Walls may know about what has been changed. Ryan states that a note in the contract would be a good place to address the expectations for what as-built information is collected and how it's delivered. Ryan believes a special note was used on the lake projects to require an as-built deliverable (throughout the project). Ryan has the full data package for that project, and he saved it to PW. Kevin believes it's too

person-intensive to gather as-builts and having the contractor capture that continuously is the best solution. Ryan believes this solution also aids the limited staff resources faced by most offices. (CID 141279 D1 Item 1-180.60 Palmer and MB is a good example, but the project was high budget.) Ryan believes the intent for Bluebeam in the section offices was for as-built (markups of the pdf plan set). Ryan likes the idea of having AEI maintain the as-builts throughout the construction phase. Peter offers again Lidar and scans as needed. Ryan states pipe as-builts are still needed and would have to be done separately from a drive-through lidar scan. (NOTE: From the composite group discussion, it was stated that as-built responsibilities on this project have yet to be assigned. Brad would expect the contractor to develop as-builts as an ongoing effort. Derrick is currently doing this and doesn't see the contractor performing the same quality level.)

Group Discussion: All Meeting Participants

Model as the Legal Document is being discussed for this project. AEI will retain design files through construction within Quadri.

Primary point of contact for AEI will be Jason or Therese, but this could change post-letting.

The meeting adjourned at 12:30 pm EST, after 3.5 hours of discussion.

Appendix N DPD Pilot Project Implementation Plan Template

PROJECT:
ITEM NO., COUNTY, CONTRACT ID

DIGITAL PROJECT DELIVERY PILOT PROJECT IMPLEMENTATION PLAN

Version 0
Month, Year

DIGITAL PROJECT DELIVERY (DPD) AT KYTC

The DPD Pilot Program supports KYTC's efforts to provide streamlined digital deliverables from Project Development through Construction. Testing 3D design models and using design data on pilot projects will yield opportunities to improve efficiency. KYTC selected this project for the program.

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3. Project Team and Stakeholders 2
4. Pilot Project Objectives 2
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8. Software and Equipment Inventory 6
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PROJECT DETAILS

1. Pilot Project Description and Scope

Describe this project's purpose, including the type of work and locational context. List challenges associated with the project, such as utility impacts or complicated construction phasing. Explain why and when the project was chosen as a pilot.

2. Project Milestones and Schedule

List design milestones, anticipated construction letting date, contract completion type (e.g., working days, completion date, calendar days) and construction duration (if available). Once construction begins, document the percentage of the construction contract complete (as needed).

-
-

3. Project Team and Stakeholders

Name	Representing	Contact Information
	KYTC Project Development/Design	
	Designer	
	KYTC Construction/Section Office	
	KYTC Construction/Section Office	
	Contractor	
	Subcontractor	
Catherine Keathley	Digital Project Delivery Core Staff	Catherine.Keathley@ky.gov
Corinne Willmerdinger	Digital Project Delivery Core Staff	CWillmerdinger@ky.gov
Rachel Catchings	KTC Digital Project Delivery Core Staff	Rachel.Catchings@uky.edu

4. Pilot Project Objectives

Edit as necessary, removing objectives that will not be tested during this pilot. Objectives must align with project team goals. List specific knowledge, skills, and abilities that KYTC staff will gain from the pilot project.

1. **TRAINING AND SUPPORT**: (All pilots) Digital Project Delivery (DPD) core staff will directly and indirectly (coordinate) aid in mitigating obstacles. Core staff will identify, relay, and document information about obstacles met and unmet. For example, if existing technology (hardware and software operating systems)

are incompatible or insufficient to support construction-phase use of Electronic Engineering Data (EED), DPD core staff will relay this information to appropriate personnel.

2. **DESIGNER AVAILABLE DURING CONSTRUCTION**: (All pilots) Project designer availability within construction phase will be formalized through professional services contract under the guidance of KYTC Project Development staff.
    a. Consult Professional Services when developing terms of this agreement. Because projects occur within unique contexts, tailor the scope of this effort to the project context. For example, a pilot that entails software testing may require more person-hours from the consultant than a pilot that does not involve software testing.
    b. Involvement of the project designer following the award may include progress meeting participation, construction updates to design data (e.g., proposed DTM), and change management.

3. **DESIGN DELIVERABLES:** (All pilots) KYTC Project Development staff will be able to create (or receive from designer) useful Electronic Engineering Data (EED) for transmittal to construction staff. Project Development staff will be able to judge the completeness of the EED, including:
    a. Current KYTC CAD Standards requirements
    b. KMZ (GIS formatted) project information
    c. Manuscript-style PDF file of plans
    d. CAD Standard files converted to Trimble Business Center (TBC) file format
    e. Plan notes and quantities in PDF, Word, and/or Excel

4. **TOOLS FOR DAILY CONSTRUCTION INSPECTION:** Using KYTC provisioned technology (iPads, iPhones, laptops, desktops), KYTC Construction staff (*with daily field inspection responsibilities*) will be able to find, access, and use electronic engineering data (EED) for the project including:
    a. Current KYTC CAD Standard deliverables files
    b. KMZ (GIS formatted) project information
    c. Manuscript-style PDF file of plans
    d. Plan notes and quantities in PDF, Word, and/or Excel

5. **SOFTWARE TEST:** Using KYTC provisioned technology (iPads, iPhones, laptops, desktops), KYTC Construction staff (*with daily field inspection responsibilities*) will be able to find, access, and test use electronic engineering data (EED) for the project through a new software solution (Bentley Synchro or Trimble Quadri) including:
    a. Current KYTC CAD Standard deliverables files
    b. Software-specific CAD data exports
    c. KMZ (GIS formatted) project information
    d. Manuscript-style PDF file of plans
    e. Plan notes and quantities in PDF, Word, and/or Excel

6. **CONSTRUCTION SURVEY:** KYTC Construction staff (*with responsibility for field survey verification of the contractor's work*) will be able to find and upload files into available Section Office survey equipment. They will be able to perform progress checks of the contractors' work (i.e., spot-checking subgrade elevations.) Staff will be able to measure construction progress by comparing interim site-obtained construction topographic data to proposed, finished construction details (as found in the EED.)

7. **LEVEL OF EFFORT EVALUATION**: Digital Project Delivery core staff, in coordination with Professional Services staff, will be able to describe the scope of design deliverables that KYTC construction staff found useful. Core staff, through Professional Services staff, will offer this information to KYTC Project Managers for future project scoping guidance. For tracking purposes, DPD core staff will evaluate the production hours and terms of the Professional Services agreement(s) in relation to the EED construction personnel value, thus improving scoping decisions on future projects. Field visits and staff surveys may be used as DPD core staff garner feedback from KYTC construction staff. This evaluation should include but is not limited to:
    a. Relevant software issues (including licensing and versioning)
    b. Level of design effort and detail with respect to construction deliverables. For example, recommend modeling guidance specific to project types and work types (e.g., earthwork, drainage, paving), using feedback from the Division of Construction.
    c. Design changes initiated and tracked during the construction phase

8. **MODEL AS LEGAL CONTRACT DOCUMENT (MALD):** There are several options to pilot the Model as Legal Contract Document (MALD). The project context dictates to what extent MALD may be piloted. The proposed 3D model may be supplied as the single reference for bidding and construction management. Alternatively, proposed 3D design information may be provided in addition to the existing bid package, along with a Special Construction Note that adjusts the hierarchy of plan information to situate the digital model above other bid package contents. MALD piloting may provide opt-in or opt-out clauses in bid documents, so that piloting occurs only when KYTC and the contractor reach a post-award piloting agreement.

9. **DRAINAGE FEATURES MODELED**: Model drainage networks (including curb and gutter and storm sewer). Provide model details to construction management in coordination with the Drainage Section of the Division of Highway Design.

10. **UTILITY FEATURES MODELED:** Represent belowground utilities in the proposed 3D model. Provide model details to construction management in coordination with the Division of Right of Way and Utilities.

11. **GEOTECHNICAL INVESTIGATION INCLUDED IN MODEL DETAIL:** Represent details from the Geotechnical Report in the proposed 3D model. Provide this detail to construction management in coordination with the Division of Structures.

12. **STRUCTURE DESIGN MODELED:** Test Bentley OpenBridge Software. Model structure design using Bentley's 3D modeling software solution for structures. Coordinate with Division of Structures.

13. **LETTING WITH EED (NO PAPER PLANS FOR BIDDERS):** In coordination with the Division of Construction Procurement, test whether the Construction Procurement process is compatible with DPD file sharing — with and without ePlanRoom.

14. **DESIGN REVIEW TOOLS:** Amend latter-stage design review to make use of 3D modeling, especially where construction expertise is traditionally sought during design review (e.g., clash detection, maintenance of traffic, constructability). Non-CAD users may require software solutions that allow for this type of modern plan review. The scope of this objective should vary based on project characteristics and schedule.

15. **DIGITAL AS-BUILTS:** Develop and deliver digital as-built drawings of the completed project as a function of final project closeout. Explore options for developing, updating, and housing as-built data (e.g., responsible party and file format) in coordination with multiple KYTC divisions, such as Division of Operations or Division of Planning, as appropriate.

5. Deliverables (Design to Construction)

Edit list of deliverables according to pilot objectives, software/hardware inventory, and staffing needs.

Reference Plan Processing requirements and CAD Standards. KYTC Highway Design website: https://transportation.ky.gov/CADD-Standards/Documents/KYTC_CADD_Standards_Policy.pdf

- DGN Container Files (refer to KYTC CAD Standards policy for folder structure and file organization)
- Existing Manuscript and Proposed Corridor (.dgn files)
- EX Terrain, PR Finished and Subgrade and Geometry XML files
- Superelevation report (.xml file)
- Earthwork Calculations (.xslx file)
- Template Library (.itl file)
- Existing Manuscript and Proposed Corridor Graphics (.dxf files)
- Proposal information in PDF format
- Plan notes and quantities in PDF, Word, and/or Excel
- Large-format (manuscript style) PDFs of the proposed corridor that contain minimal detail and annotations
- GIS-compatible graphics (KMZ file)

6. Affected Partners and Processes

List KYTC divisions and external stakeholders or partners impacted by pilot testing that are not been listed above and which are not immediately responsible for project execution. Include approvers or regulatory agencies for which conventional information exchange will be altered. Modify example list below as needed. Include contact information as available.

- KYTC Division of Construction Procurement
- ePlanRoom vendor
- FHWA
- Railroad
-

7. Special Notes or Contract Terms

As needed, draft Special Notes that detail pilot procedures and responsibilities. Prepare for the mandatory pre-bid meeting if the project team deems it appropriate.

- Special Note
-

8. Software and Equipment Inventory

List construction inspection staff equipment. Include survey equipment, desktop computers and laptops, tablets and cellular devices, and software. Give consideration to the availability and reliability of cellular service in the vicinity of the project site. Depending on the project context and pilot objectives, it may be necessary to set up wifi hotspots.

- Equipment
-

9. Terminology and References

Include specialized terminology and references if the project team determine this information is necessary in the implementation document.

The following definitions and abbreviations apply specifically to this KYTC Digital Project Delivery Pilot.

Model/surface-is a 3-dimensional depiction of the project to be built.

Our models are created in InRoads and will have the file extension *.dtm. A DTM is a “triangulated irregular network” that also has feature lines from the modeling process that are treated as breaklines.

Breakline-in InRoads, a line which cannot be triangulated across.

Feature-an InRoads term for parts of the model

A feature can be a breakline (i.e. EPs, CLs, ditch lines), a random feature (ground shots not associated with a breakline). Random features can be triangulated across. Features can also be classified as contours, interior and exteriors. Interiors do not allow triangulation inside that feature, and exteriors do not allow triangulation outside that feature. Contours would be simply contour lines.

The use of features and breaklines in InRoads is one example of how Construction’s input should be used to match the level of design effort to the acceptable field tolerances on a final project.

Longitudinal Feature-a feature parallel or semi-parallel to the horizontal alignment. Longitudinal features include EPs, CLs, curbs, gutters, ditches, etc.

Transverse Feature-a feature perpendicular to the horizontal alignment. If included, these would be, basically, a feature across your cross section.

LandXML-XML is a universal file format used to get our DTM into a form that contractors could use to get into their machines. XML files are created through an InRoads Export process.

Design’s CADD Section anticipates using this process to get our surface into a form the contractors can use. This would get us away from supplying data in a proprietary format.

TTM-Trimble Triangulated Model. We have the capability within InRoads to export directly to a format that can be used by Trimble controllers. The TTM is just the triangles of the surface and not any features.

Design’s CADD Section anticipates using this process to get information into our construction survey controllers for quality checking.

10. Appendices

May include meeting minutes, internet speed trial data, software vendor agreements, etc.

Appendix O DPD Pilot Project Implementation Plan — Grayson County

LEITCHFIELD BYPASS, KY 3155
ITEM NO. 4-8954, GRAYSON COUNTY

DIGITAL PROJECT DELIVERY
PILOT PROJECT IMPLEMENTATION PLAN

Version 1.0
August 2021

DIGITAL PROJECT DELIVERY (DPD) AT KYTC

The DPD Pilot Program supports KYTC's efforts to provide streamlined digital deliverables from Project Development through Construction. Testing 3D design models and using these design data on pilot projects will yield opportunities to improve efficiency. KYTC selects projects for this program.

PROJECT DETAILS

1. Pilot Project Description and Scope

KY 3155 William Thomason Byway Extension, Item No. 4-8954, Grayson County

The new route has been designed with a rural, cross-country template except for one section near KY 259 which will include curb and gutter with storm sewer systems. Truck volumes are anticipated to be high at this location. The project includes work to provide a grade separated crossing for an existing T&L Railroad at-grade crossing. CSX is aiding T&L with the plan review and coordination. The railroad alignment is being moved to allow continuous rail use during construction as well as the new crossing configuration. The railroad will install its own rail after the structure has been constructed via KYTC construction contract. The structure design is KYTC (Earl Downey) via OpenBridge Modeler (OBM). The project is presently scheduled for February 2022 letting, but Brad advises that a later 2022 letting is more feasible.

2. Project Milestones and Schedule

List upcoming design milestones, anticipated construction letting date, construction contract type, and construction duration (if available). Once construction begins, document the percentage of the construction contract complete (as needed).

- A construction review can be held prior to letting.
- Construction letting is planned for early summer 2022.
-

3. Project Team and Stakeholders

Name	Representing	Contact Information
Kevin Blain	KYTC Construction/Section Office	kevin.blain@ky.gov
Derrick Dennison	KYTC Construction/Section Office	derrick.dennison@ky.gov
Bow Warren	KYTC Project Delivery and Preservation	Bowo.warren@ky.gov
Kevin Hodge	KYTC Project Delivery and Preservation	kevin.hodge@ky.gov
Kevin Pierce	KYTC Project Delivery and Preservation	kevin.pierce@ky.gov
	Contractor	
	Subcontractor	
Brad Bottoms	KYTC Project Development/Design	bradley.bottoms@ky.gov
Chris Smith	KYTC Project Development/Design	chris.smith@ky.gov
Jason Littleton	AEI, Design Consultant	jlittleton@aei.cc
Therese Wimsatt	AEI, Design Consultant	mwimsatt@aei.cc
Peter Overmohle	AEI, Design Consultant	povermohle@aei.cc
Adrien Patané	Trimble	adrien_patane@trimble.com
Lori Ann Gronman	Trimble	loriann_gronman@trimble.com

4. Pilot Objectives

Edit as necessary, removing objectives that will not be tested during this pilot. Objectives must align with project team goals. List specific knowledge, skills, and abilities that KYTC staff will gain from the pilot project.

1. **TRAINING AND SUPPORT**: (All pilots) Digital Project Delivery (DPD) core staff will directly and indirectly (coordinate) aid in mitigating obstacles. Core staff will identify, relay, and document information about obstacles met and unmet. For example, if existing technology (hardware and software operating systems) are incompatible or insufficient to support construction-phase use of Electronic Engineering Data (EED), DPD core staff will relay this information to appropriate personnel.

2. **DESIGNER AVAILABLE DURING CONSTRUCTION**: (All pilots) Project designer availability within construction phase will be formalized through professional services contract under the guidance of KYTC Project Development staff.
    a. Consult Professional Services when developing terms of this agreement. Because projects occur within unique contexts, tailor the scope of this effort to the project context. For example, a pilot that entails software testing may require more person-hours from the consultant than a pilot that does not involve software testing.
    b. Involvement of the project designer following the award may include progress meeting participation, construction updates to design data (e.g., proposed DTM), and change management.

3. **DESIGN DELIVERABLES:** (All pilots) KYTC Project Development staff will be able to create (or receive from designer) useful Electronic Engineering Data (EED) for transmittal to construction staff. Project Development staff will be able to judge the completeness of the EED, including:
    a. Current KYTC CAD Standards requirements
    b. KMZ (GIS formatted) project information
    c. Manuscript-style PDF file of plans
    d. CAD Standard files converted to Trimble Business Center (TBC) file format
    e. Plan notes and quantities in PDF, Word, and/or Excel

4. **TOOLS FOR DAILY CONSTRUCTION INSPECTION:** Using KYTC provisioned technology (iPads, iPhones, laptops, desktops), KYTC Construction staff (*with daily field inspection responsibilities*) will be able to find, access, and use electronic engineering data (EED) for the project including:
    a. Current KYTC CAD Standard deliverables files
    b. KMZ (GIS formatted) project information
    c. Manuscript-style PDF file of plans
    d. Plan notes and quantities in PDF, Word, and/or Excel

5. **SOFTWARE TEST:** Using KYTC provisioned technology (iPads, iPhones, laptops, desktops), KYTC Construction staff (*with daily field inspection responsibilities*) will be able to find, access, and test use electronic engineering data (EED) for the project through a new software solution (specifically Trimble options and Trimble Quadri) including:
    a. Current KYTC CAD Standard deliverables files
    b. KMZ (GIS formatted) project information
    c. Manuscript-style PDF file of plans
    d. Plan notes and quantities in PDF, Word, and/or Excel

6. **CONSTRUCTION SURVEY:** KYTC Construction staff (*with responsibility for field survey verification of the contractor's work*) will be able to find and upload files into available Section Office survey equipment. They will be able to perform progress checks of the contractors' work (i.e., spot-checking subgrade elevations.) Staff will be able to measure construction progress by comparing interim site-obtained construction topographic data to proposed, finished construction details (as found in the EED.)

7. **LEVEL OF EFFORT EVALUATION**: Digital Project Delivery core staff, in coordination with Professional Services staff, will be able to describe the scope of design deliverables that KYTC construction staff found

useful. Core staff, through Professional Services staff, will offer this information to KYTC Project Managers for future project scoping guidance. For tracking purposes, DPD core staff will evaluate the production hours and terms of the Professional Services agreement(s) in relation to the EED construction personnel value, thus improving scoping decisions on future projects. This evaluation should include but is not limited to:

a. Relevant software issues (including licensing and versioning)
b. Level of design effort and detail with respect to construction deliverables. For example, recommend modeling guidance specific to project types and work types (e.g., earthwork, drainage, paving), using feedback from the Division of Construction.
c. Design changes initiated and tracked during the construction phase

8. **DRAINAGE FEATURES MODELED**: Model drainage networks (including curb and gutter and storm sewer). Provide model details to construction management in coordination with the Drainage Section of the Division of Highway Design.

9. **UTILITY FEATURES MODELED:** Represent belowground utilities in the proposed 3D model. Provide model details to construction management in coordination with the Division of Right of Way and Utilities.

10. **DESIGN REVIEW TOOLS:** Amend latter-stage design review to make use of 3D modeling, especially where construction expertise is traditionally sought during design review (e.g., clash detection, maintenance of traffic, constructability). Non-CAD users may require software solutions that allow for this type of modern plan review. The scope of this objective should vary based on project characteristics and schedule.

5. Deliverables (Design to Construction)

Edit list of deliverables according to pilot objectives, software/hardware inventory, and staffing needs.

Reference Plan Processing requirements and CAD Standards. KYTC Highway Design website: https://transportation.ky.gov/CADD-Standards/Documents/KYTC_CADD_Standards_Policy.pdf

- DGN Container Files (refer to KYTC CAD Standards policy for folder structure and file organization)
- Existing Manuscript and Proposed Corridor (.dgn files)
- EX Terrain, PR Finished and Subgrade and Geometry XML files
- Superelevation report (.xml file)
- Earthwork Calculations (.xslx file)
- Template Library (.itl file)
- Existing Manuscript and Proposed Corridor Graphics (.dxf files)
- Proposal information in PDF format
- Plan notes and quantities in PDF, Word, and/or Excel.
- Large-format PDFs of the proposed corridor that contain minimal detail and annotations.
- GIS-compatible graphics (KMZ file).

6. Other Affected Partners and Processes

List KYTC divisions and external stakeholders or partners impacted by pilot testing that are not been listed above and which are not immediately responsible for project execution. Include approvers or regulatory agencies for which conventional information exchange will be altered. Modify example list below as needed.

- KYTC Division of Construction Procurement
- ePlanRoom vendor
- Railroad
-

7. Special Notes or Contract Terms

As needed, draft Special Notes that detail pilot procedures and responsibilities. Prepare for the mandatory pre-bid meeting if the project team deems it appropriate.

- Special Note
-

8. Software and Equipment Inventory

List construction inspection staff equipment. Include survey equipment, desktop computers and laptops, tablets and cellular devices, and software. Give consideration to the availability and reliability of cellular service in the vicinity of the project site. Depending on the project context and pilot objectives, it may be necessary to set up wifi hotspots.

- District 4 survey equipment
- Section office
-

9. Terminology and References

Include specialized terminology and references if the project team determine this information is necessary in the implementation document.

10. Appendices

May include meeting minutes, internet speed trial data, software vendor agreements, etc.

Appendix P DPD Pilot Project Implementation Plan — Elliott County

KY 7 WIDENING IN SANDY HOOK
ITEM NO. 9-0228.30, ELLIOTT COUNTY

DIGITAL PROJECT DELIVERY
PILOT PROJECT IMPLEMENTATION PLAN

Version 1.0
August 2021

DIGITAL PROJECT DELIVERY (DPD) AT KYTC

The DPD Pilot Program supports KYTC's efforts to provide streamlined digital deliverables from Project Development through Construction. Testing 3D design models and using these design data on pilot projects will yield opportunities to improve efficiency. KYTC selects projects for this program.

PROJECT DETAILS

1. Pilot Project Description and Scope

3-Lane Curb and Gutter Widening of KY 7 in Sandy Hook, Item No. 9-0228.30, Elliott County

KY 7 is a half-mile urban widening project. Beginning south of Sandy Hook, the roadway starts with a rural template, then transitions to a 3-lane curb and gutter section into town. The proposed design addresses several vertical curves and access management issues throughout the corridor. Sidewalk will be added throughout the urban piece of the project. It touches every aspect of design – rural and urban templates, cross pipes and storm sewer, utility impacts, and maintenance of traffic hurdles.

2. Project Milestones and Schedule

List upcoming design milestones, anticipated construction letting date, construction contract type, and construction duration (if available). Once construction begins, document the percentage of the construction contract complete (as needed).

- Currently in Right of Way and Utility Relocation phase
- Construction Letting 2022
-

3. Project Team and Stakeholders

Name	Representing	Contact Information
Kyle Bidwell	KYTC Construction/Section Office	kyle.bidwell@ky.gov

Darrin Eldridge	KYTC Project Development/Design	darrin.eldridge@ky.gov
Joey Mosley	HMB Engineers, Design Consultant	jmosley@hmbpe.com
Jadie Tomlinson	HMB Engineers, Design Consultant	jtomlinson@hmbpe.com
Matt Sipes	HMB Engineers, Design Consultant	msipes@hmbpe.com
Cameron Brunty	HMB Engineers, Design Consultant	cbrunty@hmbpe.com
Mari Reyes	Bentley	mari.reyes@bentley.com
Alan Esguerra	Bentley	alan.esguerra@bentley.com
Joey LouAllen	Bentley	joey.louallen@bentley.com
Rick Wagner	Bentley	rick.wagner@bentley.com

PILOT OBJECTIVES

Add objectives and edit them as necessary. Remove objectives that will not be tested on the pilot.

- Specify training requirements and support needs for construction inspection staff. This information must be included for all pilots and should be tailored according to pilot objectives, equipment inventory, and individual staff needs.
- Convert OpenRoads data into construction survey-level inspection format (e.g., TBC) and provide to KYTC inspection staff.
- Convert OpenRoads data into contractor-preferred formats (e.g., TBC, AWG). Deliver the converted data to bidders.
- Provide geospatial format design data (e.g., KMZ to be used with Google Earth) to KYTC construction staff and bidder.
- Provide manuscript, large-format PDF of project plans. When establishing the deliverable requirements for design products, give careful consideration to the functionality of Adobe software available to construction staff.

- Project designer availability within construction phase will be formalized through professional services contract under the guidance of KYTC Project Development staff.
    - Consult Professional Services when developing terms of this agreement. Because projects occur within unique contexts, tailor the scope of this effort to the project context. For example, a pilot that entails software testing may require more person-hours from the consultant than a pilot that does not involve software testing.
    - Involvement of the project designer following the award may include progress meeting participation, construction updates to design data (e.g., proposed DTM), and change management.
- Monitor the consultant scope and contract to inform future Professional Services policy decisions. For tracking purposes, evaluate the production hours and terms of the Professional Services agreement(s) in relation to the digital design information construction personnel value, thus improving scoping decisions on future projects. This evaluation should include but is not limited to:
    - Relevant software issues (including licensing and versioning)
    - Level of design effort and detail with respect to construction deliverables
    - Design changes initiated and tracked during the construction phase
    - Frequency of site visits/progress meetings
- There are several options to pilot the Model as Legal Contract Document (MALD). The project context dictates to what extent MALD may be piloted. The proposed 3D model may be supplied as the single reference for bidding and construction management. Alternatively, proposed 3D design information may be provided in addition to the existing bid package, along with a Special Construction Note that adjusts the hierarchy of plan information to situate the digital model above other bid package contents. MALD piloting may provide opt-in or opt-out clauses in bid documents, so that piloting occurs only when KYTC and the contractor reach a post-award piloting agreement.
- Model drainage networks (including curb and gutter and storm sewer). Provide model details to construction management in coordination with the Drainage Section of the Division of Highway Design.
- Represent belowground utilities in the proposed 3D model. Provide model details to construction management in coordination with the Division of Right of Way and Utilities.
- In coordination with the Division of Construction Procurement, test whether the Construction Procurement process is compatible with DPD file sharing — with and without ePlanRoom.
- Amend latter-stage design review to make use of 3D modeling, especially where construction expertise is traditionally sought during design review (e.g., clash detection, maintenance of traffic, constructability). Non-CAD users may require software solutions that allow for this type of modern plan review. The scope of this objective should vary based on project characteristics and schedule.
- Test Bentley iTwin and Synchro for construction phase software option.
- Use feedback from the Division of Construction to establish modeling guidance for different work types (e.g., earthwork, drainage, paving).
- Develop and deliver digital as-built drawings of the completed project as a function of final project closeout. Explore options for developing, updating, and housing as-built data (e.g., responsible party and file format) in coordination with multiple KYTC divisions, such as Division of Operations or Division of Planning, as appropriate.

4. Performance Measures

List performance measures for the selected objectives. Align performance measures with team expectations. Specify hurdles that must be overcome. Consider how follow-up evaluation can be conducted and methods for quantifying benefits and costs.

-

-

5. Deliverables (Design to Construction)

Edit list of deliverables according to pilot objectives, software/hardware inventory, and staffing needs.

Reference Plan Processing requirements and CAD Standards. KYTC Highway Design website: https://transportation.ky.gov/CADD-Standards/Documents/KYTC_CADD_Standards_Policy.pdf

- DGN Container Files (refer to KYTC CAD Standards policy for folder structure and file organization)
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- Superelevation report (.xml file)
- Earthwork Calculations (.xslx file)
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- Existing Manuscript and Proposed Corridor Graphics (.dxf files)
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- Plan notes and quantities in PDF, Word, and/or Excel.
- Large-format PDFs of the proposed corridor that contain minimal detail and annotations.
- GIS-compatible graphics (KMZ file).

6. Other Affected Partners and Processes

List KYTC divisions and external stakeholders or partners impacted by pilot testing that are not been listed above and which are not immediately responsible for project execution. Include approvers or regulatory agencies for which conventional information exchange will be altered. Modify example list below as needed.

- KYTC Division of Construction Procurement
- ePlanRoom vendor
-

7. Special Notes or Contract Terms

As needed, draft Special Notes that detail pilot procedures and responsibilities. Prepare for the mandatory pre-bid meeting if the project team deems it appropriate.

- Special Note
-

8. Software and Equipment Inventory

List construction inspection staff equipment. Include survey equipment, desktop computers and laptops, tablets and cellular devices, and software. Give consideration to the availability and reliability of cellular service in the vicinity of the project site. Depending on the project context and pilot objectives, it may be necessary to set up wifi hotspots.

- Equipment
-

9. Terminology and References

Include specialized terminology and references if the project team determine this information is necessary in the implementation document.

10. Appendices

May include meeting minutes, internet speed trial data, software vendor agreements, etc.

Appendix Q DPD Standing Meeting Agenda

STANDING MEETING AGENDA – Digital Project Delivery Core
(12-10-21) notes highlighted gray

I. DPD Core Work Tasks and Priorities List

A. Catherine:

1. Construction sub-committee invitation with doodle poll
2. Follow-up with prior participants in DPD committees
3. Scotty's Chris Higgins – follow up

B. Cory:

1. Level (900+) naming updates – related to DPD and central to successful ORD transition, almost done, potentially by the end of the year (with CAD section help). This includes some line styles and colors. This was a recommendation from multiple sub-committees.
2. Website

C. Rachel:

1. Forward graphics updates for Catherine and Cory to review
2. Prepare for 12-21-21 KYBOELS conversation – include note about ACEC/KAHC contact/involvement
3. Jim's email question about construction models
4. Interim Report "Year One"
5. Glossary
6. Agenda draft and meeting materials for January 26, 2022 MBDC Committee (include tracking procedures, committee operation, see below list)
7. Draft Project-Specific Implementation Plans and timelines to share with vendors (include recommended points for follow-up meetings)
8. Format standardized email update for committee members and KYTC leadership
9. FHWA Peer Exchange summarized

II. Pilot Projects

A. Meetings/Workshops/Training –

1. WSP Training – planning meeting w/Lance December 15, 2021
2. HDR Training
3. Peer Exchange (format TBD) for internal KYTC - work with Tracy Wright mindful of audience as KYTC construction staff who are interested and/or part of a pilot (e.g., MSTeams meetings for survey skills sharing between district staff)

B. Draft Implementation Plans – work toward first versions for each project April/May 2022 to coincide with next 6YP, including some intermediate Project Development milestones (e.g., Plan Processing) on timelines

C. Software Test – Have design consultants had exposure to software? When will they?

D. Pilots List Changes/Updates (Excel workbook in Projectwise)

E. Status/Tracking – April/May follow-up will be needed (after 2022-2024 6YP is official) since the funding availability affects the progression of all the pilots, regardless of their proximity to letting.

III. Model Based Design and Construction (MBDC), Main DPD Committee

A. Tracking – standard-format email for pilot project staff? Tracking of decision-making?

B. Status and next steps – Meeting is set for January 26, 2021. Meeting materials and agenda may include decision list from subcommittee recommendations, graphic of organization of committees/decision-making, and draft change management (committee) procedure that includes legal opinion as needed.

IV. DPD Subcommittees

A. Subcommittees – Chairs of the subcommittees that have met will be contacted to offer updates. Subcommittees may be reorganized from the original list, and interaction format changed (from meeting to email updates with as-needed meetings) moving forward. For example, structures and drainage may be rolled into other groups. Legal has been removed from the list below and will be addressed as described in the MBDC Committee description. FHWA involvement will remain as efficient as possible, typically following KYTC internal work through policy and process change and coordinating with the MBDC Committee.

B. Survey

C. Utilities

D. Environmental

E. Drainage Design – Tim Robinson as member of RD subcommittee. Catherine has been keeping him updated.

F. Right of Way

G. Roadway Design (RD)

H. Construction – Committee makeup has been drafted. Doodle poll for potential dates with invitation to be sent.

I. Operations

J. Traffic

K. Structures

V. Information Exchange (outside KYTC)

A. FHWA (Aaron Buckner and Jill Asher) Related to training specifics – Tim is following up.

B. KAHC – initiate a follow-up with status updates, PAIKY is Feb 7-9

C. ACEC - initiate a follow-up with status updates

D. Other

VI. Products and Tracking

A. Website - Tim has been made aware and has given the go-ahead for moving ahead. Content is in PW folder for website, and will be checked through Tim. Consideration will be given to whether information is already publicly available (e.g., before pilot project details are posted.) Cory will work with Dave VanAtter, with the approach of reworking the format (simplifying it like the HKP website) and offering content as soon as available – such as the FAQ and some of the graphics – rather than waiting and trying to complete everything prior to going live. Removing all but "news, resources, and pilot program" links for now.

B. Infographics – KTC work session 12-9-21. Cory suggested working on a graphic that shows objectives for pilots and illustrates the overlap between pilots testing similar objectives.

C. Presentations

D. Glossary - priority to accompany and supplement the FAQ and implementation plans

E. FAQ - V1 has been submitted to Tim for review. Will serve as a dynamic working document from which future lists are drafted. This and Excel spreadsheet "To and From Questions for Stakeholders" will track this content. Rachel has notes from Steve to add to this document.

F. One-Pager – November version in PW folder. Update? What update format is useful for email newsletters?

G. Surveys

H. Tracking Tools

1. Funding (Excel)
2. Timeline of Pilots – will be updated early spring 2022 or earlier, as appropriate

I. Reports –

1. Year One (2021) Report
2. FHWA Peer Exchange Summary – April 2021. Using 10-13-21 email from David Unkefur – Rachel will clean up materials and summarize.

VII. Related Projects

A. IT Project: CAD to FME Conversion

B. Digital As-Builts (EDC-6, Matt Simpson)

C. UAS for KYTC Operations

D. ORD Transition (Aaron McCown)

VIII. New or Upcoming

A. KRS/KAR scan – work has started. KYBOELS request for presentation/status

STANDING MEETING AGENDA – Digital Project Delivery Core
(12-10-21) notes highlighted gray

B. Professional Services coordination - re. ORD transition and scope of professional services contracts. Study some contract modifications for overlap, with Gormley. This can be taken to the HD committee for policy or guidance training. Draft production hour descriptions and ranges for reference and relate this to project type.

C. Trimble Mobile Inspector as a potential pilot will have to be coordinated with the KYTC shift to AASHTO Construction and Materials (from SiteManager and LIMS) Jack Calvin is John Suddith's contact.