AASHTO
AASHTO INNOVATION INITIATIVE

AASHTO Innovation Initiative

[Improved project delivery process with the aid of GIS repository and advanced surveying techniques]

Nomination of Innovation Ready for Implementation

Sponsor

Nominations must be submitted by an AASHTO member DOT willing to help promote the innovation. If selected, the sponsoring DOT will be asked to promote the innovation to other states by participating on a Lead States Team supported by the AASHTO Innovation Initiative.

1. Sponsoring DOT (State): California DOT

2. Name and Title: Amarjeet S Benipal, District Director

Organization: California Department of Transportation (Caltrans)

Street Address: 703 B Street

City: Marysville

State: California

Zip Code: 95901

Email: amarjeet.benipal@dot.ca.gov

Phone: (530) 741-4233

Fax: Click or tap here to enter text.

Innovation Description (10 points)

The term "innovation" may include processes, products, techniques, procedures, and practices.

3. Name of the innovation:

Improved project delivery process with the aid of GIS repository and advanced surveying techniques.

4. Please describe the innovation.

Early Utility Information in Planning Phase: The improved project delivery process recommends requesting existing utility facility maps from utility owners earlier in the project development phase (as early as the planning phase), identifying potential impacts based on preliminary data using GIS utility repository and notifying utility owner of the project for planning and resourcing of possible relocations. Early Utility Conflicts/Utility Relocation Design: In Environmental phase identifying positive location of utilities, utility conflicts, private property impacts, and utility easements while assessing alternatives of the preliminary designs of the project. Based on anticipated preferred alternative after public meeting on the project, assess three-dimensional footprint to finalize utility conflicts preliminary utility relocation plans This allows assessing project environmental impacts more accurately and identifies utility easements for the relocation by the end of Environmental analysis phase of the project. Once National Environmental Policy Act (NEPA) process completes the project goes for final design and provides utility owners enough time to relocate utilities prior to begin construction. Advanced Surveying Techniques: Engineering Survey data is in critical path for the improved process as designers performing preliminary designs needs to identify the three-dimensional footprint of the project to determine utility conflicts and right of way requirements early in the environmental phase. Where applicable LIDAR survey with unmanned Aerial Systems (Colloquially known as drone) are being used for projects with less than 4 miles length to efficiently provide project survey information. Our preliminary data shows this survey is 46% more efficient than conventional survey. Another survey technique that has been implemented is Mobile Terrestrial Laser Scanning (MTLS), allowing our field crews to be safely off the roadway while collecting high quality topographic data. Retain Utility Location Data: A GIS database repository is being developed to register identified utilities three dimensionally for future projects as much of the SUE data collected has been effectively “lost” in project files after its intended initial use. Coordination with Utilities: Early coordination and monthly coordination with utility owners are initiated based on complexities of the project and involvement of utilities. The improved project delivery process in identifying utility locations and conflicts and preliminary relocation plans from utility owners early expedites the final design and relocation of the utilities by utility owners prior to begin construction of the project. Benefits: Timely positive identification of underground lines, reduces project delivery risks, minimizes potential safety issues to the public and construction workers, save money by reducing costs from construction delays and utility conflicts/relocation/damage and saves time. The improved project delivery process, advanced survey techniques along with implementation of FHWA SHARP 2 solutions 3D Utility Location Data Repository (R01A), Utility Investigation Technologies (R01B) when beneficial, Identifying and Managing Utility Conflicts (R15B) minimizes or avoids project delays related to Utility impacts during pre-construction stages and relocation of utilities occurs prior to construction.

5. What is the existing baseline practice that the innovation intends to replace/improve?

In the existing state positive location of utilities is being done in environmental phase. The baseline/existing practice identifies utility conflicts, relocation plans and easements in design phase/post environmental phase which limits the process time for relocation of utilities prior to construction and causes project delays. In the existing practice SUE data collected has been potentially "lost" in project files after its intended initial use. The Baseline practice for survey's are conventional methods which are cumbersome and time taking.

6. What problems associated with the baseline practice does the innovation propose to solve?

Existing SUE that have not been documented needs to be identified early to reduce project delivery risk and provide information necessary for a complete comprehensive design and constructible project. This innovation incorporates state of the art tools into the improved project delivery process: advanced survey techniques, Utility Investigation Technologies, and 3D Utility Location Data Repository. Identifying and managing Utility Conflicts to minimize or avoid project delays during pre-construction stages and ensuring that relocation of utilities occurs prior to construction. Project Delays due to Utility Relocation: According to Texas DOT sponsored FHWA/TX-15/0-6806-FY15 WR#3 study performed by Texas A&M transportation institute assessed the costs attributed to project delays during project pre-construction stages. The study reports a project size of $10.6M has $87K for every month of delay, project size of $28.4M has $420K for every month of delay and Project Size of $85.2M has $1.3M for every month of delay. Project Costs due to Utility Relocation: Every year, State, City and County Department of Transportations (DOTs) spend millions of dollars on problems that arise due to utility conflicts and expending time and resources for pot-holing. In a report conducted by Purdue University entitled cost savings on highway projects utilizing subsurface utility engineering, December 1999, a study of seventy -one projects with a combined construction value in excess of $1 billion indicated a total of $4.62 in savings for every $1.00 spent on SUE. Qualitative savings were not measured, but those savings were significant and may be many times more valuable than the quantifiable savings. Similar studies conducted concluded $7 to $1 by Virginia and $18 to 1 by Maryland. Other Pertinent Research: A study conducted by the University of Florida for Florida DOT in 2003, A study conducted by the National Academies of Science Engineering, Medicine (National Cooperative Highway Research Program) in 2009 as part of Second Strategic Highway Research program, A study conducted by University of Kentucky for Kentucky DOT in 2014, A study from Utah DOT conducted by the University of Utah in May 2017 indicates the enormity of utility impacts on transportation projects. Most of these studies address and recommend developing a SUE repository, setting up separate accounting system to track and assess impacts, improving communication between DOT's and utility owners and usefulness of a one call system.

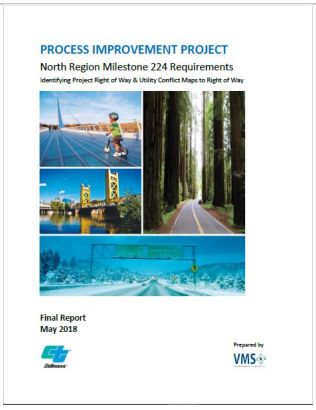
7. Briefly describe the history of its development.

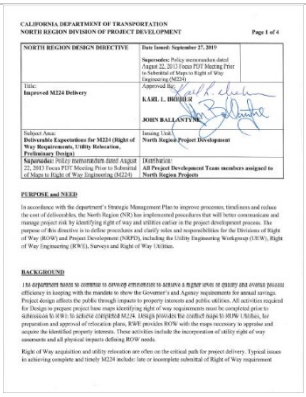
The improved project delivery process developed from a value analysis study exercising Lean Six Sigma (L6S) to alleviate R/W and Utility impacts related to project delays. The Study was sponsored by Caltrans North Region Executive team in the spring of 2018 and assembled a team of experienced project delivery practitioners from Design, project management, Right of Way utilities, utility engineering, Right of Way Engineering, Surveys, GIS, Environmental etc. The Team developed best practices and improved project delivery process flow chart that has been reviewed and refined. As part of enterprise data management, a GIS repository was created in 2017 for existing utilities, right of way, drainage. In 2019 Drone for LIDAR survey was acquired for efficient survey deliverables.

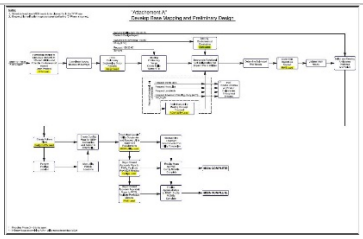
8. What resources—such as technical specifications, training materials, and user guides—have you developed to assist with the deployment effort? If appropriate, please attach or provide weblinks to reports, videos, photographs, diagrams, or other images illustrating the appearance or functionality of the innovation (if electronic, please provide a separate file). Please list your attachments or weblinks here.

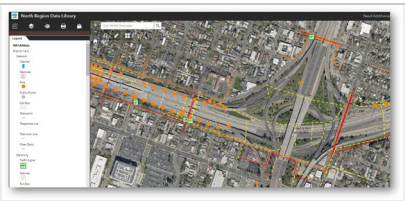
A Value Analysis Report, a policy to implement, flow chart of improved project delivery process, presentation of the new process in several internal engineering forums to bring practitioners on board, a GIS repository of existing utilities, right of way, drainage and geometry as they are being identified as part of the project. Outreach and communication plan with utility companies on conflicts and relocation plans. Tools for Surveys such as Drone with LIDAR survey capabilities and MTLS with SUE capabilities.

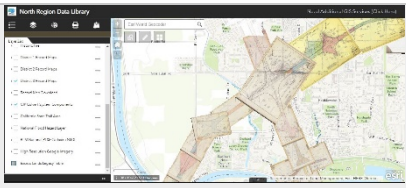
Attach photographs, diagrams, or other images here. If images are of larger resolution size, please provide as separate files.

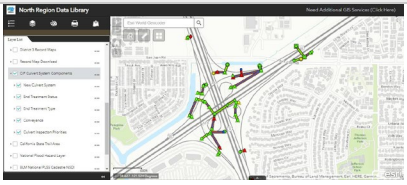








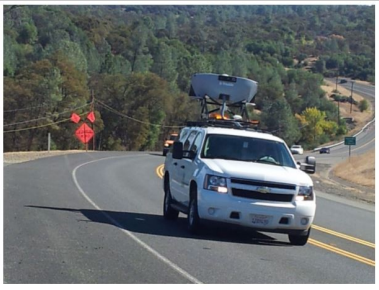




EFFECTIVE JANUARY 1, 2018

Mission

This page is to provide direction to all divisions and departments in District 3 that may wish to utilize a drone (UAS) for any purpose related to your work needs. This information on this website is strictly for UAS operations by District 3 employees. District 3 UAS operations by others (including contractors or encroachment permittees) is currently prohibited. **ALL flights are to be conducted under FAA FAR Part 107 requirements.**



The field surveyors will perform all control, engineering, and right of way field surveys required for project delivery. They will also stake all lines and grades needed for construction surveys. See Surveys Manual Chapters 9, 10, 11, and 12 for more details.

State of Development (40 points)

Innovations must be successfully deployed in at least one State DOT. The AII selection process will favor innovations that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.

9. How ready is this innovation for implementation in an operational environment? Please select from the following options. Please describe.

☐ Prototype is fully functional and yet to be piloted

☐ Prototype has been piloted successfully in an operational environment

☒ Technology has been deployed multiple times in an operational environment

☐ Technology is ready for full-scale implementation

The improved project delivery process was piloted in 2018 and has been in implementation and projects following the improved process since 2019 in Caltrans North Region.

10. What additional development is necessary to enable implementation of the innovation for routine use?

Setting up a GIS repository that can track utilities in 3D and has an accurate right of way information layer. Populating the utility and right of way repository with past project information so that I can be utilized in this process. Survey's are the critical path for the improved process and in need of advancing of surveys with the aid of drones using LIDAR method, MTLS survey to efficiently provide survey information using better extraction methods from LIDAR in disseminating to designer very early as possible in the environmental phase of a project. This will allow designers to develop better preliminary designs of the three-dimensional footprint of the proposed project with early identification of utility conflicts. Training for current and new staff on Unmanned Aircraft Systems operation, pilot licenses, and software. GIS staff may need to develop new pipelines, processes, and be trained as well. Acquiring advanced geophysical technology equipment in order to locate subsurface utilities and develop 3D mapping.

11. Are other organizations using, currently developing, or have they shown interest in this innovation or of similar technology?? ☒ Yes ☐ No

If so, please list organization names and contacts. Please identify the source of this information.

FHWA SHARP2 solutions recommends 3D Utility Location Data Repository (R01A), Utility Investigation Technologies (R01B), Identifying and Managing Utility Conflicts (R15B). The innovation progresses with the solutions provided and advanced surveying techniques along with the improved project delivery process in avoiding project delays and provides reasonable time for planning, resourcing and relocation of the utilities by utility owners prior to begin construction of the project.

Potential Payoff (30 points)

Payoff is defined as the combination of broad applicability and significant benefit or advantage over baseline practice.

12. How does the innovation meet customer or stakeholder needs in your State DOT or other organizations that have used it?

The innovation meets the stakeholder needs of keeping project on schedule within scope and budget, eliminating project delays and impacts during construction related to utilities. The improved process provides reasonable time for planning, resourcing and relocation of the utilities by utility owners prior to begin construction of the project. Timely location of underground lines minimizes potential safety issues to the public and construction workers, save money by reducing costs from construction delays and utility conflicts/relocation/damage and saves time.

13. Identify the top three benefit types your DOT has realized from using this innovation. Describe the type and scale of benefits of using this innovation over baseline practice. Provide additional information, if available, using quantitative metrics, to describe the benefits.

Benefit Types	Please describe:
Cost Savings	Reduced project delays: According to Texas DOT sponsored FHWA/TX-15/0-6806-FY15 WR#3 study performed by Texas A&M transportation institute assessed the costs attributed to project delays during project pre-construction stages. The study reports a project size of $10.6M has $87K for every month of delay, project size of $28.4M has $420K for every month of delay and Project Size of $85.2M has $1.3M for every month of delay. Reduced utility conflicts/damage: Every year, State, City and County Department of Transportations (DOTs) spend millions of dollars on problems that arise due to utility conflicts. In a report conducted by Purdue University cost savings on highway projects utilizing subsurface utility engineering, December 1999, a study of seventy -one projects with a combined construction value in excess of $1 billion indicated a total of 4.62 in savings for every

	$1.00 spent on SUE. Qualitative savings were not measured, but it is clear that those savings were significant and may be many times more valuable than the quantifiable savings. Similar studies conducted concluded $7 to $1 by Virginia and $18 to 1 by Maryland. Timely location of underground lines minimizes potential safety issues to the public and construction workers, save money by reducing costs from construction delays and utility conflicts/relocation/damage and saves time. Advanced Surveying Techniques: Our preliminary data shows this survey is 46% more efficient than conventional surveys.
Improved Quality	The improved project delivery process and information available from a GIS repository improves quality during pre-construction stages and improves quality of the bid package, results in fewer contract change orders and delays.
Improved Customer Service	Better customer service to funding agencies and public by delivery of projects within budget and on schedule. Better collaboration with utility companies by providing reasonable time for planning, resourcing and relocation of the utilities by utility owners prior to begin construction of the project.

Provide any additional description, if necessary:

Click or tap here to enter text.

14 How broadly might this innovation be deployed for other applications. in the transportation industry (including other disciplines of a DOT, other transportation modes, and private industry)?

The improved project delivery process, advanced surveying techniques and enterprise data management using GIS repository of utility, R/W, drainage and existing geometry can be deployed to state, county and cities transportation projects, as well as provide benefit to maintenance operations.

Market Readiness (20 points)

The AII selection process will favor innovations that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.

15. What specific actions would another organization need to take along each of the following dimensions to adopt this innovation?

Check boxes that apply	Dimensions	Please describe:
☒	Gaining executive leadership support	Process Improvement study to fit into each state's project development process.
☒	Communicating benefits	Outreach to Utility companies.
☒	Overcoming funding constraints	Develop program for gathering state owned utility info systemwide for GIS database, in advance of project planning phase.
☒	Acquiring in-house capabilities	Use of advance survey and subsurface exploration technology. In-house/A&E design training to advance early preliminary utility relocation design.
☐	Addressing legal issues (if applicable) (e.g., liability and intellectual property)	Click or tap here to enter text.
☐	Resolving conflicts with existing national/state regulations and standards	Click or tap here to enter text.
☐	Other challenges	Click or tap here to enter text.

16. Please provide details of cost, effort, and length of time expended to deploy the innovation in your organization.

Cost: There is no additional cost to the improved project delivery process other than rebalancing of support resources between environmental phase and design phase. The cost of setting up GIS repository

is low (about 40 hours of staff time approximately $2000) for an organization with an established GIS unit or function to high (need a consultant contractor or hire staff with GIS capabilities plus software approximately 20,000 to $ 75,000) for an organization without this ability. Data collection including the necessary tools varies depending up on size of the DOT. For advanced Surveying techniques, a drone with LIDAR capabilities was bought with an approximate cost of $500K.

Level of Effort: Caltrans North region developed a Value Analysis study, flow chart of the improved process, policy to implement, GIS repository, implemented advanced surveying techniques.

Time: The effort would be minimal for adopting the new improved process. Setting up a GIS repository may take up to 6 months. The effort of data collection from past projects into GIS repository may take up to 1-2 years depending on size of the DOT and number of staff employed to collect the data. Caltrans North Region built the repository with a unit of 7 GIS staff and completed a good base of past projects with 3 of those staff working on populating data from past projects for about 2 years.

17. To what extent might implementation of this innovation require the involvement of third parties, including vendors, contractors, and consultants? If so, please describe. List the type of expertise required for implementation.

The improved project delivery process doesn't require third party's assistance. The Enterprise Data management/GIS repository, survey information collection tools may require third parties for any needed assistance.