AASHTO Innovation Initiative

[Proposed] 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): Colorado

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# Innovation Description (10 points)

## The term “innovation” may include processes, products, techniques, procedures, and practices.

3. Name of the innovation:

LIDAR- based Viewshed Analysis for Visual Resource Scoping

4. Please describe the innovation.

A standardized data-driven visual analysis process has the potential to save Colorado Department of Transportation thousands of dollars on each project, help visually communicate impacts to stakeholders and the design team, and add to project buy-in early in the planning phase. Our process uses ArcGIS Pro software and Light Imaging Detection and Ranging (LIDAR point-cloud) data available through the Office of Information Technology (OIT) to run a series of viewshed analyses for a proposed CDOT project. The preliminary process runs a viewshed analysis across a topographic ground surface and overlays this data with local agency land use and recreational information to identify impacted viewers. This process takes less than an hour to complete in-house now that a repeatable process has been developed. A secondary process runs a viewshed analysis that takes vertical elements, such as trees and buildings, into account. This process takes about 5 hours to complete, including downloading LIDAR data. There are two workflows for the secondary analysis. One is for running a viewshed along a corridor, for projects where lanes of highway are being added or modified. The other workflow is for running a viewshed from the high point of a proposed bridge or wildlife overpass. These workflows help determine potential viewers of a CDOT project and the impacts on their views. These two workflows were tested on two VIAs: Greenland Wildlife Overpass and the Eisenhower Johnson Memorial Tunnel to Bakerville Climbing Lane project. We developed a more advanced process to run a viewshed that takes into account the added visual obstruction of a bridge or wildlife overpass on views from the road. Another layer to this process involves refining the viewshed to only include a driver’s cone of vision, which varies depending on driver speed and direction. ArcGIS Pro can also be used to view the proposed project in 3D and develop renderings.

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

CDOT’s Geographic Information Systems (GIS) professionals have the data, programs and skills to run comprehensive viewshed analyses in-house, but we lack a standardized process across regions. Viewshed analysis is a GIS tool that can streamline Visual Impact Assessments (VIAs), and each CDOT region completes VIAs, but we currently don't have any involvement of internal GIS staff or programs in the VIA process. The new CDOT VIA Guidelines, initially released in August 2019, simplified, standardized and streamlined the process of VIAs, thus increasing instances where visual resources are scoped in the National Environmental Policy Act (NEPA) process. However, in an evaluation of recent VIAs, the cost of outsourcing these increasingly common VIAs has been less standardized than anticipated. Consultant fees can range from as low as $10,000 to as high as $75,000 per project, with minimal correlation to scoping questionnaire point score This discrepancy could be due to inconsistent use of GIS and the viewshed analysis tool. There are few firms that have the capacity, staff, and software to conduct VIAs in house. There are even fewer firms that have expertise conducting viewshed analyses using GIS and big data. For this reason, VIA consultants might leave viewshed analysis out of the scope entirely or conduct a watered down viewshed analysis. The viewshed analysis might be based on ground surface topography without vertical elements like trees and buildings, which is a great starting point, but does not give the full picture of visibility. Line of sight (LOS) analysis might be conducted, which introduces subjectivity because it only runs a viewshed from a few select points, not along an entire corridor. When included, about $10,000 to $20,000 of each project goes toward viewshed and LOS analysis, which is the focus of our innovation. In place of running a viewshed analysis, a consultant might conduct multiple site visits and fill in the gaps using Google street view, which is expensive in terms of hours required to complete and vehicle miles driven (not to mention it has a higher environmental impact). Views from Google street view are at double the eye level of the average driver, which can distort evaluation. Viewshed analysis, on the other hand, can be set from a custom eye level. Viewshed analysis helps standardize and streamline costs all while improving the accuracy of visual impact evaluation.

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

CDOT’s Geographic Information Systems (GIS) professionals have the data, programs and skills to run comprehensive viewshed analyses in-house, but we lack a standardized process across regions. Viewshed analysis is a GIS tool that can streamline Visual Impact Assessments (VIAs), and each CDOT region completes VIAs, but we currently don't have any involvement of internal GIS staff or programs in the VIA process. Our innovation fixes this issue and improves efficiency. It also reduces cost since expensive consultants are no longer required to run these analyses. Additionally, the CDOT process for Viewshed Analysis does not include LIDAR, however the Federal guidelines have this as a baseline expectation. By using our innovation, we are making sure we are meeting Federal guidelines.

7. Briefly describe the history of its development.

The new CDOT VIA Guidelines, initially released in August 2019, simplified, standardized and streamlined the process of VIAs, thus increasing instances where visual resources are scoped in the National Environmental Policy Act (NEPA) process. However, in an evaluation of recent VIAs, the cost of outsourcing these increasingly common VIAs has been less standardized than anticipated. Consultant fees can range from as low as $10,000 to as high as $75,000 per project, with minimal correlation to scoping questionnaire point score. ( If needed, this information can be provided by the contributors).This discrepancy could be due to inconsistent use of GIS and the viewshed analysis tool. There are few firms that have the capacity, staff, and software to conduct VIAs in house. There are even fewer firms that have expertise conducting viewshed analyses using GIS and big data. For this reason, VIA consultants might leave viewshed analysis out of the scope entirely or conduct a watered down viewshed analysis.

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.

1. ViewShed Analysis Steps (not attached. This is an internal document to CDOT containing sensitive data. However, the contributors can make a more generalized guide if there is interest shown in employing this innovation) 2. [How to Replicate Lidar-based Analysis Steps](https://docs.google.com/document/d/1vffpukamtIaiMawrGj6ZBNbP4x5ewf3r/edit?usp=sharing&ouid=110808107607658543190&rtpof=true&sd=true) ( attached) 3. [Visibility Analysis\_Evan Kirby ---this was an external resource credited below on Question 11](https://docs.google.com/document/d/1y2XQSzGEoWbbnLwd6QwyHnvLGByQ9oZf/edit?usp=sharing&ouid=110808107607658543190&rtpof=true&sd=true). (attached) 4. [Examples 1 EJMT to Bakerville](https://drive.google.com/file/d/1HDqvQAZwo-Q9PqSDDIQORu1Z5kjV8yth/view?usp=sharing) ( attached)5. [Example Greenland Visibility](https://drive.google.com/file/d/18P0bZa1xHNnG644JAE6I-1VQXgOcVRId/view?usp=sharing) ( Attached)

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

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# 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

[x]  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

This process would be used in the screening and scoping phase of NEPA. The preliminary viewshed analysis process would be a step that could help a NEPA practitioner determine whether visual resource documentation is required early on in projects, and it will help the VIA practitioner complete the VIA scoping questionnaire. The secondary viewshed analysis would be implemented in the scoping and inventory phase of a VIA (see VIA guidelines linked below). We created a process document with screenshots to guide a GIS user in implementing these steps It consists of steps in GIS and links to obtain necessary data to run the viewshed analyses.

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

We are still developing the process and refining it. The data is so large that it utilizes a lot of computing power. We need higher computing power to support this analysis. We need a dedicated computer to run this routinely for projects.

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

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

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| --- | --- | --- | --- |
| **Organization** | **Name** | **Phone** | **Email** |
| DiExSys, LLC | Evan Kirby, Principal, GIS Manager | (303) 807-6297 | evan.kirby@diexsys.com |
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# 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?

It improves the external customer experience by making more accurate and customized analysis. It also helps with internal customers with engineering by giving them more accurate and detailed data to work with during projects. This analysis ensures that stakeholders have a data-driven process rather than subjective process. It enhances accuracy.

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.

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| --- | --- |
| **Benefit Types** | **Please describe:** |
| Cost Savings | Consultant fees and hours can be reduced by using this innovation. Viewshed Analysis are very costly. This innovation eliminates the need for that. |
| Shorter Schedule | \*Consultant hours for this same work range from 80 to 123 hours per project This innovation eliminates the need for external consultant. It shortens lead and lag times and implementation schedules. |
| Improved Customer Service | Provides more accurate analysis for both internal and external customers. |

Provide any additional description, if necessary:

All projects that go through the NEPA process require a visual resource clearance. The NEPA practitioner follows a decision tree to determine if visual resource documentation is necessary: https://www.codot.gov/programs/environmental/landscape-architecture/visual-resources/assets/decision-tree.pdf If visual resource documentation is necessary, a VIA practitioner completes the VIA scoping questionnaire. Using a point scoring format, the scoping questionnaire evaluates and documents whether a project will require a Standard VIA (20-30 points), VIA Memo (10-19 points), or can be cleared by the questionnaire (0-9 points). Even if projects are cleared by the questionnaire, recommendations for mitigation measures are noted. **https://www.codot.gov/programs/environmental/landscape-architecture/visual-resources/assets/via\_scoping-questionnaire-template\_revisions\_09252020.pdf** The new CDOT VIA Guidelines, initially released in August 2019, simplified, standardized and streamlined the process of VIAs, thus increasing instances where visual resources are scoped. As documented in the CDOT Form 128, the percentage of projects addressing visual resources has increased from 0.3% prior to Aug 2019 to 12.6% after Aug 2019 when the guidelines were released. Out of 68 instances of visual resource scoping from 2004 through March 2022, 54 (79%) were after the implementation of the VIA guidelines. This data shows that VIAs are becoming increasingly prevalent, increasing consultant costs to CDOT.

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)?

This can be used by any agency or department that would require scoping and GIS imagery analysis. Any organization that is required to evaluate visual resources can utilize this.

# 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?

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| **Check boxes that apply** | **Dimensions** | **Please describe:** |
| [x]  | Gaining executive leadership support | Some sponsorship would be needed.We did not need it for the scale we used it at. |
| [x]  | Communicating benefits | Agencies would need to understand the scope of the benefits in order to push for its usage. |
| [ ]  | Overcoming funding constraints | Click or tap here to enter text. |
| [x]  | Acquiring in-house capabilities | Buying the software and getting trained on using the processes.  |
| [ ]  | Addressing legal issues (if applicable) (e.g., liability and intellectual property) | Click or tap here to enter text. |
| [x]  | Resolving conflicts with existing national/state regulations and standards | Depends on each agencies adherence of policy for use of scoping analysis. We have made our process up to par with Federal guidelines. |
| [ ]  | 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**: We had all the software already available.

**Level of Effort**: Moderate

**Time**: It took us about 6 months to put together the steps and research. For someone to implement it would only take a day as long as they have sufficient computing power.

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.

 Fully using this innovation can greatly reduce the use of consultants and the corresponding fees attached to hiring consultants. Vendors for the software might need to be enlisted for additional training to users. Data sources for topographical/LIDAR is not readily available. Other agencies might need to buy it if they don’t have access to it.