VISUALIZATION CASE STUDIES

A Summary of Three Transportation Applications of Visualization

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I. Background

Visualization is a vehicle for collaboration with the public, resource and regulatory agencies, and stakeholders. There have been many recent, successful examples of visualization used to improve the transportation project development process, including enhancing communication among these groups. As a first step toward learning and disseminating some experiences and lessons learned in developing visualization tools, the USDOT Volpe National Transportation Systems Center (Volpe Center), in coordination with the Federal Highway Administration's (FWHA) Office of Project Development and Environmental Review and FHWA's Office of Interstate and Border Planning, developed the three case studies presented here. The case studies are based on a series of interviews with a wide range of people including staff from FHWA Division Offices, state Departments of Transportation (DOT), State Historic Preservation Offices (SHPO), resource agencies, local governments, consultants, and other stakeholders, such as environmental organizations and chambers of commerce (see Appendix A for interview guides).

Case study one, "The Arizona Department of Transportation Uses Animation to Explain a Complex Project Alternative," investigates Arizona DOT's use of visualization during formal public information meetings for proposed enhancements to the I-10 corridor. The second case study, "Use of Visual Impact Assessment in Wellington, Ohio's Grade Separation Project," summarizes visualization's role in helping Ohio DOT quantify the visual impacts of a proposed transportation project. The final case study, "Hoback Junction, Wyoming: The Role of Visuals in Developing the East Segment Environmental Impact Statement," describes Wyoming DOT's effort to better communicate project alternatives to resource agencies and analyze resource impacts through the use of visualization.

It is hoped that these case studies can be helpful to other transportation agencies in identifying effective techniques for enhancing and streamlining the project development process, including public outreach activities, for transportation improvements.

II. The Arizona Department of Transportation Uses Animation to Explain a Complex Project Alternative

PROJECT BACKGROUND

Phoenix, Arizona is one of the fastest growing regions in the United States. In a 1988 Interstate 10 Corridor Refinement Study, the Arizona Department of Transportation (ADOT) projected that by 2005 portions of Interstate 10 (I-10) would see 250,000 vehicles per day; in actuality, in 2005, traffic volumes exceeded 294,000 vehicles per day. The increased traffic demand is causing the I-10 corridor and the adjacent major streets to become congested during peak travel periods. As projected growth is expected to further worsen congestion issues, ADOT has concluded that improvements to the I-10 corridor are needed to alleviate traffic congestion and support growth demands. In 2002, ADOT began the I-10 Corridor Improvement Study to evaluate capacity improvements on a 14-mile stretch of the I-10 corridor (see Figure 1) from SR 51 in Phoenix to the Santan Freeway (Loop 202) in Chandler.

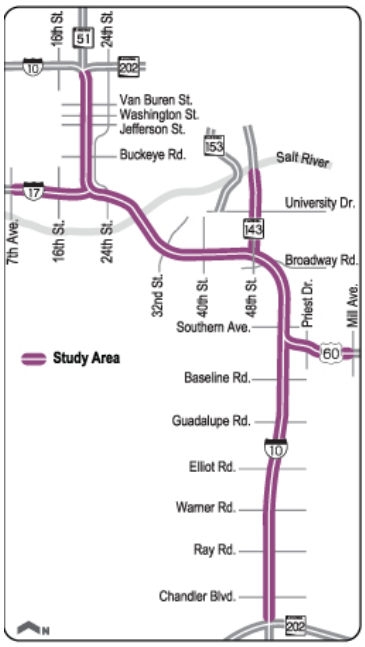

Figure 1: I-10 Study Area

A number of widening concepts were developed during the alternatives development phase. Through public and agency input the alternatives were narrowed down to two that were recommended for additional study:

- Express/Local Lanes Concept (two variations with slightly different lane configurations)
- No-Build Alternative

The Express/Local Lane concept is a roadway design that separates regional through traffic from local traffic. This road design, which has not been utilized in Arizona before, involves constructing independent roadways to separate regional traffic on express lanes from local traffic on local lanes with transfer ramps providing access between the two at selected locations. ADOT staff believes that creating an express/local lane system would relieve congestion on the I-10 by eliminating the weaving maneuvers that currently occur due to numerous entrance and exit points along the freeway between the I-10/I-17 interchange and the I-10/US 60 interchange. The express/local lane project alternative will double the number of lanes on the segment of I-10 between the SR 143 and the US 60 systems interchanges from 12 to 24 lanes.

THE NEED FOR VISUAL TOOLS

The express/local lane concept is complex and was not one which Arizona residents were familiar with. There was confusion about how the project would separate through traffic from local traffic. When the concept was presented to the public during the early

stakeholder outreach meetings it was primarily met with puzzlement. One west Phoenix resident said, "It is mind boggling. It seems to be confusing. I will be glad I will be so old [when it is built] that my kids will have to drive me around."[1] Another local resident worried that with so many lanes it would be difficult to figure out how to get off the freeway.[2] The confusion expressed during these early meetings convinced ADOT that before conducting formal public information meetings for the Alternatives Selection phase they needed to find a better way to communicate the details of this complex project to the public.

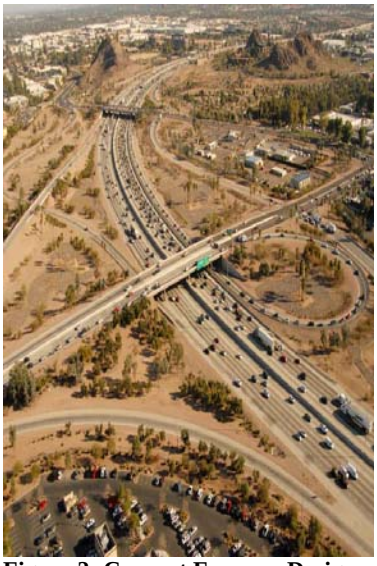

Figure 2: Current Freeway Design

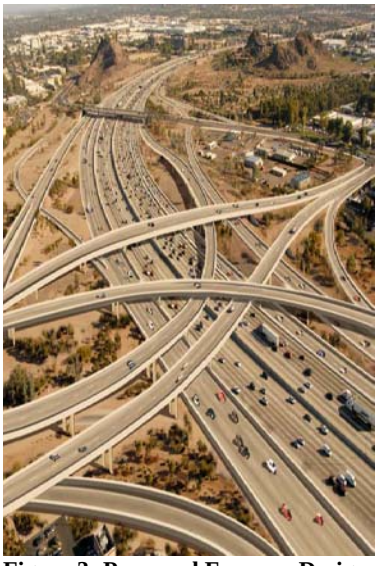

Figure 3: Proposed Freeway Design

CREATING THE VISUALIZATION TOOLS

A Public Involvement Team (PIT), a Study Team subgroup comprised of the FHWA Area Engineer and Environmental Program Manager and ADOT and consultant project management, public involvement and environmental planning staff, realized that the traditional communication tools used in public involvement meetings, namely engineering plans and two dimensional renderings, would be inadequate in explaining this complex project to the public. As a result, ADOT's Project Manager for the I-10 Corridor Improvement Study searched the Internet to find examples of how other states handled similar situations. Upon viewing a video simulation used by the Rhode Island Department of Transportation (RIDOT)[3] and talking with the video's producers, the Project Manager suggested that ADOT create a simulated animation for the I-10 Corridor Improvement Study project. FHWA Arizona Division also sought feedback from the FHWA Rhode Island Division of the effectiveness of the animations developed for the Rhode Island project.

[1] Beard, Betty. (June 24, 2005). *State hopes to untangle traffic chaos at Broadway Curve*. The Arizona Republic

[2] Id.

[3] Rhode Island DOT. [Content no longer available on line.]

ADOT worked with its engineering consulting firm and Pineapple Studios, a multimedia production company, to develop a suite of visualizations to simulate how the project area will look if the Express/Local Lane alternative is built. The multimedia consultants created the visuals using engineering plans, project design drawings, photographs of the existing project area and basic computer aided design (CAD) information as the baseline data. Various computer virtual imaging software, including 3D Studio Max, Adobe Photoshop and PhotoModeler were used to create the "after" visual (see Figures 2 and 3). In addition to the photographic renderings, a video animation simulating driving along the proposed I-10 Corridor was also developed to demonstrate how travelers will navigate the regional and local lane system. The photo-renderings and the video animation were compiled to create a DVD, which includes a narrative description of the project.[4]

INCORPORATING VISUALIZATION IN THE PROJECT DEVELOPMENT PROCESS

The project team utilized the visualizations in each of the three public meetings held for the I-10 Corridor Improvement Study during the alternatives selection phase. The public meetings, which were held in an open house format, began with a presentation on the project followed by a showing of the DVD and then a Question and Answer session. The public was then invited to view the various photo-simulation boards stationed around the room to gather further information about specific roadway segments. A team member was assigned to each station to answer the public's questions. The visualizations displayed at the public meetings were made available through ADOT's webpage for those that were unable to attend the meetings. Having a narrative description of the project included on the DVD ensured that the public received the same information about the project whether they came to a public meeting or viewed the video from the internet.

ADOT noted that, in relation to other projects, this project generated a great deal of interest. Following the public meetings, the ADOT received a number of requests for copies of the DVD, and to date, has sent out about 40 copies to various groups including community transportation departments, fire departments, and special interest groups.

OUTCOMES

The package of visualizations used for the I-10 Corridor Study had a positive impact on the public's understanding of the project. According to ADOT's Community Relations Project Manager, a number of people came to the public meetings with residual negative feelings from a controversial project that is also currently under study in the metropolitan area. ADOT noticed a definite change in attitude from the time participants walked into the public meetings to the time they left. For the Community Relations Project Manager, "It was a very nice experience to see the positive public response. Those who walked into the meeting with a pre-conceived negative impression were, in the end, quite supportive of the project. The visualization techniques contained on the DVD played a big role in that."

[4] Arizona DOT. (2007). I-10 Corridor Improvement Study Video Clips. Available at www.azdot.gov/highways/Valley_Freeways/I10/Maricopa/meetings_notices.asp

The visuals were not only instrumental in addressing those who were skeptical, but also helped to answer questions for those advocating for highway improvements. Transportation is a priority issue for the Phoenix Chamber of Commerce, and as a result, they requested that ADOT present information on the I-10 Corridor project to the association's Transportation Committee. For the Vice President of Public Affairs and Economic Development for the Phoenix Chamber of Commerce seeing the proposed project in the context of its real world surroundings demonstrated that this complex project was achievable in spite of the area's land constraints.

The feedback attained by the public and agency stakeholders for the project's express/local lanes concept provides a level of support in moving forward with detailed analysis of the project alternatives in the Draft Environmental Impact Statement (DEIS). It is anticipated the visualization tools will be utilized again to convey the project concepts during the Public Hearing to be conducted after the DEIS is prepared.

LESSONS LEARNED

There are several lessons learned from Arizona DOT's use of visualization in the I-10 Corridor Study project, in relation to its development and its use.

- ***Carefully refine visuals before presenting to the public:*** The I-10 Corridor Study DVD went through several in-house revisions before ADOT was satisfied with its ability to explain the complexities of the project in simple terms to the public. Continually refining and improving the clarity of the DVD played an important role in its success with the public. Presenting earlier versions of the DVD, which were heavy with technical language, may have created more confusion among the public thereby defeating the purpose of the tool itself.

- ***Context is an important component of visualization:*** Showing recognizable landmarks and features is an important characteristic of developing an effective communication tool. Providing a static image of the current view against which viewers can compare the proposed project view helps viewers orient themselves and build a connection between the before and after images.

- ***If planned for early, using visualizations can save both time and money:*** ADOT decided early on to utilize visualizations in the public involvement process and, as a result, was able to incorporate the time needed to create the visuals (approximately 5 months) into its project development timeline. While creating the visualizations added an additional cost to the project development, its success in the public involvement process enabled ADOT to avoid time delays and additional costs associated with projects that are not supported by the public. All the stakeholders involved in the project believe creating the visualization tools was worth the cost.

- ***Visualizations can lead to better collaboration:*** Early reports and explanations of the I-10 Corridor project left the public confused particularly on how ADOT

proposed to handle both local and regional traffic. Presenting animations showing how a driver entering the roadway system at point A would navigate to point B or C or D was extremely effective at communicating the design concept to the public. Having a clear understanding of how the express/local lane system worked allowed the public to engage more effectively in the review process.

CONCLUSION

A well-developed visualization can be a powerful communication tool to explain complex projects. As ADOT's Project Manager noted, "if you want to convey information to the public and there is anything that relates to the unknown, visualizations can really help deliver your message." Investing additional time and money to create an effective visualization can help to engage non-technical stakeholders, leading to more robust discussion and increased public support. Following upon the success of using visualizations in the I-10 project, ADOT is considering using the tool in other similarly complex highway projects.

III. Use of Visual Impact Assessment in Wellington, Ohio's Grade Separation Project

PROJECT BACKGROUND

One of the primary transportation issues in Lorain County, Ohio is the number of at-grade rail crossings on the CSX railroad tracks, which run northeast to southwest through the cities of Grafton, LaGrange, and Wellington. Recent consolidations within the railroad industry lead to a significant increase in the daily number of trains, from a rate of 14 per day to more than 70 a day, with an average of 3 trains per hour. On average, the tracks are blocked for 2 minutes per train, which result in 15 hours of total traffic delay per day.[5] This increase in rail traffic, along with concerns about transportation routes being blocked to emergency service vehicles, led the Lorain County Engineer to study potential locations for grade-separated crossings.[6] The engineering study identified possible sites in each of the above-mentioned towns where grade separation would be feasible. In Wellington, the feasible grade-separation project is located on State Route 58, north of downtown Wellington and south of a residential neighborhood (see Figure 1).

Figure 1: Existing alignment looking northeast

[5] TranSystems. (September 14, 2004). *Visual Impact Assessment: National Register of Historic Places, Railroad Grade Separation*. LOR-58-7.36.

[6] Lorain County Commissioners. (2005). *Needs Assessment and Strategy*. Lorain County, Ohio.

State Route 58 runs through two historic districts, the Wellington Center Historic District and the Wellington Historic District. Section 106 of the National Historic Preservation Act of 1966 requires that all federally funded, permitted, or licensed projects be reviewed before work commences to determine whether they will affect historic properties. As part of the review, the FHWA must consult with the State Historic Preservation Office (SHPO) regarding the project's affect on historic properties. When the Ohio SHPO initially reviewed the proposed Wellington grade-separation project, they found that it would adversely affect the historic area because it "will introduce new elements in and adjacent to the National Register listed districts…and will thus diminish their integrity, mainly setting, feeling, and association."[7] Under the Section 4(f) regulations, an adverse effect finding by SHPO would have resulted in a "constructive use", which would have required an individual Section 4(f) evaluation, a timely and complex process. In order for Ohio Department of Transportation (ODOT) to construct the grade separation in the historic district they would have to prove that there is no prudent and feasible alternative to the using the Section 4(f) resource and that the selected alternative includes all possible planning to minimize harm to the resource.

ODOT had previously ruled out each of the other possible alternatives for grade separation in Wellington – identified during the original engineering study – due to engineering difficulties or because they did not meet the purpose and need of the project. As a result, the ODOT had to address SHPO's adverse effect ruling on the proposed grade-separation alternative.

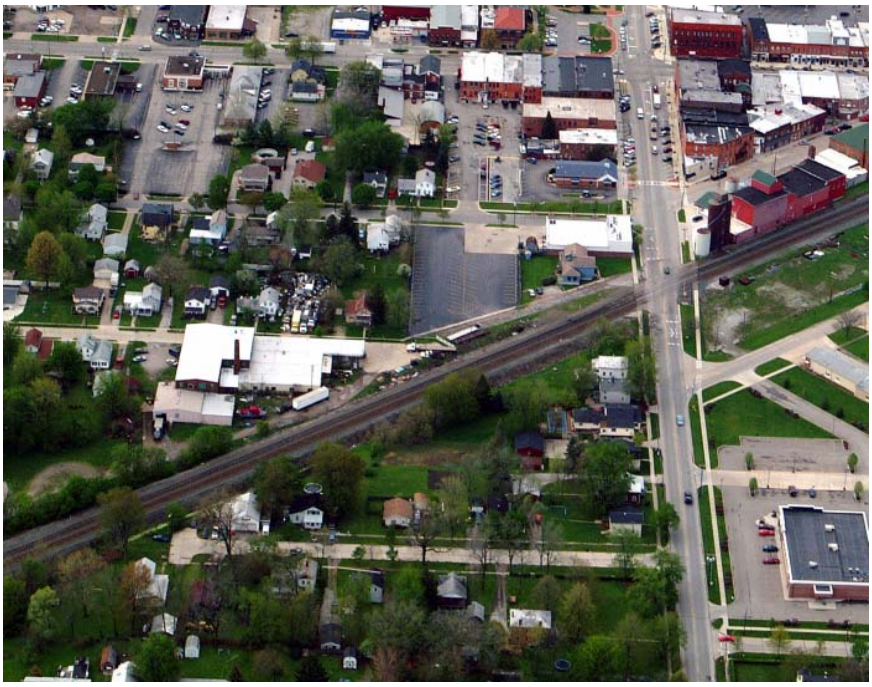

Figure 2: Existing alignment looking south

[7] Mark J. Epstein. (October 17, 2003). *Memo re: LOR 58-7.36 (PID 23104) Wellington Grade Separation Project*. Ohio Historic Preservation Office.

INCORPORATING VISUALIZATION IN THE PROJECT DEVELOPMENT PROCESS

In order to address SHPO's adverse effect ruling, ODOT needed to employ a systematic and objective method to determine and quantify the project's potential adverse impacts. ODOT needed to better understand and quantify the project's impacts before they could begin to discuss mitigation options. At the suggestion of the FHWA, ODOT undertook a Visual Impact Assessment analysis, a six-step method for quantifying the visual impacts of a proposed transportation project that was developed by the Minnesota DOT and the FHWA.[8] The analytic process was previously used on the ODOT Maumee River Crossing project, in Toledo, and its successful application their persuaded ODOT to apply it to their Wellington Grade-Separation project. ODOT contracted with TranSystems, which was already under contract to perform the preliminary engineering and design for the Wellington project, to prepare the Visual Impact Assessment.

VISUAL IMPACT ASSESSMENT

The Visual Impact Assessment is a six-step process for identifying, measuring, and assessing the nature of visual impacts. The six steps are:

1. Identify affected visual resources
2. Identify affected people
3. Define existing visual quality
4. Analyze impacts to visual quality
5. Summarize visual impacts by alternative
6. Mitigate adverse visual impacts and enhance existing visual quality

Identification of Affected Resources and People (Steps 1 and 2)

TranSystems took aerial and on-site photographs along the existing alignment, and conducted site visits to inventory the existing natural, cultural, and project resources. To determine the existing viewers (neighbors and travelers) within the project area, zoning and land use maps were reviewed for existing residential, retail, commercial, industrial, agricultural, recreational, and civic facilities. In addition, demographic data from the U.S. Census Bureau as well as traffic and rail data from ODOT and CSX were inventoried to determine probable affected parties.

Define Existing Visual Quality (Step 3)

TranSystems assigned each of the resources identified in the previous step as either natural, cultural, or project visual resources, which are the geometrics, structures and fixtures that compose the project environment. Each resource was then determined to be either harmonious or disharmonious to the natural environment, orderly or disorderly to the cultural environment, or as coherent or incoherent with the project environment. TranSystems synthesized the information for each resource and found that overall, although the project area includes many historic resources, many existing structures in the area are inconsistent with the historical feeling of the district. In addition, while the

[8] FHWA. *Visual Impact Assessment for Highway Projects*.

existing roadway geometrics are coherent, the majority of roadway fixtures are incoherent with the project's historical environment.

Analysis of Impacts to Visual Quality (Steps 4 and 5)
Once the visual quality of the existing project area is determined, the next step is to analyze how the proposed project will impact the visual quality. The visual impact assessment found that although the roadway design would be impacted by the loss of its straight-line geometrics, the new alignment "may enhance historic feeling in that several disorderly buildings…and incoherent features including artificial lighting, signage, and rail crossing signals and gates are to be removed along the existing alignment. These features which are considered inconsistent with historic setting will no longer be within the neighbor and traveler viewsheds."[9] The impacts to the visual quality by the proposed project were depicted via digital altered photographs (See Figures 1 through 4), as well as an animation simulating driving through the area on the new project alignment.

Mitigate adverse visual impacts and enhance existing visual quality (Step 6)
The visual impact assessment concluded that no mitigation was necessary because there were no adverse effects to the existing cultural visual resources. The proposed alternative provided the least impact on Wellington's historical districts and moves the footprint of the project away from the historic district. The analysis also determined that the proposed project would improve the natural resources of the area by adding additional greenspace. Moreover, the study concluded that the cultural order of the area would be enhanced through the use of context sensitive solutions. "Roadway fixtures, including overhead power and telecommunication cables, poles with street lighting arms and fixtures, roadway signs, and rail crossing signals and gates located north of the historic district are considered inconsistent with the historic setting. Through selection of the preferred alternative, these elements will be eliminated from the traveler viewshed as they proceed to and from the downtown area"[10] The new project design will incorporate appropriate fixtures and structural treatment, such as lighting fixtures that are consistent with the existing historic setting, to maintain the visual orderliness and cohesiveness of the environment.

RESOURCES USED IN DEVELOPING THE VISUALIZATION

The creation of the photo simulation and drive thru simulation involved a number of data sources, hardware and software applications[11].

Data:

- Aerial Photographs from Helicopter
- Existing building shots of downtown and surrounding buildings ~ approx 200

[9] TranSystems. (September 14, 2004). Visual *Impact Assessment: National Register of Historic Places, Railroad Grade Separation*. LOR-58-7.36, p. 7.
[10] TranSystems. (September 14, 2004). *Visual Impact Assessment: National Register of Historic Places, Railroad Grade Separation*. LOR-58-7.36, p. 7.
[11] Elizabeth A. Fulton. P.E., Associate, Assistant Vice President TranSystems. Interviewed on October 2, 2007

- Plan, Profile, GPK align, Sections, Elevation Structure Sheets, Sections for Bridge Deck, RR Bridge Parapet Detail Sheets

Hardware:

- Dell Pentium 4 - 1.4mhz, with 1 gig Ram
- 256 nVidia geForce Video Card
- Rendering Farm: 6 Machines, Pentium 3-4 1 – 1.4mhz
- 512 – 1 gig Ram
- 128 VRAM Video Cards

Software:

- Bentley MicroStation/GeoPak
- Autodesk 3D Studio Max
- Adobe Photoshop
- Adobe After Effects
- ArchVision RPC (3D Content Cell Library

OUTCOMES

The Visual Impact Assessment Report, which included the impact analysis results, a substantial photolog of photographs from the project area, and a three-dimensional drive through simulation of the new roadway alignment, was shared with the State Historic Preservation Office, accompanied by ODOT's request that they issue a conditional no adverse effect finding. The analysis and visualization tools created through the Visual Impact Assessment, coupled with a visit to the project site, enabled the SHPO representatives to firmly grasp the impacts that the proposed project would create. According to the History/Architecture Transportation Reviews Manager for the Ohio State Preservation Office, "the complexity of this project, in that it involved a complicated grade and alignment change and removal of buildings, made it particularly difficult to visualize in the abstract. The Visual Impact Assessment report and visualization tools really made it clear how the proposed project would affect the area."[12] After review of the visual impact materials and a visit to the grade crossing location, the Ohio SHPO felt that the vibrations and air pollution associated with the existing and growing truck and traffic idling caused by the at-grade crossing had greater negative impacts on the historic district than the proposed project would.

[12] Nancy Campbell, History/Architecture Transportation Reviews Manager, Ohio Historic Preservation Office. Interviewed on October 1, 2007

Figure 3: Proposed alignment looking northeast

The Highway Engineer in Ohio's FHWA Division Office believes "the amount of money spent on developing the visualization tool was money well spent[13]." Developing the Visual Impact Assessment and the visualization tools took the consultant 3 months, and amounted to 10 percent of the TranSystems contract cost (and only 0.5 percent of the total project cost). The reversal of the adverse effect finding meant that this project did not "use" a section 4(f) property, and as a result ODOT avoided the time delay and costs that would have resulted from a Section 4(f) review process. Even if the analysis supported an adverse effect, the assessment would have provided critical information needed to develop mitigation measures.

While the main purpose for undertaking the Visual Impact Assessment was to address the adverse effect finding from the Ohio SHPO, ODOT found it to be a very powerful communication tool to use throughout the public involvement process as well. While the visualization did not appease the opponents of the project, it did aid the public in grasping the details. As the project moves forward, the visualization has also been useful to ODOT's real estate personnel in its right-of-way acquisitions by providing a very clear before and after look at the project area.[14]

LESSONS LEARNED

Following a successful first experience with the Visual Impact Assessment, ODOT plans to utilize the technique on future complex projects; however, in the future, ODOT plans to employ the analysis earlier in the planning process. In addition, ODOT learned

[13] Michael B. Armstrong. Highway Engineer, FHWA Ohio Federal-aid Division. Interviewed on September 26, 2007

[14] Kenneth Wright. Transportation Planning Programming Administrator, Ohio DOT. Interviewed on September 27, 2007

detailed and realistic visual representations of the proposed project area helps communicate project implications to a diverse audience. The primary audience for the Wellington grade-separation application was the Ohio SHPO, and therefore, the visualizations focused on capturing the details of the historic district and applied a more basic portrayal of the surrounding area. While it would have increased the cost of developing the animation, the addition of more details, including adding more of the actual buildings and houses located in the area, would have made it a more effective communication tool for use during the public involvement phase.

CONCLUSION

The Visual Impact Assessment helped to streamline the project development process by providing a detailed, objective, and thorough analysis of the visual impacts to Wellington's historic districts of the proposed grade-separation project. This was key to getting SHPO approval for the project, thus avoiding a lengthy Section 4(f) approval process. While the visualization did not make this controversial project more agreeable to opponents, it did provide a powerful communication tool to help explain the complex details so that all stakeholders involved had a firm understanding of the project. Developing the visualization required both time and money but the resulting benefits had a positive net impact on the project development process.

Figure 4: Proposed alignment looking south

IV. Hoback Junction, Wyoming: The Role of Visuals in Developing the East Segment Environmental Impact Statement

PROJECT BACKGROUND

In 2000, the Wyoming Department of Transportation (WYDOT) initiated a Draft Environmental Impact Statement (DEIS) to study portions of the three highway segments that meet at Hoback Junction near Jackson, Wyoming. A decision was made to separate the project into three distinct segments, Hoback North, Hoback East and Hoback Junction (see Figure 1) due to the segments differing needs, the level of controversy for the solutions, and the proposed construction time frames.[15] This case study focuses on the Hoback East project segment.

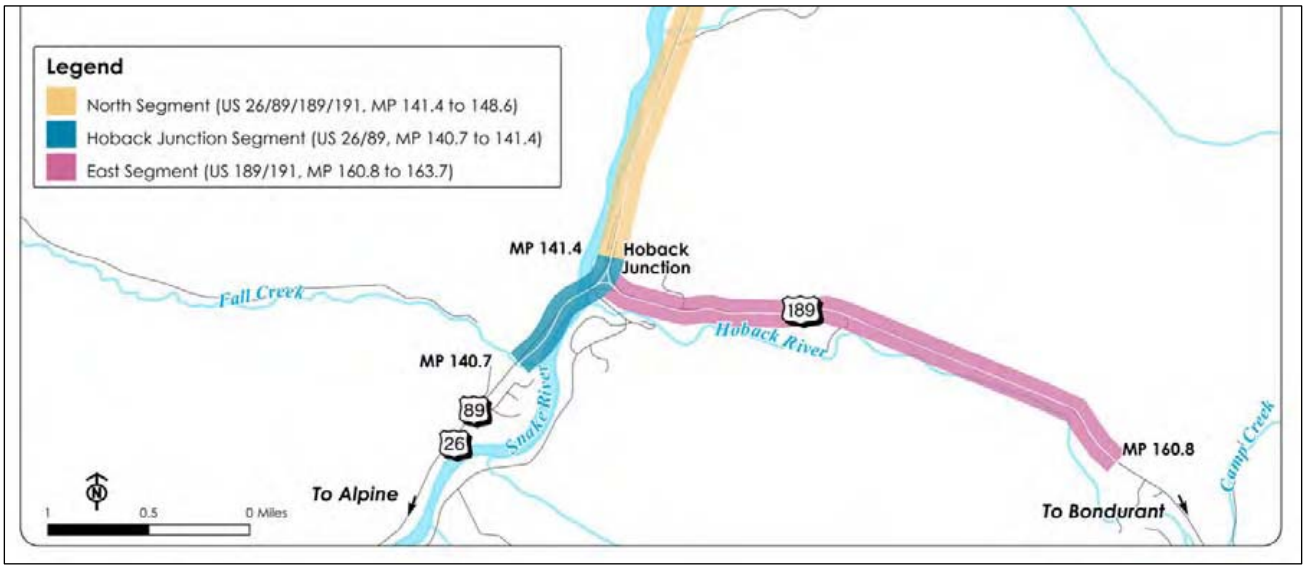

Figure 2: Project Segments

The Hoback East segment is a 3-mile stretch of Highway 191/189. This segment of the highway traverses a major landslide area. Before spending $15 million on repairing the roadway, WYDOT wanted to address the causes of the landslides. In the past, WYDOT has conducted mitigation efforts for slides but with the Hoback East segment, the depth to bedrock ratio meant that none of the traditional measures would be effective at stopping the slide mass. Therefore, WYDOT proposed two alternatives:

1. Avoid the slide by building two bridges across the Hoback River to the south

[15] Carter Burgess. (September 2007). Hoback Junction Environmental Assessment (Chapter 1). Hoback Juntion, Wyoming. Retrieved from http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Environmental_Services/Documents/Hoback%20Junction/Hoback%20FONSI.pdf

2. Build a large toe berm; 5000 cubic yards of earthen material to anchor and stabilize the land slide, allowing the highway to stay on the same alignment. Creation of a toe berm would require rerouting the Hoback River

Each of the proposed alternatives had potential environmental impacts, making the Hoback East segment the most controversial component of the project. This stretch of Highway 191 borders the Bridger-Teton National Forest, a roadless area that provides big game habitat, and also lies adjacent to the Hoback River, which is eligible for a Wild and Scenic designation. Due to the extent of environmental resources in the project area, the Forest Service and Wyoming Game and Fish Department are closely involved in the development of the Draft EIS.[16] These agencies were responsible for providing information on the existing resources and condition of the environment within the study area, as well as quantifying the resource impacts of the project alternatives.

To help with the environmental review process, WYDOT established a review team, called the ID Team, which was composed of federal, state, and local agency representatives as well as members of interest groups. While the team did not have decision-making authority, it played an important role in reviewing the project development proposals. The ID Team had been meeting for at least two years before a decision was made to explore the use of visualization to aid in presenting the alternatives to the public.

NEED FOR VISUALIZATION

Transportation agencies can face a daunting task of explaining the impacts of complex projects to the public. Often a DOT will rely on engineering plans to inform those interested. But as several interviewees noted, it can be difficult for non-engineers (which includes the vast majority of the public and non-transportation agency representatives) to understand and visualize what the proposed alternatives will look like.

The two-dimensional drawings and plans for the Hoback East project's proposed alternatives did not provide sufficient information to the resource agencies who were responsible for responding to the Hoback East EIS regarding the proposed project's resource implications. In addition, these two-dimensional plans did not provide the ID Team or the public with a clear understanding of the proposed project. In order to better communicate the project alternatives in a manner that would aid the resource agencies in identifying and quantifying the resource impacts, WYDOT decided to authorize the hiring of a consultant to create a visualization tool.

INCORPORATING VISUALIZATION IN THE PROJECT DEVELOPMENT PROCESS

In order to enhance communication and create a better public understanding of the project, WYDOT contracted with a consultant to develop a visualization tool to serve as a conceptual model of the two acceptable build alternatives being considered near the

[16] Carter Burgess. (September 2007). Hoback Junction Environmental Assessment (Appendix C). Hoback Juntion, Wyoming. Retrieved from http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Environmental_Services/Documents/Hoback%20Junction/Hoback%20FONSI.pdf

Hoback East landslide. WYDOT provided the consultant with key pieces of data including:

- Black and white aerial photography of the study area
- Terrain model developed using Microstation and GeoPak
- Standard plans/drawings of roadway features including guardrails and similar bridge designs

These data, which were delivered to the consultant in DGN (Microstation format), were imported into 3d Studio Max, to create two visualization products:

1. A photo simulation showing before and after images at specific locations (see Figures 2 through 5).
2. A series of animations from the roadway and river viewpoint for both the bridge and toe berm alternatives.

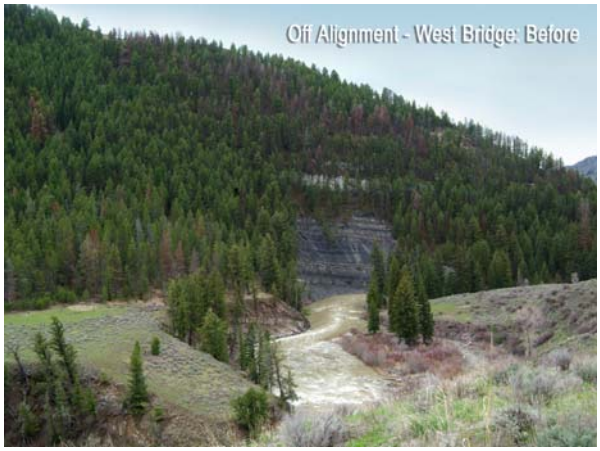

Figure 2: Off Alignment Alternative - Before

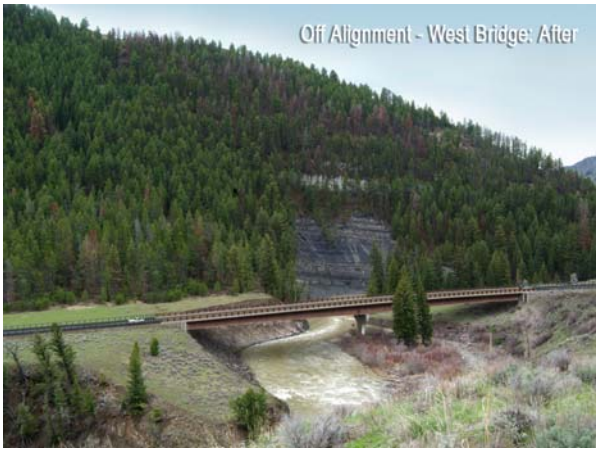

Figure 3: Off Alignment Alternative - After

According to the Chairman of the Teton County Board of Commissioners, the visualizations made a difference in the review teams understanding of the project proposals. "A real benefit of the visualization was that we were able to react to what we saw, and we weren't just reading about in a report. When you are just reading about something, it is hard to see, and it does not have that much meaning. To actually see how the river will be impacted was very helpful. "[17]

COSTS INVOLVED IN CONDUCTING VISUALIZATION AND IMPACT ON PROJECT SCHEDULE

The cost to produce the visualization products was approximately $40,000. The initial estimate for the environmental impact work was $1 million but has subsequently risen to $2 million for the three separate environmental impact statements (EISs). The estimated cost of construction for this segment is $15 million. Therefore, the visualization will end up costing about 2 percent of the total budget for environmental work. The Teton County Commissioner felt that the inclusion of visualization was cost effective- "I really think

[17] Andrew Schwartz. Chairman of the Teton County Board of Commissioners. Interviewed on October 11, 2007.

this is helpful and that WYDOT should seriously consider using it in other complex projects." WYDOT project manager Jeff Brown noted that "while the cost of the visualization products is small compared to the overall project costs, visualization can be expensive. It is important to develop clear expectations for the outcome of the visualization products."

The creation of the visualization products took about six months. The WYDOT project manager felt that any time potentially lost due to the visualization work was more than made up because the tool helped the other agencies and interest groups better understand the project.

OUTCOMES

There are no easy solutions that address the problem of landslides along this roadway and river corridor. Each proposed alternative will have adverse impacts on this environmentally sensitive corridor. To date, WYDOT has not chosen a preferred alternative. Several of those interviewed have proposed that WYDOT should construct the roadway improvements now and then deal with the landslide issues later when better technology to stabilize the land becomes available.

Although a preferred alternative has not been chosen, one clear benefit of the use of visualization came in helping the governmental agencies better quantifying the impacts of each of the alternatives. As part of the EIS document requirements, the U.S. Forest Service and the Wyoming Fish and Game Department are required to quantify the resource impacts and document specific issues and concerns associated with each alternative. Both agencies were having a difficult time documenting their specific issues, as well as quantifying the resource impacts. The visualization products allowed the agencies to better understand the potential impacts and quantify their concerns.

Several interviewees noted that the regional environmental groups near Jackson often differ with WYDOT or its roadway construction proposals. One state official noted that while the visualization tool did not necessarily make the environmental groups more accepting of the Hoback East project, but it did give people a better sense of what WYDOT was trying to accomplish and increase the comfort factor among reviewers. According to the Executive Director of the Snake River Fund, a non-profit organization whose mission is to promote stewardship of and recreational access to the Snake River Watershed, their group would like to be partners to help find solutions so that both WYDOT's and the environmentalists needs and purposes can be met. This is best accomplished through a better communication of project alternatives- something that visualization, if done correctly, can aid.

Figure 4: Toe Berm Area – Before

Figure 5: Toe Berm Area - After

LESSONS LEARNED

There are several lessons to be learned from WYDOT's use of visualization for this project. Most of those interviewed viewed the incorporation of visualization tools into the environmental process as being extremely beneficial.

- ***Use of visualization earlier in the process would have been beneficial.*** The visualization products were not developed until about two years into the environmental review process. Several interviewees thought that it would have been beneficial to have this work done earlier on.

- ***There is a need for early input and review before the final visualization is completed.*** Because the visualization products were only presented to the agencies and interest groups after they were finished, it did not allow for input early on in the process by those interested parties. It was felt by some that greater input at the very beginning of the process could have helped in identifying what aspects of the project were most important to focus on. For example, one agency would have liked to of seen greater detail of the river bank along the area of the proposed bridges.

- ***For at least several agencies and groups, the visualization helped people better understand the possibilities and work towards solutions***. Often reviewers are confronted with engineering documents that are difficult for the typical citizen to understand. The use of visualization in this environmental review was able to provide a better basis for review for those citizens. The Wyoming Game & Fish Department's representative felt that the use of visualization improved his agency's ability to provide quality input in the review- "WYDOT presented several forms of visualization. It was better than any review I have been involved with before."

- ***Use of visualization techniques should depend on the magnitude of the project.*** While it was universally agreed that the visualization products helped in the review process, a caution note was made that it may not be appropriate to include

the tools on every project.

- ***Visualization can help build informed consent.*** While everyone might not be proponents of a project, visualization can help people better understand what is being proposed. In the Hoback East project, the use of visualization did not lead to a consensus of a solution, but it did allow for a better-informed review by those interested. Visualization can help to build trust between the DOT and agencies, interest groups and the public. One reviewer stated that he believed that "for everyone in the room, the visualization products were able to make a difference in a positive way. It allowed people to be much better informed."

CONCLUSION

Visualization tools do not change the merits of the project, but provide a mechanism to help people better understand and grasp what a proposed project will ultimately look like. The more realistic the details that are incorporated into a visual the more effective it can be as a communication tool. While there are added costs to develop visualization products, it often can result in a better-informed public, more robust discussion, and possibly greater trust being established between the DOT and the reviewing public. A representative from the U.S. Forest Service noted "the visualization used in the Hoback East project helped people open up to possible solutions and then see what is feasible. People are looking for solutions, and visualization is key to this process."

V. Appendix A. DOT Interview Guide

Background

1. Provide a brief summary of the project that included visualization.

2. What visualization techniques did you use (animation, aerial photographs, etc.)?

3. What do the techniques demonstrate?

4. Why did you decide to use visualization for this project?

    a. Were there particular local circumstances that created the need for this visualization application? (i.e. a contentious local planning process, political considerations, unusually environmentally sensitive land)

    b. What was the visualization application a response to? What need does it fill?

Technical tools used

5. What visualization tools did you use (hardware, software, GIS, etc.)?

6. How did you obtain the data used in the visualization? What other data would have been helpful to have?

7. How did you use the visualization (internal or external use)?

Institutional and Public Participation Issues

8. What inter-agency coordination was involved in the development and use of the visualization?

9. What institutional issues had to be overcome to include visualization in the project development process?

10. If you used the tool to communicate with the public:

    a. How do you think the visualization affected public participation?

    b. What was the public's response to it?

<u>Costs, benefits, and lessons learned</u>

11. How did the visualization impact the time frame of the project development/decision-making process?

12. What was the cost of the visualization application relative to the total project development cost?

13. What were the benefits of using visualization?

14. Were there negative aspects of it?

15. What lessons did you learn regarding developing and using visualization?

16. What advice would you give to other states that are thinking of undertaking a similar project?

17. Does your agency plan to use visualization for other projects under development?

Referrals:
Can you provide the names of other people who can provide information from other perspectives- members of the public, environmental agency, environmental advocacy group, regional planning agency, etc.

VI. Appendix B. Non-DOT Agency Interview Guide

1. Provide a brief summary of your organization's involvement or interest in this project.

2. What is your relationship with the state DOT?

3. Prior to seeing the visualization, what was your opinion about the project?

4. In what setting did you view the visualization?

5. What did you think of the visualization? – did it provide you with helpful information?

6. How did viewing the visualization affect your understanding and/or opinion of the project?

7. What do you think the DOT could have done to use the tool more effectively?

8. Was there additional information or different visualization tools that you would have found useful?