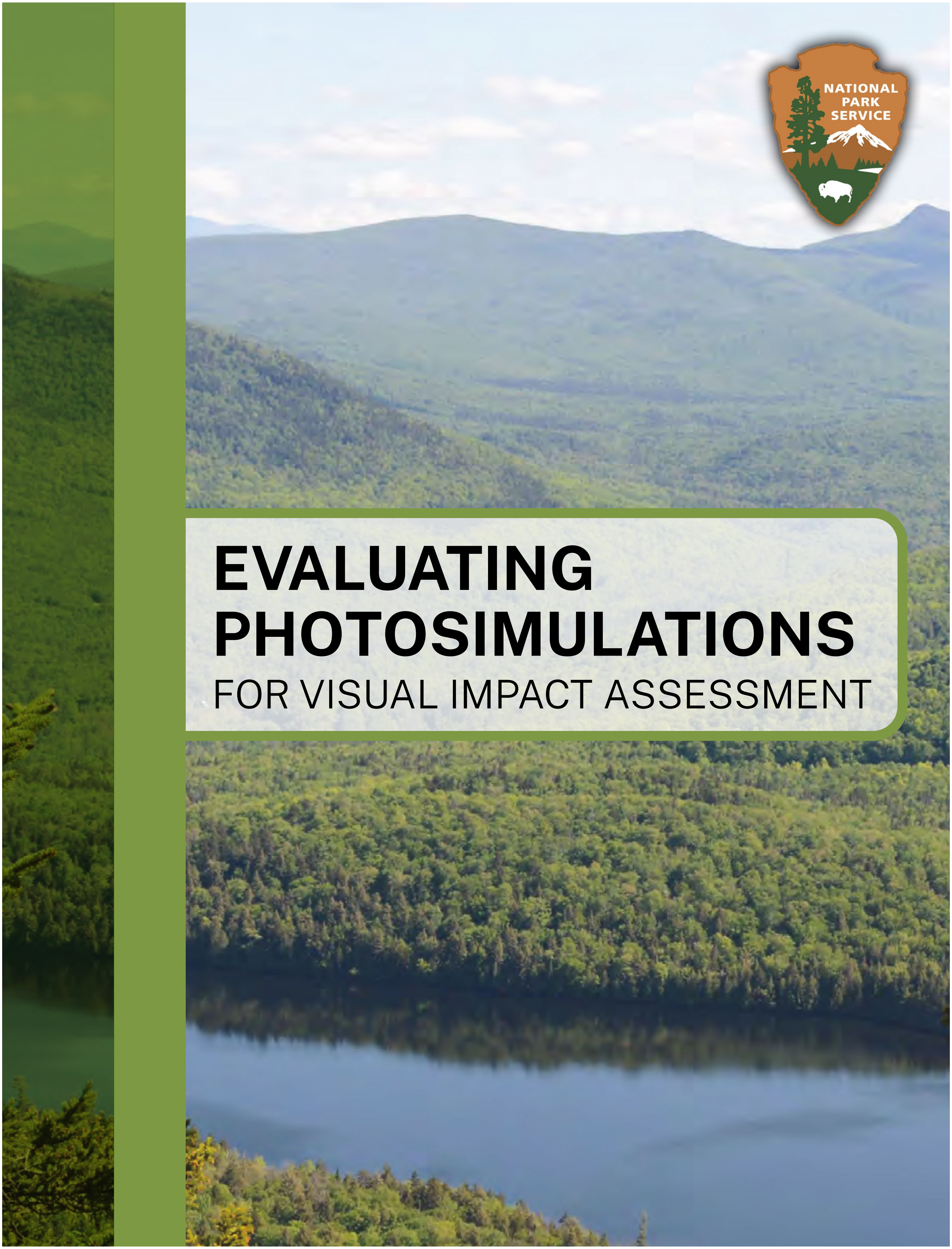
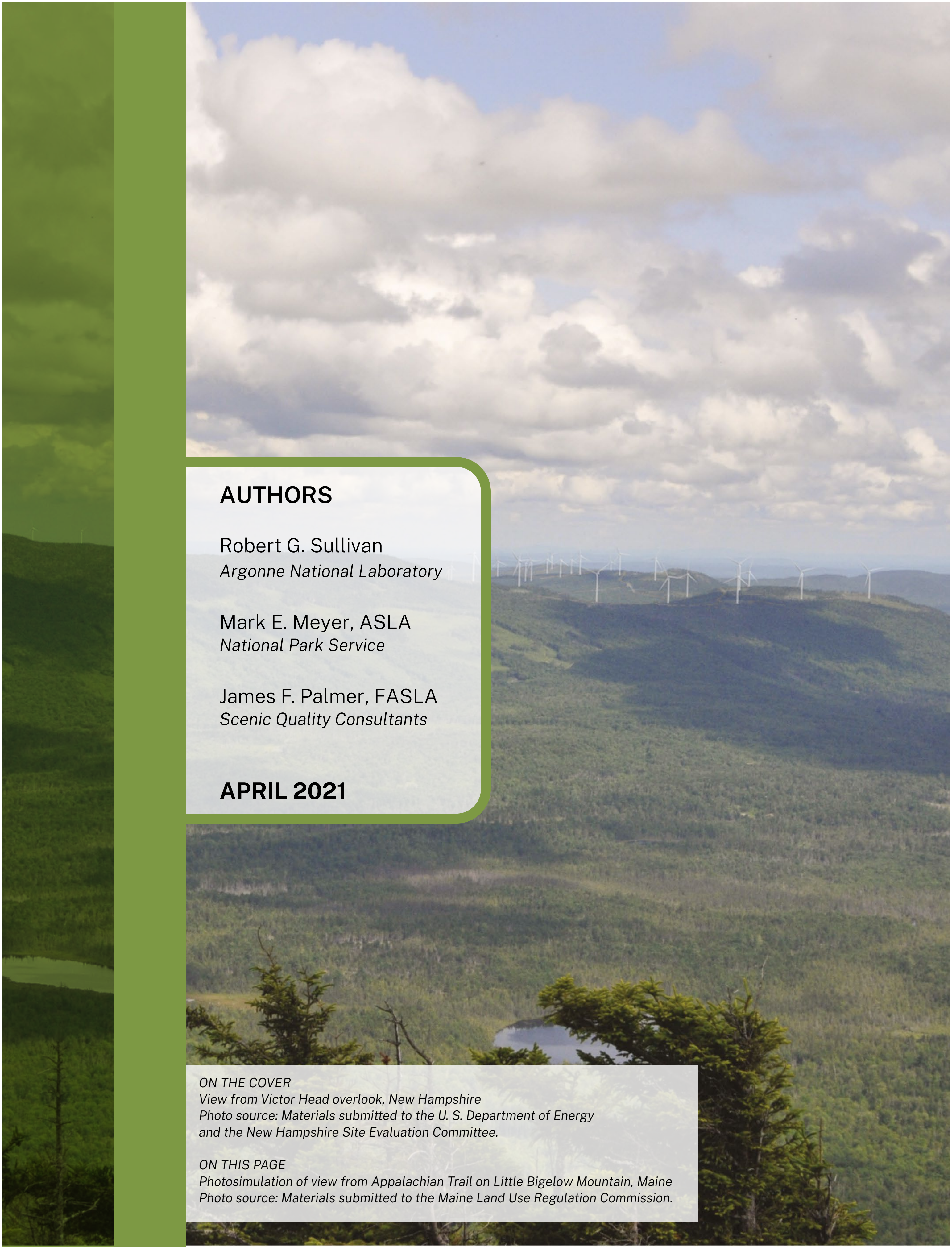


EVALUATING PHOTOSIMULATIONS

FOR VISUAL IMPACT ASSESSMENT

NATIONAL PARK SERVICE



AUTHORS

Robert G. Sullivan
Argonne National Laboratory

Mark E. Meyer, ASLA
National Park Service

James F. Palmer, FASLA
Scenic Quality Consultants

APRIL 2021

ON THE COVER
View from Victor Head overlook, New Hampshire
Photo source: Materials submitted to the U. S. Department of Energy and the New Hampshire Site Evaluation Committee.

ON THIS PAGE
Photosimulation of view from Appalachian Trail on Little Bigelow Mountain, Maine
Photo source: Materials submitted to the Maine Land Use Regulation Commission.

Contents

EXECUTIVE SUMMARY

Visual simulations are visualizations of a proposed project and surrounding landscape that show how the project and landscape will look in the future — usually when the project is operational. While there are several types of visual simulations and several purposes for which they can be used, this evaluation guide focuses on the use of photosimulations in visual impact assessments (VIAs). Photosimulations are spatially accurate and realistic computer-generated visualizations of the proposed facility superimposed onto a still digital photograph of the existing landscape. This publication provides guidance for evaluating photosimulations rather than for creating them. It is intended primarily for use by any NPS staff with professional responsibility for assessing visual impacts based on photosimulations.

This photosimulation evaluation guide focuses on the use of photosimulations in visual impact assessments (VIAs). Photosimulations must present an accurate and realistic view of a project that does not yet exist; project elements must be shown in the right place, facing the right way, at the right size, and in the right lighting conditions. Preparing photosimulations for VIAs requires skill, technical knowledge and specialized computer software. However, there are inherent limitations to photosimulations. Problems and errors can arise even when carefully, and skillfully prepared. If they are poorly executed or limitations are not properly addressed photosimulations can be misleading with problems that may not be apparent to most viewers. As a result, evaluating the accuracy and realism of photosimulations can be challenging.

The general steps to the evaluation process are checking

- the completeness of the simulation package you received,
- the presentation products of the simulations,
- if the views of the project selected are appropriate,
- that the weather and lighting conditions are appropriate,
- the accuracy of the project components in the photos and that the simulations seem realistic.

Chapter 1 provides an orientation to how to use this guide. Chapter 2 describes how photosimulations are typically made. Chapter 3 and Chapter 4 describe the limitations and commonly encountered problems with photosimulations. Chapter 5 takes you through the six-step process of evaluating photosimulations as an NPS stakeholder for a proposed project. Also included are short checklists to help track your evaluation.

The evaluation process is not solely a desktop exercise and there are certain aspects of the review that should be done at the viewpoints the simulations represent.

ACKNOWLEDGEMENTS

The authors wish to thank our reviewers: Terry DeWan, Maine Licensed Landscape Architect, Terry J. DeWan & Associates; Jeremy Owens, PLA, Senior Landscape Architect, T.J. Boyle Associates, LLC; John McCarty, PLA, ASLA, Landscape Architect, Bureau of Ocean Energy Management; Andrea Blakesley, Environmental Specialist, Denali National Park & Preserve; and Denise Nelson, Environmental Protection Specialist and Matt Robinson GIS Specialist, Appalachian National Scenic Trail. All were generous with their time and provided valuable feedback to improve the guide.

ACRONYMS AND ABBREVIATIONS

EFL	Equivalent Focal Length
FAA	Federal Aviation Administration
GPS	Global Positioning System
KOP	Key Observation Point
LiDAR	Light Detection and Ranging
NPS	National Park Service
VIA	Visual Impact Assessment

Recommended Citation:

Sullivan, R., M. Meyer and J. Palmer. 2021. Evaluating photosimulations for visual impact assessment. Natural Resource Stewardship and Science, Air resources Division. National Park Service, Lakewood, Colorado.

1 INTRODUCTION

1.1 Photosimulations in Visual Impact Assessment

We have all heard that "A picture is worth a thousand words." This is especially true when it comes to assessing the visual impacts of proposed projects that may affect the scenic quality or appreciation of the landscape[1].

Visual simulations are visualizations (typically computer-generated) of a proposed project and surrounding landscape that show how the project and landscape will look in the future — usually when the project is operational. Visual simulations are important tools used to predict the visual impacts of proposed projects. They also can help decision makers and stakeholders understand the project's likely appearance and effects on scenic quality. Visual simulations are used routinely in preparing visual impact assessments (VIAs) that are part of the environmental impact assessment for a proposed project. They are also useful in identifying mitigation measures intended to minimize adverse visual impacts and perhaps most importantly.

While there are several types of visual simulations and several purposes for which they can be used, this evaluation guide (Guide) focuses on the use of **photosimulations** (sometimes called photomontages) in VIAs. Photosimulations are spatially accurate and realistic computer-generated visualizations of the proposed facility superimposed onto a still photograph of the existing landscape. When properly done, they will look just like a photograph of the proposed project would look, at least to an untrained eye. However, they are subject to errors and omissions that may not be obvious to the untrained eye. Being able to recognize these common errors in photosimulations is important to the proper assessment of the proposed project's impact on scenic quality. It also affords the opportunity to request that photosimulation errors and omissions be corrected.

[1] *In this guide, for convenience, we will use the word "landscape" to describe both landscapes and seascapes.*

This Guide will teach you how to review photosimulations submitted as part of a VIA. It will help you to develop the "trained eye" that is needed to critically assess the completeness, spatial accuracy, and realism of photosimulations so that you and others can better understand the proposed project's likely visual impacts.

VISUAL SIMULATIONS VS. PHOTOSIMULATIONS

A *visual simulation* is a hand-or computer-generated visualization of a proposed project and surrounding landscape that shows how the project and landscape will look when the project is built. There are several types of visual simulations, including hand-drawn sketches, entirely computer-generated images, video simulations that show movement over time, and photosimulations. Most types of visual simulations are not based on "real-world" photography of the project area. A *photosimulation* is a spatially accurate and photorealistic visual simulation of the proposed project superimposed onto a digital photograph of the existing landscape.

1.2 Why this Guide Is Needed

Photosimulations are an important component of VIAs. Their primary use is to help the impact analyst assess the visual contrasts created by the project and to help decision makers and stakeholders understand the project's likely appearance and visual impacts.

Assessing the accuracy and realism of a photographic image might seem straightforward. However, errors and bias can be very hard to detect because most people are conditioned by experience to accept as real what is represented in photographs. This Guide is needed to help people who must evaluate photosimulations to detect errors and bias in photosimulations so they can make better judgments about visual impacts.

The addition of elements that do not actually exist yet — the project and any ancillary facilities — in exactly the right place, facing exactly the right way, shown exactly the right size, and matching the colors, materials, textures, and lighting conditions perfectly, is complicated and prone to error and omissions, even when done carefully by a skilled preparer. In addition, choices must be made about which view to simulate, from which viewpoint, and which time of day or season of the year to simulate. Likewise, the size of the image used to present the project must be determined so the viewer sees the project at the proper scale. Finally, in order to get a true understanding of the size and color of the project and surrounding landscape, photosimulations must be viewed from a specific distance under specific lighting conditions. The choices made for these variables and any mistakes made in the process may cause errors or create bias that leads to poor quality impact assessment even though the photosimulations seem to portray the overall appearance of the project accurately. This Guide helps identify common limitations and errors and also provides key principles for evaluating photosimulations.

KEY PRINCIPLES OF PHOTOSIMULATION EVALUATION

1. **Check the documentation and presentation of photosimulations:** Are correct viewing instructions provided, and is there appropriate documentation for the photosimulation process and the photosimulations themselves?
2. Check the views chosen for photosimulations: Are the views important to stakeholders?
3. **Check the weather and lighting conditions chosen for photosimulations:** Do the photosimulations show the maximum visual contrast that could reasonably be expected on a regular basis?
4. **Check the spatial accuracy of the photosimulations:** Are all project and other elements shown in the right locations, at the right size, and in correct visual perspective?
5. **Check the realism of the photosimulations:** Does the simulation look like a high-quality photograph of a real project?

1.3 Intended Users and Uses

This NPS publication is intended primarily for use by any NPS staff with professional responsibility for assessing visual impacts based on photosimulations. It provides guidance for evaluating photosimulations rather than for creating them. However, it should be useful to anyone who produces or evaluates photosimulations in the context of VIA. It should prove especially useful for those who create photosimulations for VIAs that NPS will review, as it describes many aspects of photosimulations that the agency will use to evaluate photosimulations for VIAs in which NPS is a stakeholder.

1.4 Scope

There are many types of visual simulations — everything from hand-drawn sketches to video simulations to augmented or virtual reality-based simulations that are not based on photographs. Similarly, there are several possible applications of visual simulation within the project development process, such as design concept visualization and public communication. Many of the evaluation practices discussed here also apply to other types of visual simulations and applications, but the Guide is focused on still-image photosimulations intended for use in VIAs.

1.5 How to Use This Guide

If you have photosimulations for a project in hand, and do not have time to read the entire Guide, go straight to Chapter 5, which provides step-by-step instructions for checking the completeness and accuracy of photosimulations. Use the checklists at the end of the chapter to complete and document your evaluation. To help quickly locate specific subjects, the other chapters are described below.

- Chapter 2–Describes how photosimulations are created.
- Chapter 3–Discusses the inherent limitations of photosimulations — even very good ones — to accurately and realistically portray the human visual experience of the landscape.
- Chapter 4–Contains more in-depth information about common sources of error in

photosimulations. Often, you may see a photosimulation and instinctively know something is wrong, but have a hard time identifying the source of the problem. Reading this chapter will help you spot common problems more quickly.

- **Appendix A** lists specific items that should be included in documentation of photosimulation.
- **Appendix B** provides a comprehensive list of best practices for evaluating photosimulations and
- **Appendix C** provides examples of simulations exhibiting best practices and problems described in the Guide.

1.6 Sources

The following publications were the primary sources for the best practices and other content in this guide.

Apostol, D., Palmer, J., Pasqualetti, M., Smardon, R., and R. Sullivan. 2016. The Renewable Energy Landscape: Preserving scenic values in our sustainable future. Routledge, Abingdon, UK.

Horner + Maclennan, and Envision. 2006. Visual Representation of Windfarms: Good Practice Guidance. Scottish Natural Heritage, Inverness, Scotland.

Landscape Institute. 2019. Visual representation of development proposals. Technical Guidance Note 06/19. Landscape Institute, London, UK.

Sheppard, S. R. J. 1989. Visual simulation: A user's guide for architects, engineers, and planners. Van Nostrand Reinhold, New York.

Sheppard, S. 2001. Guidance for crystal ball gazers: developing a code of ethics for landscape visualization. Landscape and Urban Planning. 54:183-199.

Sullivan, R., and M Meyer. 2014. Guide to evaluating visual impact assessments for renewable energy projects. Natural Resource Report NPS/ARD/NRR—2014/836. National Park Service, Fort Collins, Colorado.

2 HOW PHOTOSIMULATIONS ARE MADE

2.1 Development Responsibilities

Preparation of photosimulations is normally the responsibility of the project developer. Because photosimulation development is a complex technical process, they will usually hire a contractor who specializes in conducting VIAs and preparing simulations. Good contractors will have trained and experienced simulation professionals with adequate resources to develop high-quality photosimulation products.

For controversial projects, additional photosimulations may sometimes be prepared by third parties, such as peer reviewers or project opponents (or contractors that project opponents hire). Additional photosimulations may be prepared to:

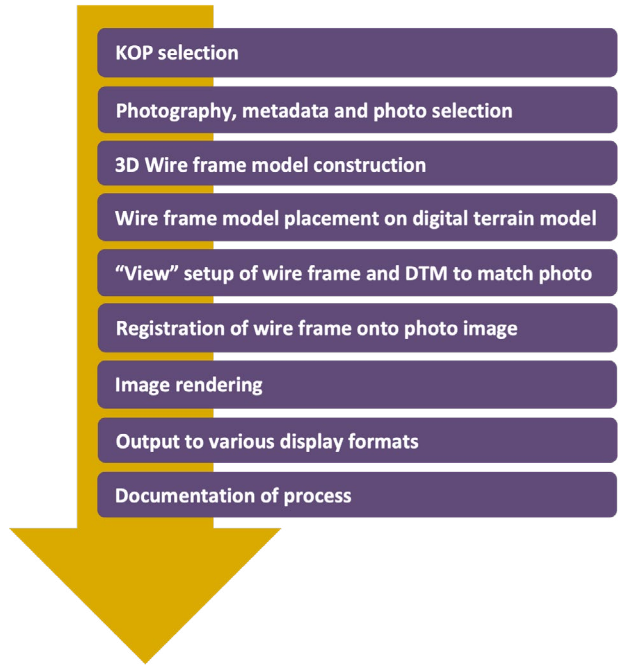
- verify or refute simulations or
- verify or refute statements about impacts in a VIA,
- simulate impacts at additional locations or
- simulate impacts under different lighting conditions.

Photosimulations prepared by third parties should not be used for impact assessment unless properly prepared and documented by qualified personnel.

2.2 Photosimulation Production Summary

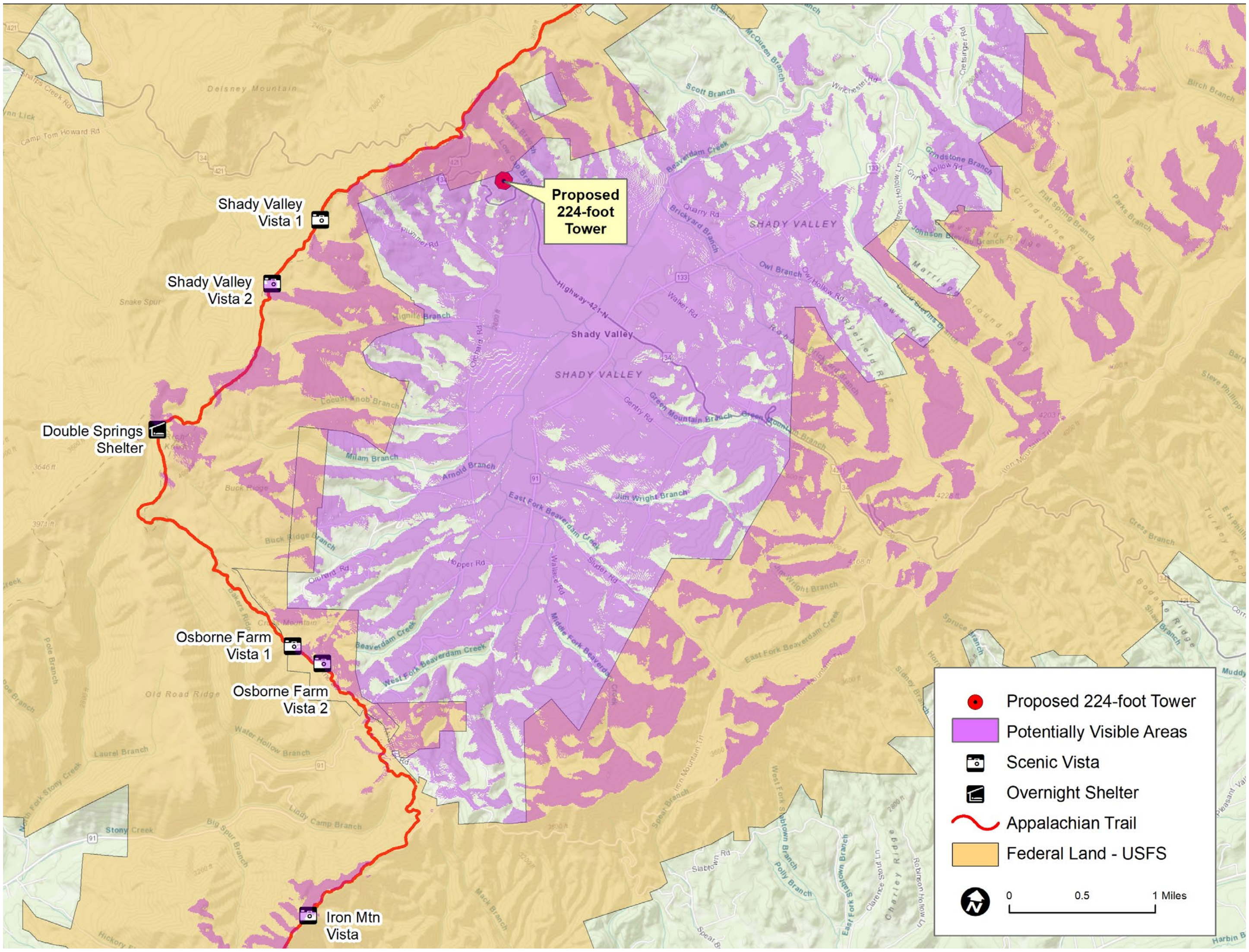
Photosimulations developed for VIAs use specialized computer software to superimpose a computer-generated image of the proposed project facility onto a digital photograph of an existing view of the proposed project site. The general sequence of production is shown in Figure 1 and the steps are summarized below. Note that there may be some variation in the steps taken and the order of steps in the process.

Figure 1. Photosimulation Production Process



1. **KOP selection.** A project viewshed map is prepared showing all locations within a specified distance of the proposed project from which the project may be visible, considering topography, vegetation, and structures that might screen the project from view (Figure 2). Typically in consultation with potentially effected stakeholders (including NPS) the viewshed map is used to identify important viewpoints (e.g., scenic vistas), linear features (e.g., hiking trails), scenic areas (e.g., wilderness areas) or other locations from which the project may theoretically be visible. From these locations, some are selected as Key Observation Points (KOPs) that will be used in the VIA to assess the visual impacts of the project. A KOP is not necessarily a precise point on the ground; it could be an area, such as a parking lot, or a scenic overlook with a number of possible points from which to experience the view.

Figure 2. A viewshed map with colored shading showing areas where a proposed tower may be visible and the viewpoints along the Appalachian Trail that could be affected. *Credit: NPS/Matt Robinson*



2. Photography, metadata and photo selection. The project location is photographed from the previously selected KOPs using high-quality digital cameras and lenses, and in good weather and lighting conditions. The actual location at the KOP where photos of the project are taken is often referred to as the photo point or camera location. Typically, photos are taken from multiple photo points at the KOP in order to allow for choice in selecting the clearest view of the project or to avoid distracting foreground elements, such as shrubs or fences. In addition to the date and time of the photography, other data collected includes the location of the camera and the point at which it is aimed, visible control points in the surrounding landscape that can be used for registration, and the lens focal length. Locations are typically determined using high-accuracy global positioning system (GPS) technology.

If the simulation depicts a project that may affect a large portion of the view, overlapping photos of the landscape are taken and then stitched together on the computer to create a panoramic view. Panoramas are also used to show the visual context of the project, i.e., the larger landscape in which the project is located.

After discussion and evaluation of the photos, a set of photos from a particular photo point is chosen for use in the photosimulation for the KOP.

3. Wire frame construction. Using appropriate visualization software, a spatially accurate three-dimensional (3D) "wire frame" model of the project is built. The model is referred to as a "wire frame" model because the computer image shows only a general outline of the model elements, which together look like an assembly of wires.

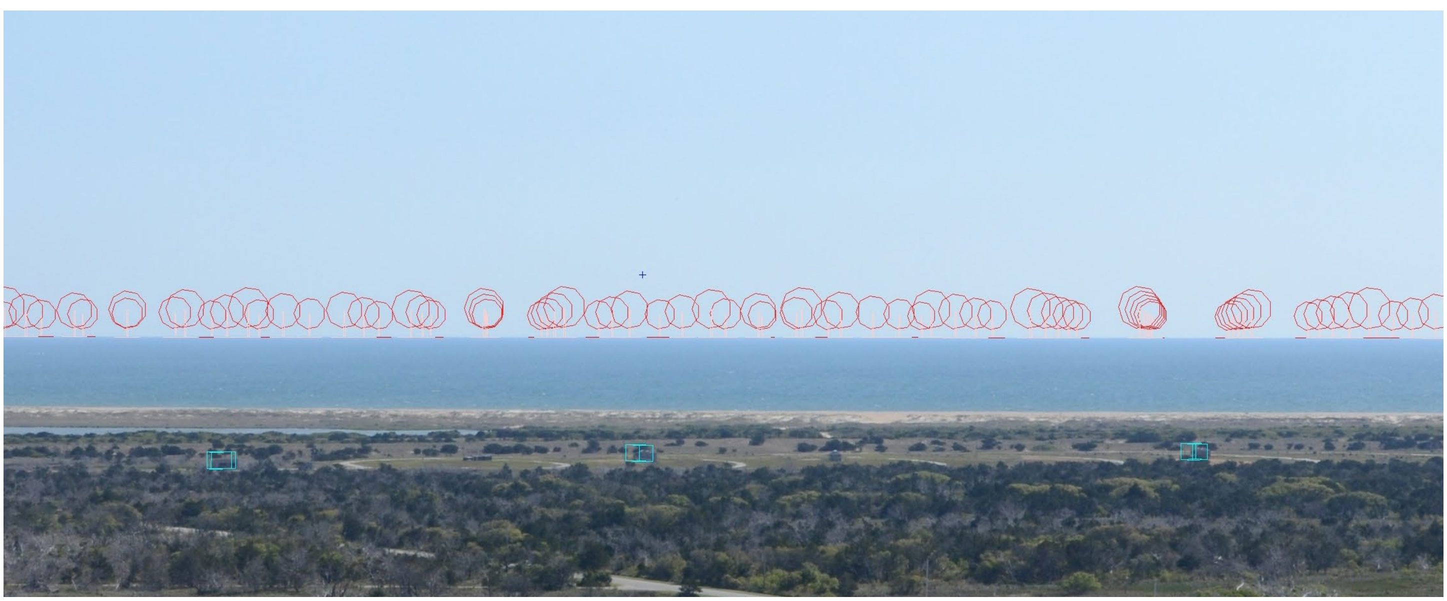
4. Wire frame placement. The wireframe model of the project is then placed in a spatially accurate 3D terrain model of the project landscape, derived from elevation data for the earth's surface. The control points in the base photograph (which may be flagpoles, road intersections, or other large fixed objects, or surveyed flags or stakes) are located and shown in the terrain model.

5. Camera view setup. A "view" of the project wire frame model and the surrounding terrain model is set up in the visualization software. The software controls mimic the operation of a camera and allow the simulation preparer to specify the identical lens focal length, camera height, and project coordinates used for the base photograph from the KOP. As a result, the digital model of the project is shown at the same apparent size, in the same orientation, and from the same visual perspective as it would be seen from the KOP.

6. Registration. In a process called registration, the wireframe digital model is superimposed precisely onto the base photograph using the control points from both the base photograph and the digital model to assure accurate alignment of all of the layers of information (Figure 3). When properly registered, the 3D model is shown in the correct location, at the correct size and aspect, and in the correct visual perspective. Minor adjustments are often necessary because of imperfections in the elevation and/or project data. Where there is a long distance between the viewpoint and the project, such as in an offshore wind project, correction for earth curvature needs to be considered in the registration process, because these factors will change the apparent height of objects at various distances in the landscape.

Figure 3. A wire frame model registered to a photograph. The red circles represent the sweep of wind turbine blades. The 3D model is registered to the photograph using the red lines at the horizon and the blue boxes around known landscape features.

Credit: T. J. Boyle Associates



7. Rendering. The wireframe terrain model is then removed from the image while the project model superimposed onto the photograph is retained. Using the visualization software, the project model is rendered with colors and textures that match those of the proposed project (Figure 4). Depending on the project, real textures and materials from other photographs are sometimes overlaid on the project model for added realism (e.g., forested, canopy, or excavation operations). The visualization software uses the date, time, and location of the base photograph to calculate the position of the sun in the sky. It uses the calculated sun position, along with cloud cover and weather information recorded at the time the base photograph was taken, to shade the project model and simulate the correct positioning and intensity of shadows cast by the model elements. Minor adjustments to the rendering may be made to achieve greater realism. Image editing tasks related to landscape changes associated with project construction may involve modifications of landforms, removal of trees and existing structures, and adjustments of foreground elements that would be seen in front of the project.

Figure 4. The rendered 3D model is located on the photograph and digitally edited to remove portions of the turbines that are beyond the horizon. *Credit: T. J. Boyle Associates*

8. Output. The photosimulations are prepared for presentation in one or more output formats, which typically include large-format, high-resolution prints, digital files for computer projection, and smaller format prints for use in reports and other communication pieces. Presentation layouts typically include supplementary information to aid viewers in interpreting the simulation.

9. Documentation. The final step is to clearly describe the context of the KOP and the view, the photography and simulation process, and viewing instructions should accompany the simulation(s). The summary above is general in nature, and individual practitioners may use slightly different processes. A variety of photographic equipment and software may be used. The combination of different processes, equipment and software, as well as the skill of the simulation preparer, may affect the quality of the simulation.

3 INHERENT LIMITATIONS OF PHOTOSIMULATIONS

3.1 Introduction

While the simulation creation process may seem relatively straightforward, there are many opportunities for error, from choosing the content of the simulation — what to simulate and from where — to developing a simulation that is spatially accurate and realistic in appearance. Chapter 4 discusses the many possible sources or errors in photosimulations; however, even the best photosimulations are limited in their ability to show what a project will really look like, because of limitations that are "baked-in" to still-image photography. This chapter discusses the inherent limitations of photosimulations to depict the real visual experience of a project in the landscape.

The inherent limitations of photosimulations fall into two general categories: the limitations of camera and image display technology, and the limitations of still imagery to depict motion and change over time. These factors are very important because they ultimately limit the ability of a photosimulation to accurately represent the visual impact of a proposed project, no matter how carefully it is prepared.

3.2 Camera and Image Display Technology

Photosimulations are based on photography. However, the camera does not "see" like a human eye. A two-dimensional image on a screen or piece of paper is not the same as the three-dimensional stereoscopic view of a real scene that the human eye takes in and transmits to the brain. Ultimately, a photosimulation simulates what the proposed project would look like in a photograph, which is somewhat different than what it would look like when viewed in person.

3.2.1 Contrast Range

A camera cannot capture the same range of visual contrast as the human eye. Although photographers can manipulate photographs with enhanced color saturation and contrast, photographs— and simulations based on photographs—typically appear somewhat more flat and duller than real-life views of the landscape. In addition to making individual objects stand out less, this can affect the perception of distance to the project because people use color intensity and sharpness as visual cues to judge the distance to a seen object (see Sec. 3.2.5).

While this limitation affects all simulations based on photography, it is an especially important limitation for photosimulations depicting glare, such as very bright reflections from water, glass or metal surfaces. In reality, these reflections can be so bright that they cause visual discomfort or even pain. It is not possible to reproduce this level of extreme brightness on paper or on a computer screen. This limitation also makes it difficult or impossible to show the brilliance of artificial light at night in photosimulations.

3.2.2 Horizontal Field of View

Photographs also have a limited and predetermined horizontal (and vertical) field of view. They show what is "within the frame" of the shot. As a result, the visual context provided by the larger landscape that would be visible in the real landscape is lost. Panoramic photosimulations, typically constructed from multiple "stitched" images, may be used to expand the horizontal field of view of photosimulations to show more of the surrounding landscape. However, the image size at which the simulation is displayed must be dramatically increased in order to preserve visible detail. The commonly used panoramic images at an 11x17 size, can result in a loss of detail in the image, or a reduction in the apparent size of the facility such that it appears too small when viewed from a comfortable distance. Furthermore, correct viewing of panoramic images is more complicated than for "normal," single-frame views, in part, because of apparent distortions that are observed when a panoramic image is projected onto a flat surface such as a screen or a printed page.

3.2.3 Limited Viewpoints

Photosimulations developed for specified viewpoints can only depict the views from those exact locations, and thus, they omit potential views of the project from all other locations within the viewshed. Photosimulations for a large project may only represent views of the project from a relatively small part of the total area from which the project would be visible. A good selection of viewpoints should cover all views of major concern to stakeholders. However, the project will also be visible from many locations not represented by the photosimulations, including some with very different views of the facility. Impacts to these views constitute a portion of the total visual impact of the project.

3.2.4 Viewing Distance Requirements

A photosimulation (either a paper photograph or an image on a screen) must be viewed at a specific viewing distance to see the project components at the same size as they would appear to the observer standing at the viewpoint in the real landscape setting (Figure 5). Viewing the photosimulation from an incorrect viewing distance may result in the project appearing to be larger or smaller than would be observed in the field. This could result in an over- or under-estimation of the project's visual contrast. The correct viewing distance is a function of the camera's photographic sensor width, the focal length of the lens used to take the photograph, and the size at which the photosimulation is reproduced or viewed.

Figure 5. Demonstration of viewing simulations at the proper viewing distance. *Credit: T. J. Boyle Associates for BOEM*

3.2.5 Image Resolution

In order to present the sharpest image possible, professional-quality photosimulations are typically created for printing at high resolution on large-format, high-quality paper. However, especially for use in reports, the photosimulations are frequently reproduced at smaller sizes, at lower resolution, and/or on inferior paper or printers that cause a loss of detail or blurred images. This may have important effects when assessing impacts, especially for photosimulations of wind energy or transmission facilities as seen at longer distances. In these cases, the small and fine lines of towers, turbine blades, or transmission lines (conductors) may be rendered indistinguishable, or be blurred enough that they eye is fooled into seeing the facility as farther away than it actually is. The latter effect results from our tendency to judge the distance to objects based on their sharpness and color intensity. In some cases, these fine line details may not be visible at all, lost between the pixels. The same effect may occur on computer monitors displaying the photosimulation image at lower resolution. See Section 5.4 for further discussion of image resolution.

3.3 Still-Imagery

Although everyone is familiar with photographs and accepts them as close approximations of visual reality, still photographs are static, limited representations of a view from one location at one instant in time. There are multiple potential issues to keep in mind when relying on still images:

- The view is chosen by the simulation creator, not the viewer, and thus directs your attention to what they wish you to see, not what you might choose to look at.
- The human visual experience is dynamic, changing constantly as the viewer directs their gaze, or moves through the landscape in order to look at particular elements as they desire.
- The visual environment changes constantly as the sun's position changes in the course of the day and as clouds pass overhead.
- Elements of the project itself may move or change in appearance dramatically over time.

3.3.1 Inability to Depict Motion

Motion in the visual field attracts attention. Photosimulations are still images that cannot adequately capture and convey motion. In reality, motion is an integral part of the human visual experience as the viewer's eyes, head, and body move. Further the viewer's eyes are drawn tp movement of elements of the landscape, such as clouds and vehicles, and, in some cases, movement of project elements.

People normally view the landscape by scanning back and forth across the field of view, focusing visual attention on objects successively. Viewers' eyes are almost constantly in motion, and viewers themselves move around during any extended viewing experience, such that their perception of the landscape changes — at least slightly — as they move. This movement, even more than binocular vision, is the basis of our understanding of spatial and scale relationships in the landscape. The viewer controls which elements to focus upon, and for how long. Viewers in vehicles may see elements of the landscape pass by more or less quickly, depending on their speed and the distance to the elements. This is a very different visual experience than looking closely at a still image for an extended period.

In addition, movement of objects in the landscape increases their visibility and their visual contrast as perceived by viewers. The motion of turbine blades is a very important part of the visual experience of a wind energy project; vapor plumes from cooling towers and boilers are in constant motion. Billowing dust clouds from vehicular traffic associated with facilities operations can add noticeably to the visual contrasts of a project, as can the motion of operators' vehicles themselves. The inability to depict motion in photosimulations may thus result in lowered perceptions of visual contrasts associated with a project.

3.3.2 Inability to Depict Changes over Time

A photosimulation is a "snapshot in time." It portrays a project in a static view with particular lighting, shadows, and visual context that does not change no matter how long we view it. However, visual experience of the world changes over time. Although we may tend to think of facilities as generally unchanging in their appearance during the course of the day, field observation shows that passing clouds, changes in wind speed and direction, or the appearance of sudden bright reflections sometimes alter the visibility of a project in just a few minutes or even seconds. In addition, the position of the sun and changing atmospheric conditions throughout the day can dramatically affect the appearance of a facility, such that, for example, a wind facility that is difficult to see at noon on a hazy day is easily visible against the setting sun in clearer conditions later in the day. This plays out seasonally as well. Overall, lighting is weaker in the winter than in the summer, although the air may be clearer; vegetation changes in color at various times of the year; snow falls in winter; and leaves fall in many places in the autumn. All of these changes can substantially change the appearance of a facility.

Similarly, but on the scale of seconds, photosimulations cannot show the flashing of lights such as those on wind turbines, communication towers, or other tall structures. The Federal Aviation Administration (FAA) requires certain obstruction lights to flash for safety reasons. Flashing is particularly conspicuous in the case of wind energy facilities because the aviation warning lights required by the FAA flash in synchronization.

The end result of the inability to show changes over time in a photosimulation may be to underemphasize the dynamic nature of the visual experience of a facility; and in the case of flashing lights to substantially underestimate the visibility of a facility at night. Creating multiple photosimulations to depict changes in lighting in the course of the day, or to depict changing seasonal effects can partially compensate for some of these time-related effects, but is not always done in practice. While not the focus of this guidance, video and time-lapsed video simulations are sometimes used to portray the visual effects of movement, changing sun angles, variable cloud cover, and the flashing of aviation warning lights.

4 COMMON PROBLEMS IN PHOTOSIMULATION

The development of spatially accurate and realistic photosimulations to support a VIA is a complex technical process that requires skill, appropriate software, accurate elevation and project data, rigorous methods, and careful choices about the locations and conditions to simulate. Ill-chosen or poorly executed photosimulations may be misleading, but the problems may not be apparent to most photosimulation viewers. This chapter discusses the major sources of errors and other problems in photosimulations.

4.1 Improper Display of Photosimulations

Photosimulations must be displayed and viewed properly for accurate impact assessments to be made. For example, photosimulations included in typical paper copies of VIAs downloaded from Web sites and printed on standard office printers are of insufficient quality for accurate impact assessment. They will usually be duller in overall appearance relative to the real landscape view, will often have incorrect colors, and will usually lack details apparent in a simulation printed at high resolution on a high quality printer using high quality paper (See Section 5.4 for more information on image size and resolution). These display problems typically will result in underrepresentation of the visual contrast of the project.

Potential problems with photosimulation display include:

- **Improper viewing distance.** Photosimulations must be viewed from a specified distance in order for the project to appear to be at the same size as it would be seen in a real view from a given viewpoint (for example, 23.5" from the eye for a photosimulation printed on an 11" x 17" sheet at actual size). If the photosimulation is viewed from a shorter distance, the project will appear larger than it would in the real view. If the photosimulation is viewed from a greater distance, it will appear smaller than it would in real life. Photosimulations inserted in the text of a report may be reproduced at a size so small that they cannot be comfortably viewed from the required viewing distance. In this situation, viewers will usually view the photosimulation from a comfortable distance that is farther than the required distance, resulting in the project appearing smaller than it would in reality.

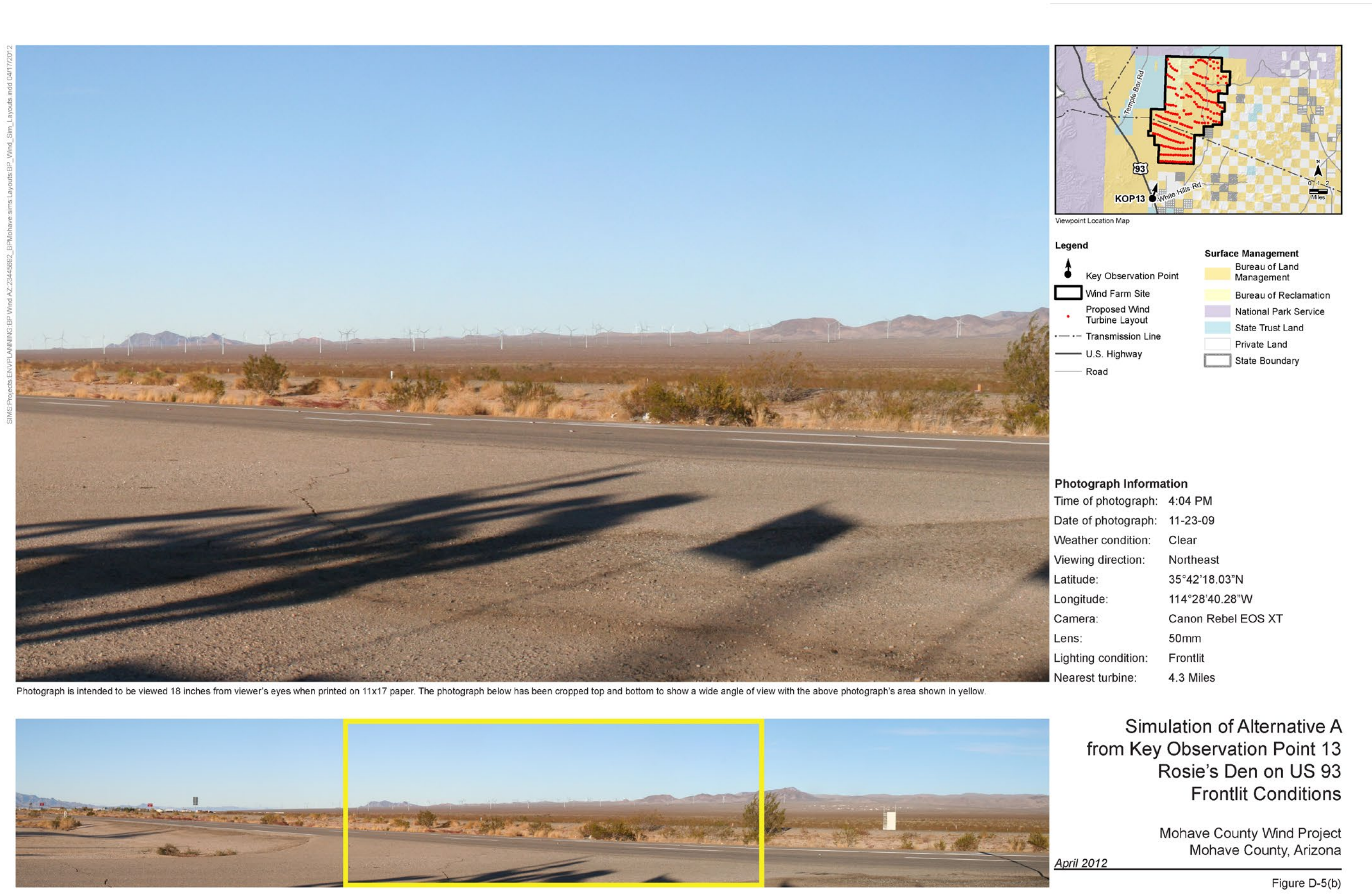
- **Lack of necessary detail in the displayed simulation.** Photosimulations presented at too small of a size also make it difficult or impossible to see details important for accurate assessment of impacts. Detail may also be lost if low-quality print reproductions are made, or if a low-resolution digital image is used to reduce the report file size for e-mail transmittal or downloading.

- **Improper display lighting.** If the lighting used for viewing the simulation is overly bright or improperly positioned, it may cause glare on printed photosimulations (or on monitors used for photosimulation display), making details difficult to see. Lighting that is not bright enough may also make details difficult to see, especially in darker images. Properly prepared photosimulations of artificial lighting at night cannot be accurately portrayed in print media, and must be projected, or viewed on a monitor. It is important that these photosimulations be viewed in a very dark room with dark-adapted eyes, or else the simulated lights will not appear as bright as they would be seen in a real view.

- **Lack of supplementary information.** A variety of information about photosimulations is needed so that those conducting the impact assessment can fully understand exactly what is being depicted and understand important parameters and limitations of the simulation. Some information needs to be available while viewing the photosimulations (e.g., date and time of the base photograph), while other information (e.g., description of simulation methodology) should be available in the VIA or other written material. Without this information, it is difficult if not impossible to evaluate the photosimulations thoroughly.

- **Distracting elements on existing condition or simulation images.** Extraneous labeling or graphic elements (logos, maps, arrows, diagrams, viewing instructions, etc.) on the "Existing Conditions" and simulation images can draw visual and mental attention away from the images themselves, and reduce the amount of available paper than can be used to display the photosimulation (Figure 6). Up close elements such as signs or shadows in the base photo can also be a distraction. Even if a simulation is well done, the distracting elements can reduce its effectiveness in communicating the project impacts.

Figure 6. Example of a simulation with technical information, location map and other information that can distract from the simulation and reduces the amount of space available. *Credit: Bureau of Land Management*



4.2 Improper Selection of Views

Views used in the impact assessment must be selected carefully to include both important and representative views of the project. They should be locations from which people view the landscape. Poorly chosen views may result in incomplete or biased VIAs.

Potential problems when selecting views for photosimulations include:

- **Not selecting enough views for simulation.** Producing high-quality photosimulations is expensive and time-consuming, but enough views of the project from different KOPs must be provided to make an informed decision about the range of project impacts.

- **Omitting views that are important to stakeholders.** KOPs should include views identified as important to stakeholders. This requires consultation with stakeholders or their knowledgeable representatives.

- **Omitting representative views for large areas where specific known viewpoints cannot easily be identified.** For areas where no specific viewpoint locations of particular importance to stakeholders can be identified, such as a wilderness area without trails or scenic overlooks, or a river or road segment where viewers are moving, views from one or more locations should be chosen in order to understand the range of project effects on these areas. The viewpoints should not be chosen arbitrarily, but rather should be chosen based on how well they represent views typical for different portions of the area, for example, from different distances, terrain types, or viewing angles.

- **Simulating too many views.** Simulating too many views of the project from multiple KOPs with similar views may confuse or bore simulation viewers, and wastes money and time.

- **Simulating views that do not include the visible project.** Photosimulations should show what the project looks like only where at least some part of the project is visible. If the project is completely screened by topography, vegetation, or structures, there is no need or value in simulation; if the KOP is important, it may be appropriate to use a wireframe model of the project (or similar means) with the base photograph to illustrate the screening. Similarly, photosimulations should not be created for lighting/weather conditions that would render the project completely invisible.

- **Selecting a partially obstructed view of the project when an unobstructed view is available.** Photo points with partially obstructed views should be avoided if an unobstructed view is available in the immediate vicinity. People will move to a nearby location with an unobstructed view of something they wish to see, In particular, views should avoid immediate foreground elements that interfere with the view, such as utility poles, handrails, or foliage.

- **Selecting views that depict unrealistic viewpoints or and/or view directions.** Selecting a photo point that results in a view that people normally cannot see is not appropriate. For example, a view 15 feet above ground level, in the middle of a hedge, or in an area that is off-limits, provides little to no value to decision-makers. Depicting a view direction so that the project is viewed peripherally when people would normally see the project in the center of the field of view is also not appropriate.

- **Selecting views for photosimulations that, as a group, minimize the perception of project impacts.** Considered as a group, photosimulations for a project should not minimize the perception of the potential visual impacts of the project through improper selection of views. This is achieved primarily by consciously avoiding the errors and problems listed above.

4.3 Improper Selection of Lighting Conditions

Proper selection of lighting conditions (as determined by date, time of day, weather, and atmospheric conditions) is important to a complete and accurate VIA. Selecting the weather and lighting conditions for photosimulations can be challenging.

Potential problems when choosing lighting and weather conditions for photosimulations include:

- **Not simulating the "typical worst case visibility scenario."** While the point of photosimulations is to portray "how the project will look," the project may look very different when viewed under different lighting and weather conditions at different times of the day and different seasons of the year. However, a primary concern of stakeholders is to understand the full extent of the impacts they may reasonably expect to see for the views they care about. The concept of the "typical worst-case scenario" is very helpful for identifying the lighting and weather conditions to simulate.

  A "typical worst-case visibility scenario" simulates conditions that would result in the greatest visual contrast from the project; these are conditions reasonably expected to occur with at least some frequency.

TYPICAL WORST-CASE SCENARIO: AN EXAMPLE

For a windfarm viewed from the west, the typical worst-case scenario lighting and weather conditions would likely be early to mid-morning on a clear day with good visibility. In this case, the wind turbines would be backlit (silhouetted) by the rising sun, and the shadowed side of the turbines facing the viewer would contrast strongly with the bright backdrop. This lighting situation would happen on most clear days, and so would be considered the typical worst-case scenario.

Although it may be useful or important to simulate views under other lighting and weather conditions (e.g., when the typical worst-case visibility scenario does not happen during seasons or times of high use [see below]), for at least some views, the typical worst-case scenario should be simulated, if possible. Otherwise, decision makers and other stakeholders will not get an accurate idea of the full impacts of the project.

- **Not depicting views during seasons or times of day of high use.** For areas where seasonal visitation varies widely (e.g., at many beaches, or where visitation is much greater at certain times of day), at least some of the simulated views should depict lighting and environmental conditions from the seasons/times of day of high use, if possible.

- **Creating photosimulations in which the weather and lighting conditions render the project invisible.** While it is reasonable to discuss the effects of weather and lighting on project visibility in the VIA, the purpose of photosimulations is to show the visual impacts of the project. When the project is not visible (e.g., in dense fog conditions), it has no visual impact; therefore, a simulation depicting non-visibility of the project serves no useful purpose.

- **Using one base photograph to simulate multiple weather and lighting conditions.** A photosimulation is based on photography, and the simulation should show the project added to a base photograph that depicts the existing conditions at the time the photograph was taken. While it is possible to simulate various weather and lighting conditions, the resulting images are overly speculative in nature.

- **Omitting photosimulations for lighting at night.** Where facilities require lighting sufficient to cause impacts at night, these impacts should be depicted in photosimulations.

4.4 Spatial Inaccuracy in Photosimulations

Spatial inaccuracy in photosimulations results from omitting elements that are visible in the real landscape; showing elements that would not be visible; or showing objects in the wrong locations, at the wrong sizes, or in the wrong visual perspective. All of these problems involve inaccuracies in the placement or 3D coordinates of simulated elements.

Potential problems with spatial accuracy in photosimulations include:

- **Changes to the project design after the photosimulations are prepared.** Design changes that occur after photosimulations are prepared are obviously beyond the control of the simulation preparer but are a relatively common problem.

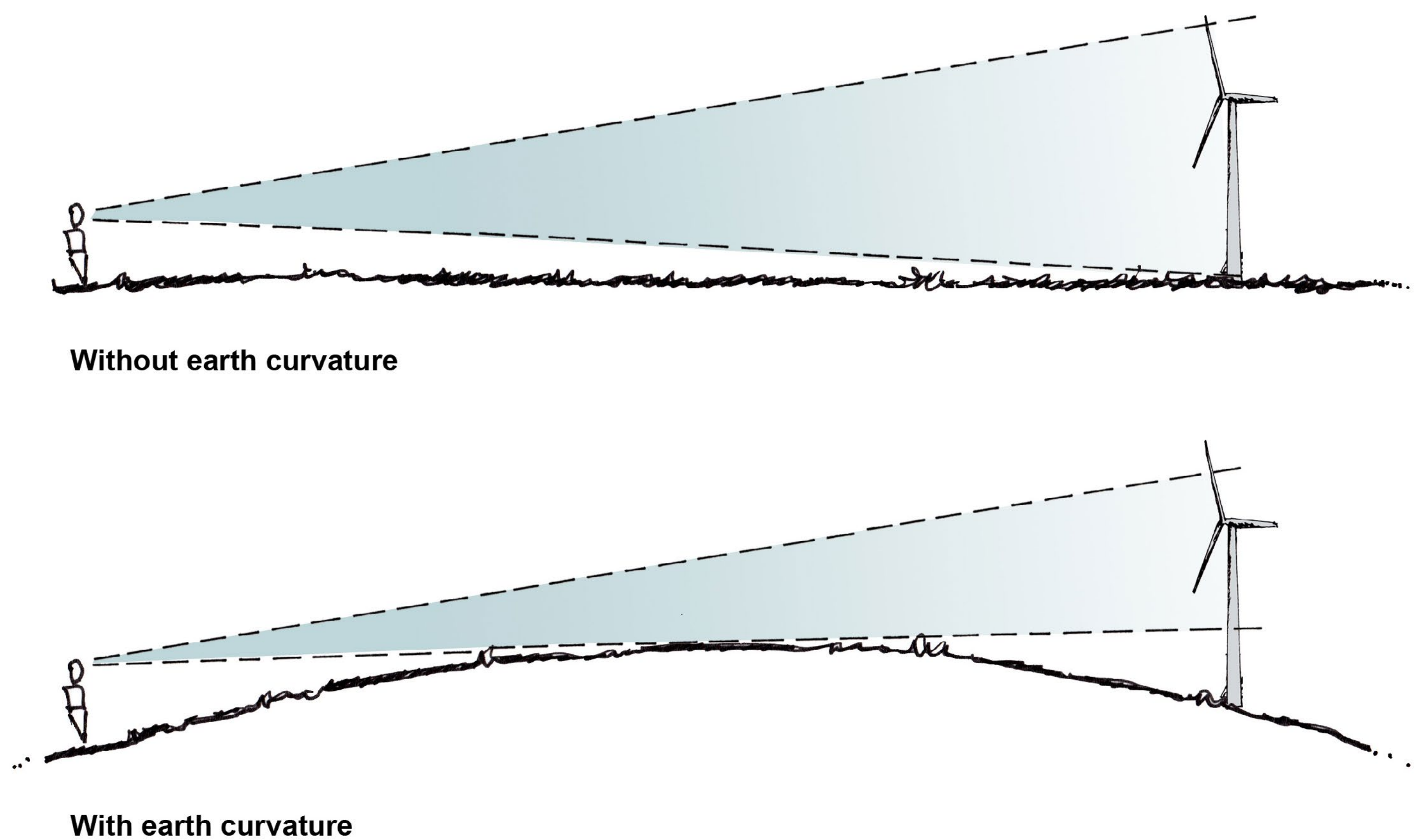
- **Incorrect locations for the KOP or project elements.** Depending on the size of the location error, incorrectly locating the viewpoint or project elements could seriously affect the simulation; however, large errors would likely be detected during simulation preparation.

- **Incorrect setup of viewing parameters in the visualization software.** Recall that preparing a photo simulation requires setting up a "camera view" in the simulation software that replicates the real camera view used for the base photograph (section 2.2). Any errors in specifying the viewing parameters in the software "camera view," such as incorrect focal length or camera height, may potentially have a significant effect on simulation accuracy.

- **Errors in elevation data used to develop the photosimulation.** All elevation data vary within their stated accuracy and are also subject to errors that may exceed the stated accuracy. Inaccuracy in elevation data may result in incorrect concealment or exposure of landforms and project elements in the photosimulation.

- **Failure to incorporate earth curvature in photosimulation development.** The effect of earth curvature is to screen the lower portions of objects, and this effect must be accounted for in photosimulations where the project may be seen at very long distances (Figure 7). Generally, for shorter distances of about 5 miles or less, it is not an issue. The effect is continuously variable but precisely known and may become noticeable at longer distances. The elevation of the viewer must also be factored into the calculation. For example, for a six-foot tall observer at sea level, earth curvature at 10 miles would conceal the lowest 33 feet of an object. At 5 miles, only about 3 feet would be hidden from view.

Figure 7. Diagram showing the effects of earth curvature on viewing projects at longer distances.
Credit: Argonne National Laboratory



- **Improper registration of terrain and project models with the base photograph.** If the terrain and project models are not correctly registered to the base photograph, project elements may appear in the wrong locations. In many cases, the effect is relatively minor, but it can be important if objects in the simulation appear very small, typically when they are distant from the viewer. For example, even a slight error in registration may have a noticeable effect in a simulation of distant wind turbines appearing just above the horizon line.

- **Failure to account properly for screening elements.** Omitting vegetation and structures in the simulation that would screen the view of the project in the real view, or incorrectly removing such screening elements in the simulation may obviously affect project visibility. When existing elements are removed, an incorrect replacement of visible elements in the previously screened area of the image can occur.

- **Failure to depict vegetation growth or regrowth accurately.** For projects where new vegetation is proposed or regrowth is depicted (e.g., along the edges of a newly cleared transmission or pipeline right-of-way), the period of time after construction that the photosimulation is meant to represent (e.g., 5-years, 10-years, 20-years) may not be specified or properly represented in the simulation. For example, mature vegetation may be depicted in photosimulations of pipeline rights-of-way, but the size and density of vegetation shown may not be achievable for several decades.

- **Use of incorrect or incomplete models of facility components.** Photosimulation accuracy depends on a complete and accurate model of the project, without missing or misplaced project elements.

- **Failure to depict visible elements connected to the project but not considered part of the project for impact assessment purposes.** If the project requires or involves ancillary facilities that are not considered part of the project, but that would be built and visible in project views (e.g., transmission lines, substations, or roads), they should be depicted in the project's photosimulations.

- **Project element models not oriented properly with respect to the viewer.** If the model is placed in the correct location in the simulated view but is not properly oriented to the viewpoint (both horizontally and vertically), the visual perspective of the simulated project will be incorrect. Errors in perspective may cause more or less of project surfaces to be visible than would be the case in the real view. For example, angles such as building corners may be "off," or lines such as structure edges may appear longer or shorter than they should.

4.5 Lack of Realism in Photosimulations

A simulation may be spatially accurate but not realistic; that is, the project elements are in the right locations and proper visual perspective, but they do not look the way they would in a real view of the project. For example, the project elements may be the wrong color, look cartoonish, or have blurred or overly sharp visual edges that do not blend seamlessly with the background. Some errors in realism may be very subtle and difficult to detect but can change the perceived contrast of project elements, causing bias in the impact assessment.

Other aspects of realism concern either the addition of elements to the simulation that do not appear in the base photograph, and/or the omission of elements that are directly caused by or associated with the project, and would normally or often be visible. A final concern for realism in photosimulations is the choice of field of view for base photographs and simulations. Additional details of these potential causes of lack of realism are described below:

- **Insufficient contrast range.** As noted in Section 3.2.1, photographs tend to be duller than a real view, especially when reproduced on certain output media. This affects the perception of distance of objects in the simulation and may reduce the overall impression of contrast from the project.

- **Improper atmospheric effects.** Depicting the atmospheric conditions between the KOP and the project as overly hazy or clear results in project elements appearing too dull and dark, or too clear and bright to match the surroundings.

- **Improper coloring and shading of project elements.** Poor color choices and shading techniques result in incorrect colors for project elements, a flat appearance to the project, or an overemphasis on three-dimensionality.

- **Improper blending of model edges with the background photograph.** Not properly blending the rendered model with the image background results in overly sharp or sawtooth edges on objects, or "mushy" blurred edges that are inconsistent with the edges of other objects in the base photograph. Besides looking unnatural, either of these problems may affect perception of distance to the project.

- **Incorrect lighting and shadow casting.** Incorrect date or time specification (which the simulation software uses for sun positioning) or other lighting-related errors may cause illumination and shadowing of the project elements to not match the lighting and shadows in the base photograph.

- **Addition of elements that are not part of the base photograph.** While it is possible to convincingly fabricate other elements of the photograph by adding structures, vehicles, people, vegetation, waves, and sky, the resulting images are speculative in nature. Photosimulations used in a VIA should be based on a real photograph taken at a particular time and place so that you can assume that this is the "true" existing condition. The only added element that has a factual basis is the project and it should be constructed and rendered to match the same location, time, and conditions of the base photograph. You can then assume this to be a true" representation of the project. When the base photograph and rendered project are combined, you should be able to assume that additional editing is kept to a minimum so that the completed simulation is faithful to the time and place of the base photograph. In extreme cases, most of the image is fabricated, containing elements that do not currently exist in the setting, and may never exist (Appendix C). Such images may qualify as "artists' renderings'" but are not suitable as photosimulations for use in VIAs.

If the project itself would include routinely visible but transient elements (e.g., vapor or dust plumes, parked vehicles, glare, or lighting), these elements should be included in the impact description in the VIA even if they are not always added to the photosimulation. If they contribute to the typical worst-case visibility scenario, they should be included in simulations. However, the depicted elements must have some documented factual basis, and the addition of these elements must be clearly called out in the photosimulation documentation.

- **Incorporation of mitigation measures that are currently not part of the project design.** If visual impact mitigation measures are proposed or under consideration but have not actually been incorporated into the project design, they may not be implemented. Thus, their incorporation into photosimulations would be misleading for the impact assessment. There may be situations where preparation of additional simulations that depict proposed mitigation is appropriate, such as at the request of stakeholders.

- **Overly Narrow or Wide Field of View.** The use of wide angle views for simulations (not accompanying panoramas used to show visual context) often results in overly "zoomed out" simulations they cannot comfortably be viewed at a close enough distance from the viewer. Because these simulations are viewed from too far away, project and landscape elements will appear too small, the images may lack realistic detail, and this may present an unrealistic distorted visual perspective. The use of telephoto lenses or cropped images often results in overly "zoomed in" images that cannot be conveniently held at a long enough distance away from the viewer. Because these simulations are viewed from too close project and landscape elements will appear too large, and the images may not show enough visual context for the project.

5 EVALUATING PHOTOSIMULATIONS: A STEP-BY-STEP GUIDE

5.1 Introduction

This chapter takes you through the step-by-step process of evaluating photosimulations as an NPS stakeholder for a proposed project, applying the best practices presented in Chapter 4. While reading Chapter 4 is helpful to getting the most out of this chapter, it is not essential.

At the end of this chapter there is a helpful checklist for you to track and document your evaluation. The checklist follows the steps discussed in this chapter closely, and we strongly recommend using it. An example set of simulations created following the best practices outlined in this guide is provided in Appendix C.

You should also keep in mind that you do not have to complete every task in the evaluation process. You may not have time, or you may not have access to software or information needed for some of the tasks. Remember, some level of evaluation is always better than none.

It is helpful to think of the evaluation process as consisting of six steps:

1. **Checking Completeness: Do you have** everything you need to conduct a thorough evaluation?
2. **Checking Presentation:** Are the photosimulations of sufficient size and display quality to see details, lighting, and colors clearly, and are you viewing them at the proper distance under the right lighting conditions?
3. **Checking View Selection:** Are the simulation viewpoints selected for photosimulations appropriate?
4. **Checking Weather and Lighting Conditions:** Do the photosimulations depict the appropriate conditions for weather and lighting?
5. **Checking Accuracy:** Are all of the components of the proposed project and the surrounding elements visible, correctly located, and shown at the right size and visual perspective?
6. **Checking Realism:** Do all of the elements in the simulation look nearly identical to how the real project would look in terms of lighting, color, texture, and sharpness?

Finally, understand that photosimulation evaluation is not solely a desktop exercise. Field review of the photosimulations should be considered a critical part of the review process. As discussed in Chapter 3, photosimulations are limited in their ability to replicate the human visual experience. Understanding how closely the simulation approximates the real visual experience of the landscape seen from the KOP can only be done in the field, with the simulation in hand. As a result, several of these steps require fieldwork at the KOPs and possibly other locations. We indicate below which steps require fieldwork. While fieldwork tasks are presented separately under each step below, those tasks requiring fieldwork should be combined into one or a few visits. A brief checklist for each simulation, including items to be checked in the field is also provided at the end of this chapter to help evaluate each simulation from its photo point and assist in taking effective notes about your observations.

5.2 Potential Critical Problems and Options for Correcting Deficiencies

For various reasons, the photosimulations and accompanying material may be deficient in one or more aspects. As you go through the step-by-step evaluation process detailed below, you will have to use your judgement about issues you consider to be critical and must be addressed before you can complete your evaluation to your satisfaction. While there are no hard and fast rules about what constitutes a "showstopper," below are some suggestions regarding issues that are likely to be serious:

- Not having high-quality photosimulation images of adequate display size, or adequate image resolution and sharpness (typical of photos taken with a wide-angle lens or cell phones) to see the project and its surroundings clearly.
- Omitting views of major importance to NPS, such as NPS-inventoried views determined to have high Scenic Inventory Values.
- Major changes to the design or the existing landscape that occured after the photosimulations were developed.
- Photosimulations with significant screening by foreground elements.
- Views selected or adjusted (in terms of view direction or field of view) to exclude visible project elements or important contextual information.
- Failure to simulate the typical worst-case visibility scenario, or photo point at a KOP.
- Photosimulations that depict conditions for only one season of the year where the viewpoint is heavily used throughout the year and there is seasonal variabillity.
- Errors in spatial accuracy or realism large enough to make a noticeable difference in the visual experience of the project.
- Photosimulations without a corresponding unique base photograph, or that depict dates, times of day, weather, or lighting conditions different than their corresponding unique base photograph.
- Photosimulations with elements other than project or directly related elements added or removed from the image, such as people, vehicles, vegetation, or structures.
- Photosimulations where most of the image area is simulated, i.e., little of the base photograph image is visible.
- Photosimulations that do not show the effect of lighting at night where it is a substantial source of impact.

Note that issues not on this list may be important in particular situations, and that issues on this list may not always indicate a serious problem.

Options for remedies may include redoing photosimulations, adding new photosimulations (which may be challenging if it requires additional fieldwork), or adjustments to the impact assessment to account for impacts omitted from the photosimulations or improperly depicted. In all cases, bringing up issues with photosimulations as early as possible will generally result in better outcomes. Lastly, documentation of photosimulation deficiencies and written correspondence regarding resolution of problems is important.

5.3 Checking Completeness

In order to make sure you have all the materials you need to do a good evaluation, check the following items:

1. Do you have the current version of all of the photosimulations that were prepared for the project?

You may have to ask the developer, simulation contractor, or permitting agency, but the VIA should include all of the photosimulations, and typically the NEPA document will include them as well. The VIA and NEPA document should also include a map showing all of the KOPs used in photosimulations, which can be very helpful for determining if you have a complete set. However, it is common for photosimulations to be revised or additional photosimulations to be prepared, so you will need to make sure you have a complete and up to date set of photosimulations.

2. Do you have other materials and data needed for a more in-depth evaluation if desired?

The GIS-generated viewshed map is important for evaluating the extent of project visibility and the selection of views for simulation. The wireframe images created during the simulation development process show the terrain and project models overlaid onto the base photograph. These images are useful for visual inspection of the fit of the models to the site, and also where project or other elements may be screened by terrain, vegetation, or structures. Both the viewshed map and the wireframe images should be provided with the photosimulations or can be requested from the simulation developer.

3. Do the photosimulations include proper documentation?

A variety of identifying and labeling information should be provided with the photosimulation, such as the KOP name, location, and the simulation field of view. Additional information regarding data and methods used for simulation should be provided in accompanying text or the VIA methodology section. Check Appendix A for the complete list.

5.4 Checking Presentation

To be sure that the photosimulations are of sufficient size and display quality to see details, lighting, and colors clearly, and that are you viewing them at the proper distance under the right lighting conditions, check the following:

1. Are the photosimulations adequate in terms of image resolution and other aspects of image quality?

If at all possible, obtain the photosimulations actually produced by the photosimulation developer, which should be provided as high-resolution images printed on high-quality photo paper. If you receive high-resolution digital photosimulations and want to also view paper versions, you will need to print them as high-resolution images on high-quality paper, if possible.

Check the image resolution of the photosimulations you have been provided; this information should be provided with the photosimulations by the photosimulation developer. If the image resolution is significantly less than about 4,800 pixels horizontally for a single frame image taken with a “normal” lens (about 50mm equivalent focal length or EFL), ask for higher resolution images.

Check the file size for photosimulations provided in digital formats. File sizes of a few megabytes or less often indicate that the file has been down-sampled or compressed, which may cause a loss of detail. Check the physical dimensions of printed photosimulation images. Do not use photosimulations less than 11x17 inches for evaluation. While 11x17 photosimulations are commonly used, in some cases you may need to request larger photosimulations in order to see project details clearly. For example, wind energy facilities or transmission lines viewed at long distances may need larger images.

2. Are you viewing the photosimulations at the right distance in the right lighting?

For each photosimulation displayed at a particular size (e.g., 40 inches horizontally), there is a correct viewing distance from which objects in the simulation will appear at the same apparent size as they would in the real landscape view. The specified correct viewing distance should be included on the photosimulation cover sheet. Viewing from any other distance will result in elements that appear too large or too small compared to the real view.

Printed photosimulations of daytime views should be viewed in a brightly lit (but not excessively bright) environment with lighting and/or the photosimulation positioned such that neither shadows nor glare are cast on the image. If accurate color rending is important, avoid viewing in conditions with excessively blue or amber lighting. You can also view in different lighting conditions to see which lighting environment shows the greatest details, contrast and color rendition.

Night-time lighting photosimulations must be projected or viewed on a monitor in a fully darkened room, or on a laptop computer screen if viewed in the field. In both cases, dark-adapted vision is required, meaning time must be allotted to allow your eyes to adjust to the darkness. Full dark adaptation can take as long as 40 minutes, which is often not feasible; ideally, at least 5 to 10 minutes should be allotted prior to viewing the photosimulations. Failure to adhere to the correct viewing conditions for artificial lighting photosimulations is likely to result in significant underestimation of lighting brightness.

3. Are the photosimulations free from distracting graphic elements so you can concentrate on the landscape and project in the images?

Photosimulations should have only minimal identifying information in a thin margin at the side or bottom of the image. The photosimulation itself should be entirely free from graphic elements such as logos, inset maps, arrows or other location indicators, or any other element that draws the eye away from the photosimulation itself. If you feel that extraneous graphic elements are a distraction for a photosimulation you are evaluating, request a "clean" version for evaluation purposes.

5.5 Checking View Selection

In order to determine if the viewpoints selected for photosimulations are appropriate, check the following:

1. Was NPS consulted on view selection?

If NPS was not involved in view selection, you may want to request additional photosimulations for important views.

2. Are views important to NPS included in the photosimulations?

The photosimulations and the VIA should include a map or maps with KOPs and the project indicated. Study it carefully to determine the extent to which views important to NPS are included. Remember that views important to NPS are not limited to scenic overlooks and include other locations within your parks, such as trailheads and trails, roads, river segments, historic sites, wilderness areas, and important day use areas. For linear features and other potentially large areas without obvious spots (e.g., scenic overlooks) where people view the landscape, KOPs should be selected to show the range of views from these areas. If important views are omitted, you may want to request additional photosimulations.

3. Is the project area visible from each photo point, are the viewpoint and the view realistic, and is the simulated view free of foreground obstructions or distracting elements that could have been easily avoided?

- In the field: Visit the KOP and assess the visibility of the project area from the photo point. Is the viewpoint and view direction appropriate for viewers who would be at the KOP? Will the project be completely or mostly obstructed by terrain, vegetation, or structures? If the view is obstructed by anything in the foreground, would moving a short distance afford a significantly less obstructed view while still being a reasonable location for people to view the project area? If the foreground view obstruction could be easily eliminated by moving a short distance, take a geotagged photo from the desired unobstructed viewpoint, and request the simulation be redone from that point.

5.6 Checking Weather and Lighting Conditions

In order to determine if the photosimulations depict the appropriate conditions for weather and lighting, check the following:

1. Is the typical worst-case visibility scenario depicted? If it is not depicted in simulations, is it discussed in the VIA or other documentation?

Consider the view direction, the sun angle, the color of the project elements, the visual backdrop of the project, the weather, and the atmospheric conditions. The relationship between these factors determines the conditions in which the project is likely to cause the greatest degree of contrast.

For example, for viewers west of a project that is silhouetted against the sky, the typical worst-case scenario may be in the-morning, when the sun is rising behind the project, and the project elements facing the viewer are in shadow, against the bright sky backdrop. If however, viewers are west of a project consisting of white wind turbines against a forested backdrop, late afternoon before sunset on a clear and sunny day may be the worst-case scenario, because the bright white wind turbines will be directly illuminated by the low-angle sun against the much darker trees.

Usually, but not always, the worst-case scenario will include lower angle sunlight behind or facing a project on a clear day (i.e., without significant haze)', because it results in brighter illumination of vertical surfaces and longer shadows, which increases contrast. A detailed discussion of the effects of all of these variables — sometimes referred to as "visibility factors" — can be found in Appendix B of the NPS's *Guide to Evaluating Visual Impact Assessments for Renewable Energy Projects*, available at: https://irma.nps.gov/DataStore/Reference/Profile/2214258.

Consider seasonal effects when identifying the typical worst-case scenario. For example, leaf drop in autumn may increase visibility of the project considerably. If the time of day or season of highest use does not include the typical worst-case scenario, you may wish to request additional simulations.

While every reasonable effort should be undertaken to simulate the typical worst-case scenario for some of the KOPs, it is not always possible to obtain photographs for those conditions due to schedules, budgets, or travel considerations. If this is the case, the accompanying text (typically the VIA) should, identify and describe the worst-case visibility scenario. The text should also discuss the differences in visual contrast depicted in the existing simulations vs. the typical worst-case scenario. As the simulation evaluator, when viewing simulations, consider whether they depict the typical worst-case scenario. If not, consider how the typical worst-case scenario might differ from the simulations provided.

- *In the field:* Visit the KOP multiple times, if possible, to develop a sensitivity to how light, weather, and viewing direction interacts with surface features to understand the typical worst-case visibility scenario.

2. Do photosimulations depict seasons or times of day of high use?

If there are particular seasons or times of day with significantly higher visitation or use of the viewpoint, these times/seasons should be depicted in photosimulations. Note that this may not represent the typical worst-case visibility scenario; additional simulations may be warranted to depict the project during seasons or times of day of high use. If producing additional simulations is not feasible, the accompanying text (typically the VIA) should state this and discuss the differences in visual contrast depicted in the existing simulations vs. seasons/times of day of high use.

3. Are artificial lighting photosimulations provided where appropriate?

The project plan should describe lighting sources associated with the proposed project, as well as any lighting impact mitigation that is part of the project design. Review it to identify lighting sources that may be significant enough to warrant impact assessment and photosimulation.

Review photographs of existing facilities similar to the proposed one to identify the presence of lighting at night.

- *In the field:* If possible, observe existing facilities similar to the proposed one to identify the presence of lighting at night and to assess the realism of lighting depicted in photosimulations.

5.7 Checking Spatial Accuracy

In order to determine if all of the components of the proposed project and the surrounding elements are visible, correctly located, and shown at the right size and visual perspective, check the following:

1. Do the photosimulations reflect the current proposed action or alternative?

Verify that the photosimulations are current. Project designs often change over time, and the photosimulations should be dated and labeled with details about exactly which design version or alternative (if there are multiple alternatives) is depicted in the photosimulations.

Check that simulations are provided for alternatives that differ significantly in their likely visual effects. This situation is particularly common for electric transmission and other linear projects that may involve many alternatives along very different routes.

2. Are the KOP, photo point, and the project correctly located, and are there no important errors in the elevation data?

GPS locations for the KOP and photo point should be provided with the photosimulation and can be easily checked using Google Maps or similar online mapping software, GIS, or Google Earth. Depending on the project, GPS locations for the project or individual components (e.g., individual wind turbines) may be available.

As above, obtaining the project and terrain models to go along with the photosimulation will help verify correct locations for the KOP and project within the terrain model.

- *In the field:* Using the simulation at the KOP, check that foreground elements visible in the simulation are also visible in the same relative directions and sizes as in the real landscape. If they do not match closely, there may be: 1) a mismatch between the KOP and the actual camera location used for the base photograph; 2) errors or imprecision in the KOP GPS coordinates or in the elevation data; or 3) incorrect view parameters set in the visualization software.

3. Does the simulation depict the proposed project as described?

The project plan should provide plan views and descriptions of the facility. The VIA should describe the visible elements of the facility as well – location, height, width, surface treatments, etc. – and may ultimately be more useful than the project plan as a source for this information. Inspect these documents to ensure that all visible elements of the project are included in the simulation and appear to be correctly located, sized and oriented to the viewpoint, and colored and textured as described.

If you have the digital project model and terrain model, access to GIS or similar software, and the requisite expertise, you should be able to check project component placement, sizing, and orientation precisely, as well as cut-and-fill-related changes to the terrain. Though considerably more work, this is far better than simple visual inspection for checking the spatial accuracy of the simulation. Google Earth can also be used for this purpose to a degree, but is far less accurate. Where possible errors are suspected, requesting the simulation as a wireframe that includes terrain or other control points can help ensure that the simulation was prepared correctly. In some instances, it may be necessary to have the simulation professionally reviewed for accuracy.

- *In the field:* While you cannot check the accuracy of the project model in the field, viewing the project area from the KOP with the simulation in hand can be useful to check the accuracy of changes to the terrain and vegetation resulting from the project, as depicted in the simulation. You can also check to see if there has been vegetation that screens project elements added in the simulation but that does not exist in the real view, or if vegetation has been shown as removed in the simulation but not documented in the VIA.

5.8 Checking Realism

Check the following to determine if all of the elements in the simulation look close to how the real project might look in terms of lighting, color, texture, and sharpness.

1. Do you know what a real project should look like?

Study photos of facilities of the same type to get a sense of what this type of facility looks like, and how its appearance changes in different lighting and weather.

- In the field: One of the best things you can do to check the realism of photosimulations is visit existing similar facilities with the photosimulations in hand. Consider your overall impression of the landscape in the simulation with your view of the real landscape. To the extent possible, observe the existing facilities in a variety of lighting and weather conditions to familiarize yourself with the dynamic qualities of the visual experience. Observe the degree of motion of facility components, workers, vehicles, vapor or dust plumes, etc., as motion cannot be simulated in a photosimulation. Note also the degree of detail seen in foreground, midground, and background, and how fine details are lost with increasing distance. If you are reviewing artificial lighting photosimulations, observe the facilities at night, to get a feel for the types of lighting used, the number of lights, and the lighting patterns (flashing or steady, time on and time off, etc.). You will need to keep these important visual qualities of the real project in mind when viewing static photosimulations.

2. Is the lighting and shadow casting correct for the time and date specified?

The simulation cover sheet should provide the exact date and time the base photograph was taken. Does the illumination of surfaces and direction and length of visible shadows on elements in the existing landscape seem appropriate for the stated solar azimuth and altitude (direction of the sun on the horizon and its height above the horizon)? Is the illumination and shadow direction the same for the project elements and other elements in the existing landscape, such as structures or trees? If not, you may want to use easily available Web tools (e.g., the National Oceanic and Atmospheric Administration's Solar Calculator (https://www.esrl.noaa.gov/gmd/grad/solcalc/) to verify the solar azimuth and altitude. It is possible the date and time stated for the base photograph is incorrect, or the project elements have been improperly illuminated, which will usually appear unnatural, and may affect their perceived contrast.

3. Do the existing elements of the landscape (vegetation, structures, sky, etc.) depicted in simulation look significantly larger or smaller, duller, less sharp, and/or less detailed than they appear in the real landscape?

The base photographs should be taken using a consistent lens focal length, so that the project and landscape elements appear at the correct size when the image is viewed from a comfortable distance. The use of a 50mm EFL lens for photosimulation base photographs is accepted professional practice in the United States. The lens focal length used for the images should be included on the photosimulation cover sheet. Note that the 50mm EFL guidance does not apply to panoramic images provided to show the project's visual context.

- *In the field:* visit the KOP in weather and lighting conditions that approximate those specified for the simulation. Hold the printed simulation up (or view it on a laptop shaded from direct sunlight). Look closely at both the simulation and the real landscape to understand any differences between the simulation and the real view in terms of visible detail, contrast range (the range between the deepest shadows and brightest highlights), sharpness, and clarity. Overall, does the simulation seem lower in contrast (dull) compared to the real view? Are distant elements significantly less distinct or "mushier" in the simulation than in the real view? Dulling and loss of perceived detail are ways humans judge distance to objects, so excessively dull or indistinct objects may be perceived as being more distant than they are. While no simulation will replicate the real conditions exactly, if the simulation is very different than the real view, you may need to request new photosimulations or adjustments to the ones presented.

4. Does the project blend appropriately with the surrounding elements?

Does the project seem abnormally bright relative to its surroundings? Does it seem to be darker than it should be? Objects at the same distance in the same direction from the viewer are equally subject to the dulling effects and loss of detail associated with atmospheric haze, dust, smoke, etc. If the brightness and clarity of the project in the photosimulations are not adjusted to match its surroundings, it will look unnatural and its distance may be misjudged.

Look closely at the edges of the project surfaces, and how they blend with their surroundings. With increasing distance, the edges of objects gradually become less distinct. If the edges of the project's surfaces are improperly blended with the background, it will look unnatural – either too crisp and "popping" from the background too much, or too fuzzy and obviously over blended. This problem may also contribute to misjudging the distance to the object.

5. Is the simulation missing anything significant that a viewer would likely see?

Review the VIA and descriptions, as well as photographs and videos of similar facilities, if possible, to determine if viewers would normally see vehicles, workers, dust or vapor plumes, glare, moving components (e.g., wind turbine blades), etc., that may be transient or dynamic visual phenomena. Judge the degree to which these elements might affect the visual contrast created by the project. These activities would not have been occurring when the base photograph was taken, but they should be considered when assessing contrast if they are not depicted in photosimulations.

Review the project plan or other resources to identify any ancillary or associated facilities not technically considered to be part of the project, but which will be built to facilitate the project and will be visible in project views. This could include, but is not limited to electric transmission lines, pipelines, cell towers, utility poles and lines, roads, cell towers, ponds, or drainage features. These should be included in all project photosimulations.

6. Have objects been added to the simulation that are not facility components, ancillary facilities, or other objects directly resulting from the project that are not in the base photograph?

Have people, vehicles, animals, clouds, sunsets, etc. been added to the simulation that are not present in the base photograph? Unless part of the project and duly documented, such elements distract the simulation viewer from the project, may unconsciously affect judgments about the project's effect on the view, and ultimately are speculative in nature. Photosimulations containing these elements are not suitable for use in impact assessment and should be rejected.

5.9 Photosimulation Evaluation Checklists

Use the Photosimulation Checklist to document your evaluation of the set of simulations you are reviewing. Use the page references to find more details regarding each item in the checklist. The Individual Simulation Review can be used to quickly evaluate each simulation including several items that are checked in the field.

PHOTOSIMULATION CHECKLIST

PROJECT NAME: **DATE:**

Page Ref	Evaluation Criterion	Ok? Y/N	Notes
23	**Completeness**		
	Have current versions of all photosimulations		
	Have materials and data for in-depth evaluation		
	Photosimulations/ VIA include documentation listed in Appendix A		
24	**Presentation**		
	Have actual photosimulations that were produced by developer		
	Images are high resolution with appropriate file size		
	Printed images are 11x17 or larger		
	Viewed photosimulations at correct viewing distance for image size		
	Viewed daytime and artificial lighting photosimulations under appropriate lighting		
	Photosimulations free from distracting graphic elements		
26	**View Selection**		
	NPS consulted on viewpoint and KOP selection		
	Views important to NPS included in photosimulations		
	Project area visible from each KOP		
	Viewpoint and view direction are accessible, realistic, and appropriate.		
	Simulated view free of foreground obstructions or distracting elements		
26	**Weather and Lighting**		
	Typical worst-case scenario simulated		
	Field checked view to verify typical worst-case scenario		
	Photosimulations depict high use seasons or times of day		
	Have artificial lighting photosimulations provided where appropriate		
	Project plan describes light sources		
	Field checked or viewed photographs of similar facilities for light sources		

PHOTOSIMULATION CHECKLIST CONT'D

Page Ref	Evaluation Criterion	Ok? Y/N	Notes
27	**Spatial Accuracy**		
	Photosimulations reflect the current proposed action or alternative		
	KOP and project correctly located with no important errors in elevation data		
	GPS locations for KOP and photo point provided and checked		
	Used project and terrain models to locate KOP and project within terrain model		
	Field checked that existing elements visible in simulations match views		
	Project plan compared to photosimulations to ensure that all visible project elements are simulated, and appear to be correctly located, sized and oriented to viewpoint, and colored and textured properly		
	Project component placement, sizing, orientation, as well as cut-and-fill-related changes precisely checked using GIS		
	Field checked accuracy of terrain and vegetation changes from project, accuracy of vegetation screening		
29	**Realism**		
	Field checked or viewed photos of similar facilities to observe real appearance		
	Base photographs used the same EFL consistently (typically 50mm).		
	Photosimulation lighting and shadow casting correct for the time and date specified		
	Field checked photosimulations to compare photosimulation contrast range, sharpness, and detail with real view		
	Project blended appropriately with the surrounding elements in terms of brightness and edge blending		
	Typical worst-case scenario simulated		
	Photosimulations not missing anything significant that a viewer would likely see		
	Photosimulations include no elements not already in base photographs that are not part of the project or directly associated with it.		

INDIVIDUAL SIMULATION REVIEW

PROJECT NAME: **REVIEWER:**

VIEWPOINT NAME: **DATE:**

For ADDITIONAL NOTES identify any other information for the viewpoint such as: Was the photo point easy to find? Does the photo point make sense? Any notable changes in the view or surrounding area since the base photo was taken? Any other general thoughts on the simulation for this viewpoint.

Evaluation Criterion	Y/N	Notes
1. Is the base photo properly exposed, in focus, and lack distracting glints or reflections from the lens?		
2. Does the simulation seem to have obvious errors or inaccuracies?		
3. Do the season, weather and lighting conditions show high contrast project visibility conditions?		
4. Does the 3D model seem to be properly inserted and not appear to float, have artificially sharp edges, or any other aspects that make it appear strange?		
5. Have any features in the base photo been removed in the simulation unnecessarily?		
6. Does the simulation contain elements added to the scene that are not in the base photo such as trees, people or vehicles?		
7. Are ancillary/secondary components (if any) such as construction access roads, staging areas, power lines and temporary buildings included in the simulation?		
Check in the field		
8. Was the photo point easy to find and does it make sense that visitors would go there?		
9. Does the photo point represent the location with most extensive potential visibility of the project area?		
10. Does the base photo capture the context of surrounding landscape? If not is there a panoramic photo that does?		
11. Do existing features shown in the simulation look similar (contrast range, sharpness, detail) to the real view?		
12. Do the grading and vegetation changes due to the project as well as any vegetation screening appear to be accurate?		
13. Do all project components seem to be accurately shown in position, scale, shape and color as they might be seen from this location?		

ADDITIONAL NOTES:

GLOSSARY

Artificial lighting Impact
An interference with use and/or enjoyment of dark night skies or darkness resulting from artificial light pollution, that may be caused by facility or other lighting.

Aspect
The positioning of a building or object in a specified direction; the direction that something (such as a building) faces or points towards. The aspect determines which side of a facility is in view from a particular viewpoint, as well as the angle of the object's vertical surfaces with respect to the viewer.

Azimuth
The horizontal angular distance from a reference direction, usually the northern point of the horizon to the point where a vertical line through a celestial body (e.g., the sun) intersects the horizon. Typically usually measured clockwise.

Best Practice
A practice or combination of practices that is determined to provide the most effective, sound, and feasible means of conducting an activity.

Color
The property of reflecting light of a particular intensity and wavelength (or mixture of wavelengths) to which the eye is sensitive. Color is the major visual property of surfaces.

Conductor
In electric transmission facilities, the cables (often called lines) that transmit electricity.

Contrast
Opposition or unlikeness of different forms, lines, colors, or textures in a landscape.

Cumulative Visual Impacts
Impacts arising from the visibility of multiple projects from one or more viewpoints, resulting in combined or sequential views.

Digital Elevation Model or Digital Terrain Model
A 3D representation of the surface terrain of an area that does not take into account trees, buildings, or other screening structures.

Digital Surface Model
A 3D representation of the landscape that includes the upper surfaces of trees, buildings, and other features above the bare earth.

Equivalent Focal Length
The equivalent focal length (EFL) of a lens is what would be needed to obtain the same field of view on a 35mm film camera.

Horizontal Field of View
The horizontal extent of the observable landscape that is seen at any given moment, usually measured in degrees.

Key Observation Point (KOP)
A point in a use area or a potential use area, with views of a proposed project, which is used as a viewpoint for assessing potential visual impacts resulting from the project. KOPs may include single points (e.g., a lighthouse), selected points on a linear feature or travel route (e.g., a road or trail), or a selected point in a larger area (e.g., a wilderness area). Where KOPs are selected to provide a representative view from a linear feature or extensive area rather than a specific view from a specific point, they are often referred to as representative KOPs, or representative observation points.

Landform
Any recognizable physical form of the earth's surface, having a characteristic shape. Landforms include major forms such as plains, plateaus, and mountains, and minor forms such as hills, valleys, slopes, and moraines. Taken together, the landforms make up the surface configuration of the earth.

Landscape
The expanse of visible scenery including landforms, waterforms, vegetation, and cultural elements such as roads and structures. An understanding of the landscape also includes the traits, patterns, and structure of a specific geographic area, including its physical environment, its biological composition, and its anthropogenic or social patterns.

Light Detection and Ranging (LiDAR)
A remote sensing method that uses pulsed laser light to measure distances to the Earth's surface and objects on the Earth's surface.

Line
A path, real or imagined, that the eye follows when perceiving abrupt differences in form, color, or texture. Within landscapes, lines may be found as ridges, skylines, the edges of structures, roads and pathways, the edges of water bodies, changes in vegetative types, or individual trees and branches.

Normal Lens
Traditionally the focal length of a "normal lens" is 50mm on a 35mm film camera. The horizontal angle of view is nearly 40°. Simulations printed to fill letter-size paper held at comfortable reading-distance, or that fills a tabloid sheet held at arm's length will represent project elements in their appropriate scale.

Photosimulation
A spatially accurate and photorealistic visual simulation of a proposed project superimposed onto a digital photograph of the existing landscape. Sometimes referred to as a photomontage.

Seascape
The expanse of visible ocean or lake scenery.

Scenic Quality
A measure of the intrinsic beauty of landform, water form, or vegetation in the landscape, as well as any visible human additions or alterations to the landscape.

Screening
A visual barrier consisting of earth, vegetation, structures, or other materials intended to block a particular view, or the actual blocking of a view through use of a visual barrier.

Solar Altitude (Solar Elevation)
The angular height of the sun above or below the horizon, usually measured in degrees. Above the horizon, solar altitude is positive; below the horizon, solar altitude is negative. Also referred to as "solar elevation."

Texture
The visual manifestations of light and shadow created by the variations in the surface of an object or landscape.

Topography
The shape of the earth's surface; the relative position and elevations of natural and manmade features of an area.

Vertical Field of View
The vertical extent of the observable landscape that is seen at any given moment, usually measured in degrees.

Viewpoint
A point from which a landscape is viewed. Also a point from which a landscape view is analyzed and/or evaluated.

Viewshed
The total landscape seen or potentially seen from a point, from all or a part of a travel route, a use area, or a water body. In VIA, it generally refers to the area from which a specific project may be visible.

Viewshed Analysis
A spatial analysis that uses elevation data to determine which parts of the surrounding landscape are likely to be visible from a designated point or points.

Viewshed Map

The outcome of a viewshed analysis that shows which areas of the surrounding landscape would theoretically be visible from the viewshed origin (the viewpoint).

Visibility

The ability to visually discern an object in the landscape; also, the distance an individual can see as determined by light and weather conditions.

Visual Contrast

Opposition or unlikeness of different forms, lines, colors, or textures in a landscape.

Visual Impact

Any modification in land forms, water bodies, or vegetation, or any introduction of structures or other human-made visual elements, that negatively or positively affect the visual character or quality of a landscape through the introduction of visual contrasts in color, form, line, or texture.

Visual Impact Assessment (VIA)

Analysis of the visual impacts of a proposed project usually presented as a stand-alone technical report or contained within an EIS.

Visual Simulation

A pictorial representation of a proposed project in its landscape setting, as it would be seen from a specified viewpoint, and used to visualize the project before it is built, typically in order to determine its potential visual contrasts and associated visual impacts.

Visualization

A pictorial representation of a proposed facility.

APPENDIX A-PHOTOSIMULATION DOCUMENTATION

The following items should be included in documentation for photosimulations. Note that some items should accompany the photosimulations themselves, while other items should be included in accompanying text, generally as part of the VIA. Documentation items to accompany photosimulations:

- ☐ Project name.
- ☐ Date and version of project data used.
- ☐ KOP name and descriptive location.
- ☐ Camera make and model for base photograph.
- ☐ Lens make and model.
- ☐ Consistent use of a single focal length (typically 50mm) for all simulations.
- ☐ Image size in pixels.
- ☐ Indicate single frame or panoramic photograph.
- ☐ Camera (viewer) height.
- ☐ Date and time of base photograph.
- ☐ Description of weather conditions and atmospheric visibility.
- ☐ GPS coordinates of base photograph.
- ☐ Elevation of viewpoint.
- ☐ Solar azimuth/elevation.
- ☐ View direction and horizontal and vertical field of view.
- ☐ Required viewing distance for photosimulation when printed as intended.
- ☐ Distance from KOP to nearest visible project element.
- ☐ Distance from KOP to farthest visible project element.
- ☐ Map (with scale) showing KOP and project locations; view direction and limits of horizontal field of view; and other relevant features, e.g. waterbodies, roads, terrain features, populated areas.

Other photosimulation documentation (to be included in VIA or text accompanying photosimulations).

- ☐ Photosimulation preparer(s) names, titles, organizations.
- ☐ Description of photosimulation technique, including process steps and software used.
- ☐ Description of any post-processing adjustments, e.g., edge blending, position adjustments, shading.
- ☐ Description of elevation data and source, resolution, and accuracy.
- ☐ Description of digital project model and source.
- ☐ Description of simulation parameters, e.g., earth curvature.
- ☐ Descriptions of assumptions made for photosimulations.
- ☐ Description of project design state, noting any missing elements or uncertainties in the simulated design.
- ☐ Description of known and possible sources of error in the photosimulation.
- ☐ In addition, the following data should be submitted for reviewers' use:
- ☐ Elevation data.
- ☐ Digital project model.
- ☐ Original single frame photographs with metadata.

APPENDIX B- PHOTOSIMULATION EVALUATION BEST PRACTICES

This appendix presents best practices for evaluating photosimulations. The best practices are organized by topic area, as was done for common problems in photosimulation (Chapter 4).

Best Practices: Evaluating Display of Photosimulations

☐ Obtain the original high-resolution photosimulations prepared for the project for impact assessment purposes. Do not assess photosimulations using low resolution or poor quality images reproduced at small size or on poor quality prints or screens.

☐ Compare the photosimulations to the existing conditions in the field, at the KOP, in addition to comparing the photosimulation to the existing conditions (base) photograph.

☐ Check that the proper viewing distance for the photosimulation (at the size it is displayed) was specified by the preparer. Measure the viewing distance in the field to verify the accuracy of the viewing instructions.

☐ Ensure that the photosimulation is viewed from the proper distance, both in the field and in the office.

☐ Ensure that the lighting conditions under which the photosimulation is viewed are adequate and not overly bright, and that glare from display lighting is not visible on the photosimulation and that shadows are not cast on it.

☐ Check that the photosimulation shows sufficient detail comparable to what is visible in the field, or at least adequate to assess visual impacts.

☐ Check that distracting elements are not present in the base photograph or photosimulation images. For printed output, existing and simulated images should be printed with narrow margins. Both printed and digital images for monitor displays should include minimal labeling, and be completely free of distracting graphic elements, such as logos, maps, arrows, diagrams, viewing instructions, etc. Where these elements are needed, they can be included in a copy of the base photograph or simulation image.

☐ Only the project name, the KOP identifier, and the “Existing Conditions” or “Simulation” label should be on the same page as the image, and these items should be located in the image margins and be visually inconspicuous.

☐ Check that the information listed in Appendix A is included with the photosimulations on a separate sheet.

☐ Check that all other documentation listed in Appendix A is included in text that supplements the photosimulations (usually the VIA).

☐ Depending on circumstances, check that the elevation and model data used to develop the photosimulations are provided so that the photosimulations can be verified.

Best Practices: Evaluating Choice of Views for Photosimulation

☐ Ensure that NPS is consulted about selection of views for the VIA.

☐ In addition to views specifically identified by NPS, ensure that KOPs for photosimulations were identified for scenic, historic, and cultural resource areas within NPS units, such as designated or non-designated overlooks or vistas; trails and trailheads; rivers and boat launches/marinas; roadways and scenic byways; rail lines, especially for scenic railways; campgrounds, visitor centers, beaches, and other recreation areas; wilderness areas; and other onshore/offshore locations where people gather and either purposefully or incidentally observe landscapes/seascapes.

☐ For areas without specific locations that can be identified as KOPs, check that one or more representative KOP with views that are typical for the areas was selected.

- [ ] Check that KOPs with very similar views of the project area were not selected without a specific reason; for example, the KOPs are known to be of concern to stakeholders.

- [ ] Ensure that all KOPs within the VIA area of impact assessment that are selected for photosimulations have at least a partial view of the project.

- [ ] Check that no KOPs selected have partially obstructed views of the project area when there are locations with unobstructed views in the immediate vicinity.

- [ ] Check that the photographs used for the simulation were taken from a realistic viewpoint that is accessible to viewers, and depict a realistic view direction that viewers would experience.

- [ ] Check that base photographs do not have visually distracting or transient foreground elements, such as people, animals, or vehicles.

- [ ] Check that leaf drop (where applicable) and seasons of peak use were considered when identifying KOPs.

- [ ] Check that a written rationale was provided for each KOP selected, including why it was selected, which area it represents, and who originally identified it.

Best Practices: Evaluating Choice of Lighting and Weather Conditions for Photosimulations

- [ ] Check that the lighting and weather conditions for the typical worst-case visibility scenario are depicted in at least some of the simulations. Photosimulations under other lighting conditions can supplement where necessary. If the typical worst-case visibility scenario is not depicted in at least some of the simulations, check that this is stated in the VIA or other documentation, that the typical worst-case conditions are described, and that difference in visual contrast can be expected under the worst-case scenario and the provided simulations.

- [ ] Where visitation to KOP varies seasonally, check that photosimulations include the season of highest use. Photosimulations for other seasons can supplement where necessary.

- [ ] Inspect the images and check the stated dates and times for base photos and simulations to ensure that each photosimulation depicts the same date, time, weather and lighting conditions as the corresponding base photograph.

- [ ] Check that photosimulations of artificial lighting impacts are provided when projects may cause artificial lighting impacts.

Evaluating Spatial Accuracy in Photosimulations

- [ ] Check that the date and status of the project design used for the photosimulation has been provided. Check for any design changes that may have occurred after photosimulations have been prepared. Compare the project plan date, VIA date, and photosimulation preparation dates to ensure you have current photosimulations that reflect the current project design and depict impacts assessed in the VIA. If discrepancies exist, consider whether the changes are significant enough to require new simulations.

- [ ] Check that simulations are provided for alternatives that differ significantly in their likely visual effects.

- [ ] For photosimulations involving alternative designs, check that the alternative shown in the photosimulation has been identified.

- [ ] Check that any changes to the project design not shown in the photosimulations have been disclosed.

- [ ] Check that any uncertainties, assumptions, or omissions related to the project design shown in the photosimulations have been disclosed.

☐ Check that Light Detection and Ranging (LiDAR) elevation data was used to create the terrain model used for photosimulations. LIDAR is a technology that can be used to create high-resolution digital elevation models. If LiDAR data was not used, determine the elevation data type and accuracy; when evaluating photosimulations, consider the possible effects of the less accurate elevation data on photosimulation accuracy.

☐ If you have the elevation data, check for errors in elevation that may affect project visibility or visual perspective, as seen from the KOP.

☐ Check that KOPs and the project were properly located and that the project's orientation with respect to the KOP was correct.

☐ Check for a statement that the effect of earth curvature was incorporated into photosimulations where necessary.

☐ If you have the elevation data and project model, check that the terrain and project models were properly registered to the base photograph. If you do not have the data but have the wireframe image for the simulation, inspect it to confirm accurate registration.

☐ Check that vegetation or other screening elements that would be added or removed by the project were, in fact, added or removed in the photosimulations.

☐ Check that all potentially visible elements of the project were included in the digital project model used for the photosimulations, and that they are represented at the correct size, orientation, configuration, and color.

☐ Check that all ancillary or associated built elements that are not technically part of the project, but result from the project and would be visible in views of the project, are included in photosimulations.

☐ In cases where vegetation is proposed or regrowth is depicted (e.g., along the edges of a newly cleared right-of-way), check that the period of time after construction that the photosimulation is meant to represent is specified and accurately represented in the photosimulation.

Best Practices: Evaluating Photosimulations for Realism

☐ Check that the base photographs were taken with a consistent lens focal length (typically 50mm EFL).

☐ Check the contrast range depicted in the photosimulation to assess how consistent it is with the base photograph, and if at all possible, with a field-based in-person comparison from the actual location.

☐ Check that the effects of atmosphere (e.g., haziness) in the photosimulations are consistent with the stated conditions, and that the effects of atmosphere on the project (as shown in the photosimulations) are consistent with these effects on the surrounding elements.

☐ Check that project elements in the photosimulation are colored and shaded properly.

☐ Check that project elements in the photosimulation are properly blended with the background elements.

☐ Check that the lighting conditions in the photosimulation are consistent with the stated conditions, and that the lighting falling on the project and the shadows project elements cast (as shown in the photosimulation) are consistent with the lighting direction and shadows cast by surrounding elements.

☐ Check that any effects of visual mitigation that is not certain to be incorporated into the project design, i.e., mitigation that is proposed or "under consideration," are not incorporated into photosimulations.

☐ Ensure that the photosimulation image is identical to the base photograph except for the addition or deletion of elements directly associated with the project. No objects should be added to the photosimulation image that are not project elements, changes to the landscape that occur directly as a result of the project, or are documented to be associated with the project.

☐ Check that for each photosimulation, both a single-frame and a panoramic view are provided, unless the entire project and the larger landscape setting needed to understand the project's visual context are visible in the single-frame view.

☐ Detecting subtle problems with realism in photosimulations can be aided by having a photograph of a similar facility in a similar setting available for simultaneous viewing.

☐ Web sites provide easy-to-use tools to calculate sun positions, lighting directions, and shadow directions and length for any location at any time of year. There are also online tools for determining a single-frame photograph's field of view (in degrees) given the camera/lens model and lens focal length.

Documentation of Photosimulations and Methodology

Sound methods are required for producing defensible, accurate, and replicable photosimulations for VIAs. The methods used to produce the photosimulations should be thoroughly documented and accompanied by the data used and other supplementary information about the photosimulation preparers, assumptions, etc. A list of documentation elements is presented in Appendix A.

APPENDIX C- EXAMPLES OF PHOTOSIMULATIONS

Example 1, pp. C2-C7, is a set of simulations that demonstrates the best practices described in this guide.
Source: U. S. Department of Energy.

Example 2, pp. C8-C10, shows an existing photograph that has been manipulated to include added features and the simulation of lighting and weather conditions that are different from the original photograph.
Source: Maryland Public Service Commission.

Example 3, pp. C11-C13 shows an existing condition and photosimulation that was revised based on review comments to more accurately reflect the proposed project.
Source: Bureau of Land Management.

Example 4, pp. C14-C17, shows two examples of photosimulations that did not accurately reflect the final projects as well as the inability to show the brightness of the glare associated with a solar facility.
Source: Argonne National Laboratory.

Example 5, pp. C18-C25, is a set is simulations that show the accuracy of photosimulations as compared to the constructed project.
Source: Maine Department of Environmental Protection.

EXAMPLE 1

Northern Pass Transmission Line Project Environmental Impact Statement

Church Street/Deerfield Center Historic District - Deerfield, New Hampshire

Viewpoint DE-2a

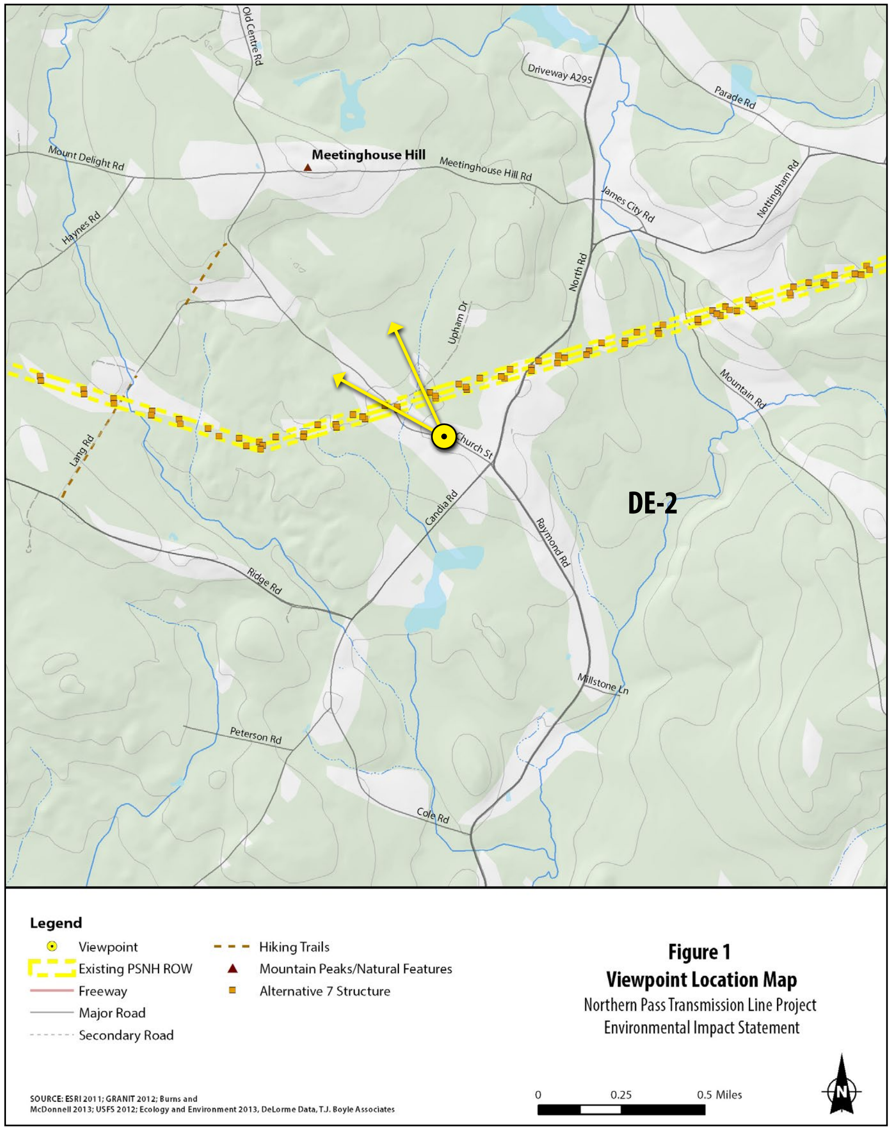


Figure 1
Viewpoint Location Map
Northern Pass Transmission Line Project
Environmental Impact Statement

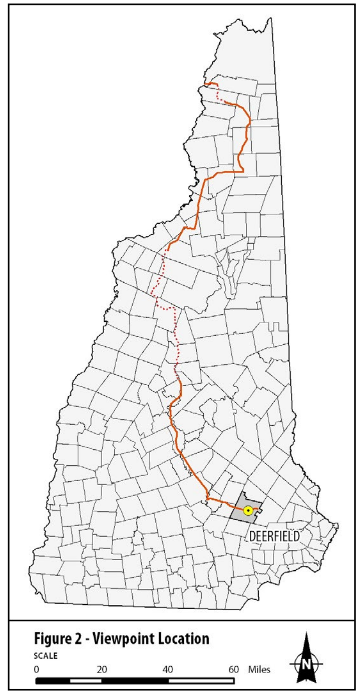


Figure 2 - Viewpoint Location

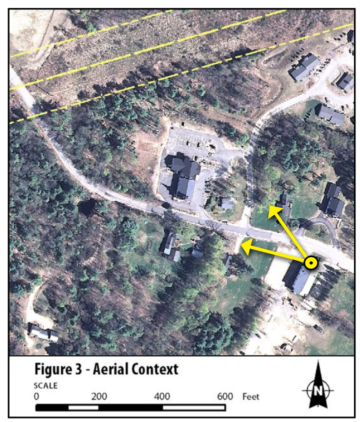


Figure 3 - Aerial Context

General Information

Base Photograph
Date: 07-27-2016
Time: 12:55 pm
Meteorological Visibility:
Concord Airport - 10 miles
Image Size: 4,928 x 3,264 pixels

Camera Properties
Camera Make/Model: Nikon D7000
Sensor Dimensions: 23.6 mm x 15.6 mm
Lens Make/Model: Nikkor DX AF-S 35 mm
Lens Focal Length: 35 mm
35 mm Equivalent Focal Length: 52.5 mm
Approximate Angles of View:
37° wide and 25° high
Camera Height: 1.5 meters (5 feet)

Viewpoint Information
Location: Church Street, Deerfield
Latitude/Longitude: 43.133331°, -71.243102°
Viewpoint Elevation: 460 feet
Viewpoint Name: DE-2
Orientation: Looking Northwest
Looking toward Alternative 2 Mile Marker: 189
Looking toward Alternative 7 Mile Marker: 188-189

Simulation Viewing Notes
The simulation is properly printed on an 11-by-17 inches sheet at actual size. If viewed on a computer monitor, use the highest screen resolution. The simulated image is at the proper perspective when viewed at 23.5 inches from the eye, or at a distance of approx. twice the image height.

Project Design
The simulations for Alternative 2 through 6b are based on the best information available in March 2014. The simulations for Alternative 7 are based on the best information available on October 2015.

Alternatives Simulated from this Viewpoint

Alternative 1 - No Action
Transmission Line Information
Distance to Nearest Visible Structure: 0 feet
Number of Visible Existing Structures: 0

Alternative 2
Transmission Line Information
Distance to Nearest Visible Structure: 980 feet
Number of Visible Transmission Structures: 1

Alternatives 3, 4a, 4b and 4c
Transmission Line Information
The transmission line is buried in this view and there is no discernible visual change from the Existing Condition.

Alternatives 5a, 5b and 5c
Transmission Line Information
There is no visible change from Alternative 2.

Alternatives 6a and 6b
Transmission Line Information
Distance to Nearest Visible Structure: 980 feet
Number of Visible Transmission Structures: 1

Alternative 7 - Proposed Action
Transmission Line Information
Distance to Nearest Visible Structure: 980 feet
Number of Visible Transmission Structures: 1

DE-2b
Northern Pass Transmission Line Project Environmental Impact Statement
Church Street/Deerfield Center Historic District - Deerfield, New Hampshire

Alternatives 1, 3, 4a, 4b and 4c
Existing/Simulated Conditions


Alternatives 2, 5a, 5b and 5c
Simulated Conditions
Northern Pass Transmission Line Project Environmental Impact Statement
Church Street/Deerfield Center Historic District - Deerfield, New Hampshire
DE-2c

DE-2d

Northern Pass Transmission Line Project Environmental Impact Statement
Church Street - Deerfield, New Hampshire

Alternatives 6a and 6b
Simulated Conditions

Alternative 7
Simulated Conditions

Northern Pass Transmission Line Project Environmental Impact Statement
Church Street/Deerfield Center Historic District - Deerfield, New Hampshire

DE-2e

EXAMPLE 2

Offshore Wind Energy Simulation

The following base photograph and simulation were prepared for a proposed offshore wind project. NPS considers the simulation to be deficient in a number of respects, noted in the comments below. While other simulations were produced for this project, of particular interest in this case is the extensive modification of the base photograph. Most of the image is completely fabricated; however, to the casual eye, the simulation is quite convincing.

Selection of Lighting Conditions (See Guide Section 4.3)

- Does not simulate the "typical worst-case visibility scenario," which would be early-midmorning or mid to late afternoon.

Realism (See Guide Section 4.5)

- Shows atmosphere as overly hazy near project, resulting in excessively low brightness of project elements and low contrast between project elements and surroundings.
- Turbines poorly blended with the surrounding elements in terms of edge blending; appear substantially more indistinct than they would in reality.
- Major fabricated distracting foreground elements added (umbrellas, people, boats). Though using the base photograph, almost all elements in the simulation, including sky, water, and beach elements are fabricated or altered, without stating this plainly on the simulation itself or a cover sheet, and without providing a scientific basis for the added elements.

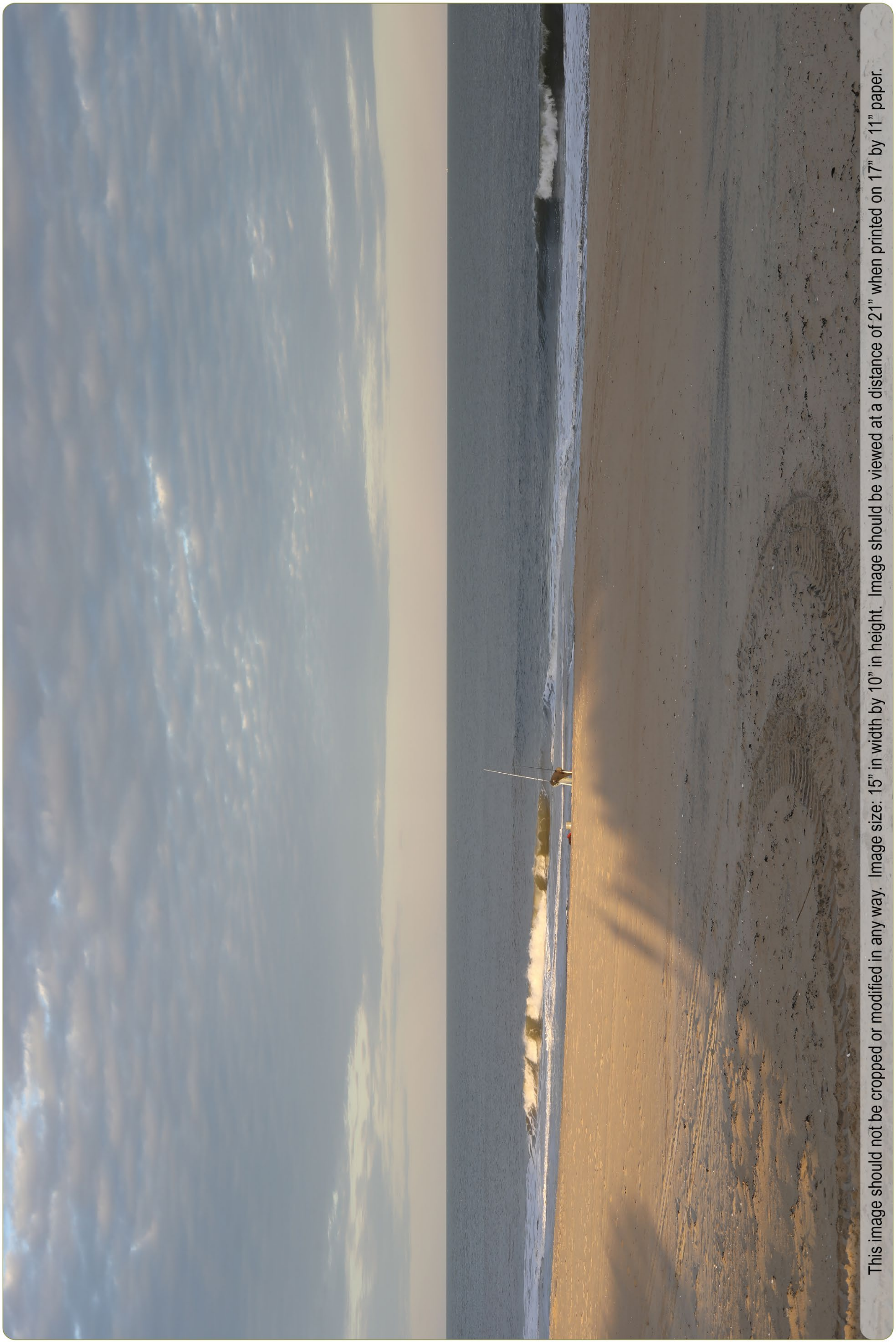
Presentation (See Guide Section 4.1)

- Stated date and time for simulation does not match base photograph.
- Somewhat cluttered with extraneous information and graphics.
- Does not include cover sheet with map (with scale) showing KOP and project locations; view direction and limits of horizontal field of view; and other relevant features.
- Does not show camera/lens make/model.
- Does not state focal length.
- Does not indicate/show horizontal field of view.
- Does not indicate image size in pixels.
- Does not state camera (viewer) height.
- Does not state elevation of viewpoint.
- Does not state solar azimuth/elevation.
- Does not indicate single frame or panoramic photograph.
- Describes weather conditions but not lighting (backlit, frontlit, or sidelit).
- Does not indicate distance to nearest and farthest visible project element.

xxx Wind Farm

View from xxxxx, xxxx, xxxx

Images should be viewed from a distance of 21 inches in order to obtain the proper perspective.



Images should be viewed from a distance of 21 inches in order to obtain the proper perspective.

Geographic Coordinates: xx.xxxx° N, xx.xxxx° W
Date Taken: August 18, 2018   **Time:** 11:54 PM
Temperature: 86°F   **Humidity:** 70%
Direction of View: 68.8° (ENE)

xxx Wind Farm
View from xxxx, xxx

EXAMPLE 3

Onshore Wind Energy Simulations

The following base photograph and two simulations were prepared for a proposed wind energy project in the western U.S. NPS considers the simulations to be deficient in a number of respects, noted in the comments below. In response to comments on the first simulation submitted by stakeholders, the simulation was revised, and the revised simulation is also presented here. While the revised photosimulation addresses some deficiencies, several issues remain, as noted below.

Comments on Original Simulation

Selection of Lighting Conditions (See Section 4.3)

- Does not simulate the "typical worst-case visibility scenario."

Spatial Accuracy (See Guide Section 4.4)

- No roads or other structures associated with the project are visible.
- View of project appears to be cut off on left side of image; i.e., it is very likely that more wind turbines would be visible.

Realism (See Guide Section 4.5)

- Image is very hazy. Not good atmospheric conditions for simulation.
- Image lacks sharpness (as presented)
- Blades on turbines are not visible but clearly should be at this distance.
- According to the time and sun angle, there should be sunlight on the right side of the turbines.
- Failure to properly account for atmospheric perspective. Some of the most distant turbines show the same or greater color contrast than much closer ones, and the same sharpness.

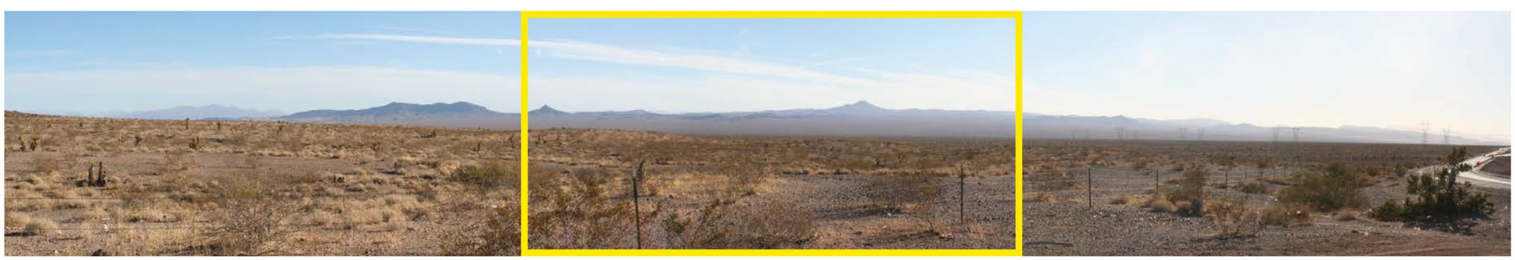
Presentation (See Guide Section 4.1)

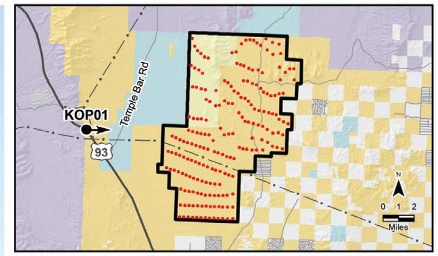
- Cluttered with extraneous information and graphics. Map, panoramic image, and other information should be on accompanying cover sheet.
- Does not show camera/lens make/model.
- Does not state focal length.
- Does not indicate/show horizontal field of view.
- Does not indicate image size in pixels.
- Does not state camera (viewer) height.
- Does not state elevation of viewpoint.
- Does not state solar azimuth/elevation.
- Describes weather conditions but not visibility or lighting (backlit, frontlit, or sidelit).
- Does not indicate distance to nearest and farthest visible project element.

Comments on Revised Simulation

- Turbines are properly illuminated (right sides are illuminated).
- Roads are shown.
- States camera make/model, but not lens. Note that the Canon Rebel XT camera is an inexpensive camera inappropriate for professional photosimulations.
- States focal length.
- States wind turbines are backlit, but they are actually side lit.
- Indicates distance to nearest project element.
- All other problems with original simulation remain.

Photograph is intended to be viewed 18 inches from viewer's eyes when printed on 11x17 paper. The photograph below has been cropped top and bottom to show a wide angle of view with the above photograph's area shown in yellow.





Viewpoint Location Map

Legend

- Key Observation Point
- Wind Farm Site
- Proposed Wind Turbine Layout
- Transmission Line
- U.S. Highway
- Road

Surface Management

- Bureau of Land Management
- Bureau of Reclamation
- National Park Service
- State Trust Land
- Private Land

Photograph Information

Time of photograph:	10:27 AM
Date of photograph:	11-23-09
Weather condition:	Partly Cloudy
Viewing direction:	East
Latitude:	35°50′40.20″N
Longitude:	114°34′28.44″W
Camera:	Canon Rebel EOS XT
Lens:	50mm
Lighting condition:	Backlit
Nearest turbine:	NA

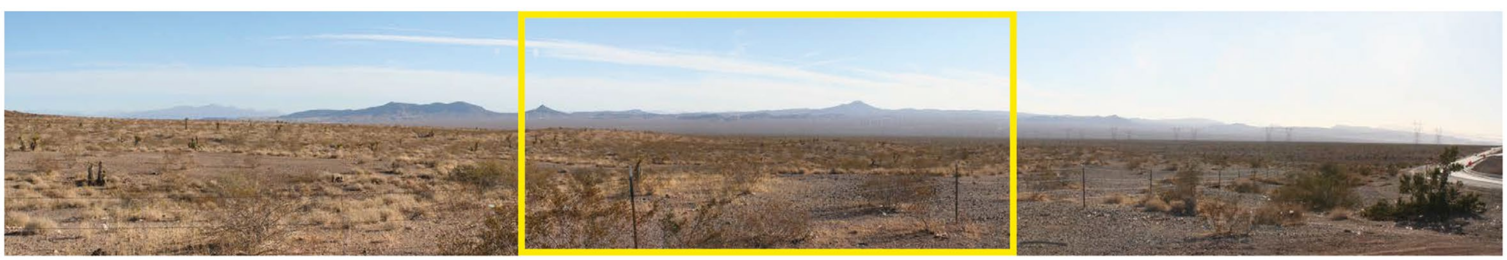
Existing Conditions from Key Observation Point 1 US 93 at Householder Pass Backlit Conditions

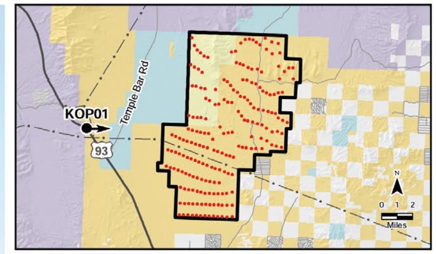
Mohave County Wind Project
Mohave County, Arizona

April 2012

Figure D-1(a)

Photograph is intended to be viewed 18 inches from viewer's eyes when printed on 11x17 paper. The photograph below has been cropped top and bottom to show a wide angle of view with the above photograph's area shown in yellow.





Viewpoint Location Map

Legend

- Key Observation Point
- Wind Farm Site
- Proposed Wind Turbine Layout
- Transmission Line
- U.S. Highway
- Road

Surface Management

- Bureau of Land Management
- Bureau of Reclamation
- National Park Service
- State Trust Land
- Private Land

Photograph Information

Time of photograph:	10:27 AM
Date of photograph:	11-23-09
Weather condition:	Partly Cloudy
Viewing direction:	East
Latitude:	35°50'40.20"N
Longitude:	114°34'28.44"W
Camera:	Canon Rebel EOS XT
Lens:	50mm
Lighting condition:	Backlit
Nearest turbine:	5.4 Miles

Simulation of Alternative A from Key Observation Point 1 US 93 at Householder Pass Backlit Conditions

Mohave County Wind Project
Mohave County, Arizona

April 2012

Figure D-1(b)

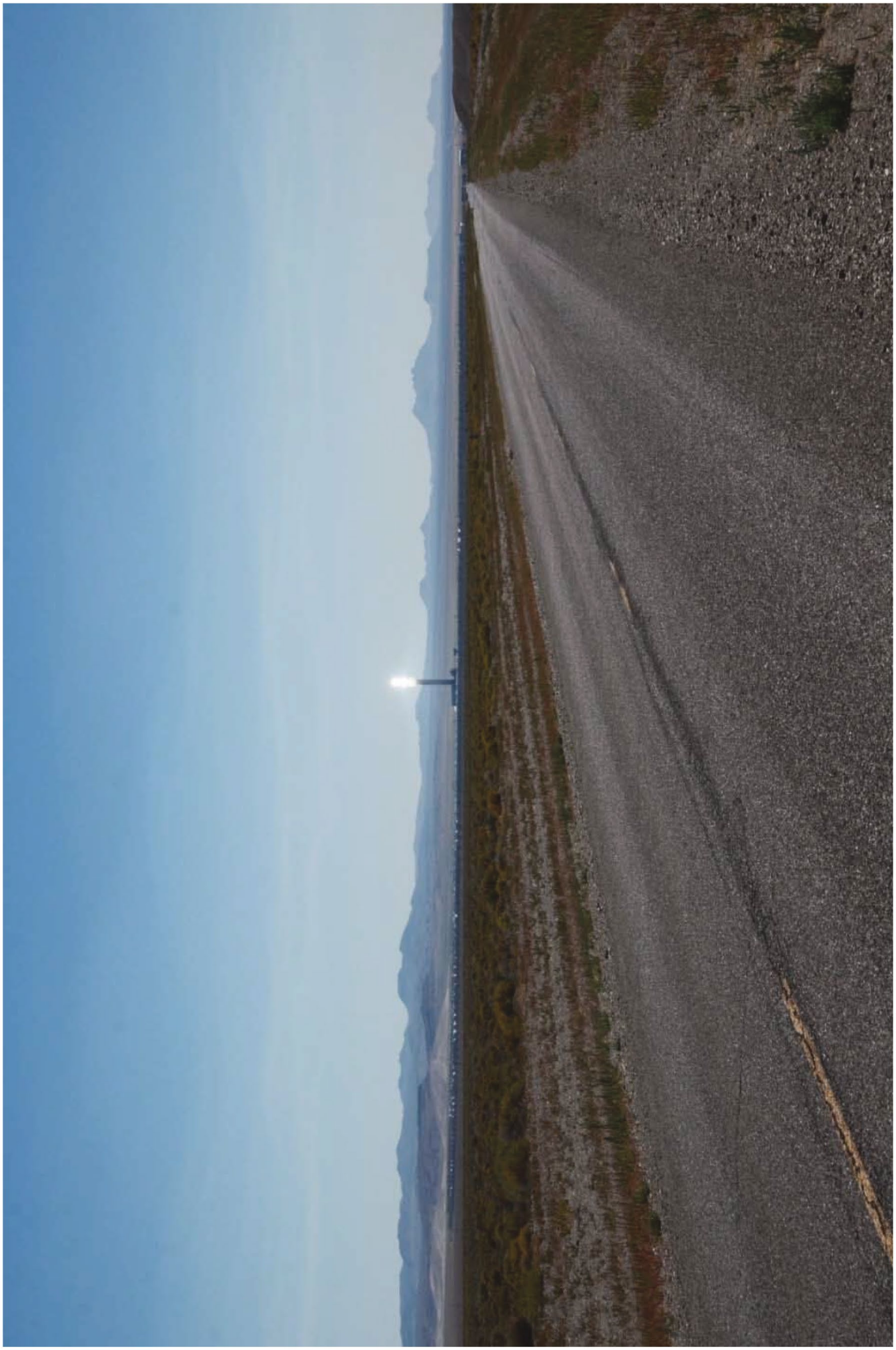
Z:\Projects\ENVPLANNING\BP Wind AZ\123445692_BPMohave\sims\Layouts\BP_Wind_Sim_Layouts.indd 05/07/2013

EXAMPLE 4

FIGURE 4.2-1 Visual Simulation of ISEGS Facility as It Would Be Seen from the Final EIS KOP 5, I-15 Nipton Rd. Interchange

FIGURE 4.2-2 Photograph of ISEGS Facility as Seen from ISEGS Visibility Study SOP 1 (ISEGS Final EIS KOP 5), I-15 Nipton Rd. Interchange

Visual Simulation of the Crescent Dunes Solar Energy Facility as it might be seen from about 2.9 miles away.



Photograph of the Crescent Dunes Solar Energy Facility from about 4 miles away.

EXAMPLE 5

EXHIBIT 1 - CMP: MAINE POWER RELIABILITY PROGRAM
Woodland Hills Condos - South Berwick, Maine

EXISTING

Previously existing conditions (prior to project construction)

Location: 43.185510° N, -70.801052° W

EXHIBIT 1 - CMP: MAINE POWER RELIABILITY PROGRAM

Woodland Hills Condos - South Berwick, Maine

PROPOSED / CONSTRUCTED

Photosimulation

Constructed

Description of Visible Change		PHOTOSIMULATION	CONSTRUCTED
• Removal of 2 H-frame structures. Construction of 2 weathering steel monopoles supporting a 345 kV line and 2 wooden monopole structures supporting a 115kV line.	**Date and time**	10/1/2012 at 2:48 PM	4/11/2017 at 10:48 AM
	Camera Focal Length	35mm	35mm
	Camera Make/Model	Nikon D70	Nikon D5500

EXHIBIT 2 - CMP: MAINE POWER RELIABILITY PROGRAM

Dyer Road - Lewiston, Maine

EXISTING

Previously existing conditions (prior to project construction)

Location: 44.038612° N, -70.167751° W

EXHIBIT 2 - CMP: MAINE POWER RELIABILITY PROGRAM
Dyer Road - Lewiston, Maine

Photosimulation

Constructed

Description of Visible Change
• Removal of 5 wooden H-frame structures. Construction of 5 new wooden H-frame structures and 7 wooden monopole structures.

	PHOTOSIMULATION	CONSTRUCTED
Date and time	3/21/2008 at 2:16 PM	4/11/2017 at2:46 PM
Camera Focal Length	35mm	34 mm
Camera Make/Model	Nikon D70	Nikon D5500

EXHIBIT 3 - CMP: MAINE POWER RELIABILITY PROGRAM

EXISTING

Woodland Hills Condos - South Berwick, Maine

Previously existing conditions (prior to project construction)

Location: 43.185458° N, -70.802155°W

EXHIBIT 3 - CMP: MAINE POWER RELIABILITY PROGRAM

Woodland Hills Condos - South Berwick, Maine

Photosimulation

Constructed

Description of Visible Change		PHOTOSIMULATION	CONSTRUCTED
There is a difference in vegetation between the photosimulation and the post-construction image. Photosimulations were often prepared early in the discussions with abutting landowners to show the project layout. As a result of these discussions, the plans were often adjusted without going back to modify the photosimulation. This is the case here. • The removal of the White Birch and Mugo Pine on the left side of the image (approximately 170 feet from the edge of the transmission corridor) was unrelated to the MPRP. • The white pine in the center of the image was removed to accommodate a dumpster that was relocated from under the transmission line. The decision to move the dumpster and remove the pine was made after the photosimulation was prepared.	**Date and time**	10/1/2012 at 2:30 PM	4/11/2017 at 10:45 AM
	Camera Focal Length	35mm	35mm
	Camera Make/Model	Nikon D70	Nikon D5500

EXHIBIT 4 - CMP: MAINE POWER RELIABILITY PROGRAM
Woodland Hills Condos - South Berwick, Maine

EXISTING

Previously existing conditions (prior to project construction)

Location: 43.185510° N, -70.801052° W

EXHIBIT 4 - CMP: MAINE POWER RELIABILITY PROGRAM

Woodland Hills Condos - South Berwick, Maine

Photosimulation

Description of Visible Change		PHOTOSIMULATION	CONSTRUCTED
• Removal of 2 H-frame structures. Construction of 3 weathering steel monopoles supporting a 345 kV line and 2 wooden monopole structures supporting a 115kV line.	Date and time	10/1/2012 at 2:47 PM	4/11/2017 at 10:50 AM
	Camera Focal Length	35mm	35mm
	Camera Make/Model	Nikon D70	Nikon D5500

APPENDIX D- CASES STUDIES OF PHOTOSIMULATIONS

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

"Worst-case" view

Statement

All things being equal, the location and direction for a simulation photograph should represent a "worst-case" view.

Explanation

A key observation point (KOP) is a localized area with potential views of a proposed project, selected to represent a particular scenic resource or landscape type.

The selection of a "worst-case" viewpoint within a KOP is based on a consideration of several criteria:

- It is the view where the project is most visible in extent and exposure.
- It is at a time of day and season when the project presents the highest visual contrast with its surroundings.
- It is a publicly accessible location chosen after considering the potential number of viewers and their sensitivity to the visual change.
- It considers the sensitivity of the viewpoint and viewed landscape to viewers and others.

The determination of the worst-case view is based on professional judgment. As such, the reasoning of the choice should be explained.

Case Study. Appalachian Trail on Little Bigelow Mountain

Highland Wind proposed a 39 turbine 117 MW wind energy project in the western part of Maine. The Bigelow Preserve is a backcountry recreation area of statewide scenic significance. The Appalachian National Scenic Trail (AT) runs over the high peaks of the Bigelow Preserve and a north-bound AT hiker coming down from Little Bigelow Mountain would see the proposed wind project at several locations. The applicant's VIA included a detailed analysis for a sequence of a 20 KOPs for approximately 5 miles of the AT.

Four distinct views that illustrate how difficult it can be to select a "worst-case" view were assessed at viewpoint (VP) 9. These four views are located in Figure 1. All hikers pass through VP 9A, which is on the AT footpath and does not have distant views. This location is at a sharp bend in the AT where an outcrop rises 10± feet blocking what promises to be a fantastic view. A hiker leaving the footpath and scrambling up the rock reaches VP 9B which has long view to landmarks in several directions. Figure 2 shows the view towards the wind project and how it will be almost entirely screened by existing foreground trees. This would be a wonderful opportunity to rest or eat a snack; the view is magnificent and well worth leaving the trail. If one wants, it is clearly possible to scramble down along this nose to another rock outcrop to VP 9C for the view in Figure 3 where 20± turbines are visible over the treetops. One can continue to the lowest outcrop at VP 9D with the unobstructed view of the project shown in Figure 4.

Discussion

The AT is a nationally significant scenic resource and it is located in one of Maine's major scenic recreation areas. All hikers must pass VP 9A, but there will be no visibility of the project from this location. On site, interviews with hikers were conducted for this VIA and the interviewers noted that VP 9B is a primary destination point for people hiking to and from Little Bigelow Mountain because it offers magnificent distant panoramic views toward three focal points, however views toward the project are almost entirely blocked. Say 50% of hikers leave the AT to find this view. The view from VP 9B is likely to satisfy nearly everyone — there was little evidence of hikers going beyond this point. However, it is clear that one might see more at VP 9C which is a scramble down the hill. Maybe 10% of the people at VP 9B continue on to VP 9C, or 2.5% of the hikers on this section of the AT. VP 9D is a lower ledge approximately 125 feet beyond VP 9C and affords an unobstructed view of the project. The interviewers did not observe any AT hikers continue to VP 9D, so a very small fraction of AT hikers get to this viewpoint, maybe just a couple a year.

The challenge is to identify the "worst-case" view. Clearly it is not VP 9A on the AT since a substantial number of people clime up the rock to VP 9B where they are rewarded with incredible views. However, there will be little to no project visibility from this viewpoint so it is a poor candidate for the "worst-case" given that there are views with greater visibility. An unknown but small number of hikers may climb down the ledge to VP 9C where the project will be clearly visible. There is an argument to be made for and against this view as the "worst-case" — since the project is clearly visible and it is known that a small number of viewers continue to this point. However, there is an unobstructed view if one wants to climb down the ledge to it, but it is unknown whether hikers are actually attracted to this location since VP 9B offers wonderful views in three directions from a more convenient location.

It is a conundrum that the VIA preparer solved by presenting all four views.

FIGURE 1. Map showing location of AT footpath and viewpoints 9A, 9B, 9C and 9D.

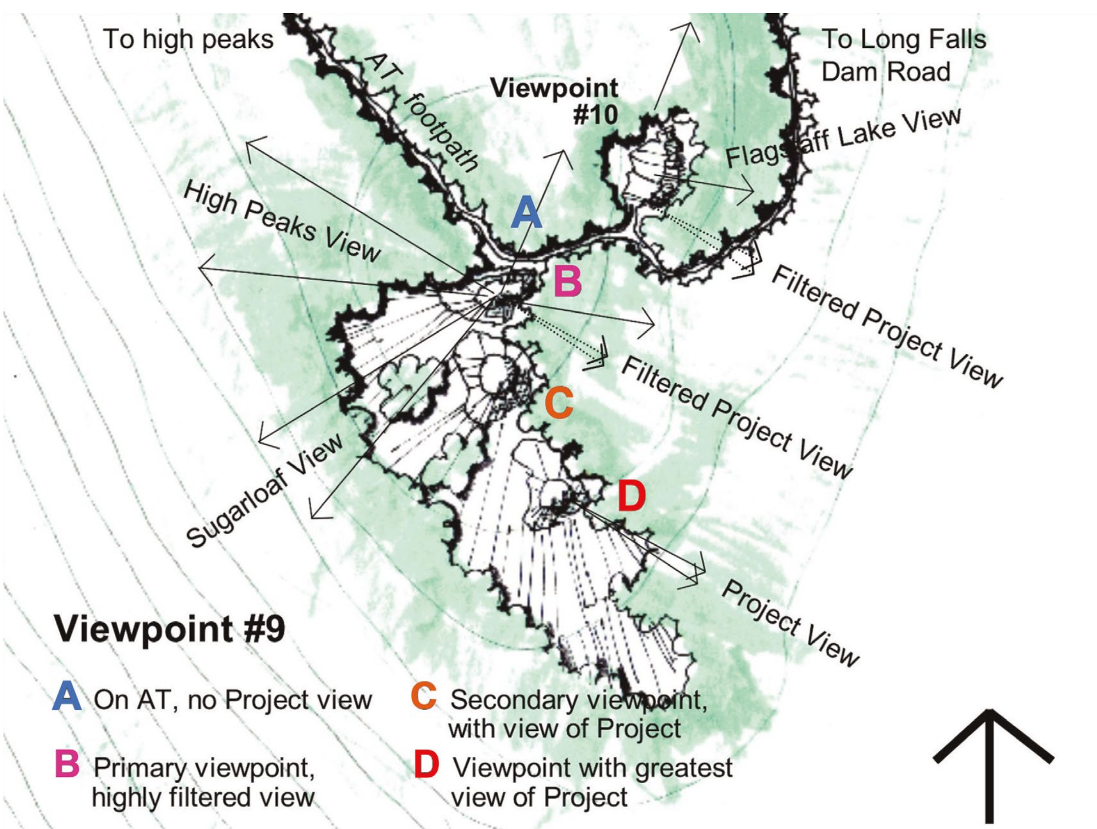


FIGURE 2. The view from viewpoint 9B, an outcrop adjacent to the Appalachian Trail.

FIGURE 3. The view from viewpoint 9C from an outcrop a bit further past VP 9B.

FIGURE 4. The view from viewpoint 9D from an outcrop a bit further past VP 9C.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the Maine Land Use Regulation Commission.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

"Worst-case" view for a KOP

Statement

All things being equal, the location and direction for a simulation photograph should represent a "worst-case" view.

Explanation

A key observation point (KOP) is a localized area with potential views of a proposed project, selected to represent a particular scenic resource or landscape type.

The selection of a "worst-case" viewpoint within a KOP is based on a consideration of several criteria:

- It is the view where the project is most visible in extent and exposure.
- It is at a time of day and season when the project presents the highest visual contrast with its surroundings.
- It is a publicly accessible location chosen after considering the potential number of viewers and their sensitivity to the visual change.
- It considers the sensitivity of the viewpoint and viewed landscape to viewers and others.

The determination of the worst-case view is based on professional judgment. As such, the reasoning of the choice should be explained.

Case Study. Deerfield Center Historic District

The Deerfield Center Historic District was placed on the Register of Historic Places in 2002. It includes 12 stylistically diverse historic buildings and many mature trees. A 115 kilovolt (kV) transmission line on 75-foot wooden poles is located outside the district's northern boundary. The proposal added a new 345 kV transmission line on 110-foot steel poles within the existing corridor.

Three visual impact assessments (VIAs) evaluated the impact of the proposed transmission line to Deerfield Center Historic District. The Deerfield Center Historic District KOP was selected because of its scenic and historic significance. The existing buildings and mature trees screened the existing and proposed transmission lines from many viewpoints within this KOP making it difficult to determine the "worst-case" view. Each of the VIAs identified a different view, as shown in Figure 1. The applicant and government selected locations in front of the Deerfield Town Hall looking toward the Deerfield Community Church. The applicant's viewpoint is located in the road, as if one were driving west on Church Street. The photosimulation of the new 345 kV transmission structure as shown in Figure 2 is colored brown and largely obscured behind a deciduous trees, even without their leaves. The government's viewpoint is located approximately 60 feet to the southwest, as if one were going to the Deerfield Town Hall. The simulation in Figure 3 shows the same transmission structure, which is clearly visible above the trees to the right of the steeple. The brown color, intended to represent rusted Corten steel, is interpreted slightly different in the two simulations. The oppositions group's viewpoint is approximately 375 feet to the west of the other two, near the entrance to the Community Church parking lot. The 345 kV structure will also have greater exposure from this location, in particular the conductor wires will be more prominent and visible to the right. The opposition group's photosimulation may have other problems though. It appears to be created from more than one photograph and may have been cropped at the top or bottom. This makes it difficult to judge the angle of view and relative size of the structures. The transmission structure is not vertical, portions of it appear to be in front of the tree, and the "arms" do not appear perpendicular to the direction of the transmission conductors.

Discussion

All three visual simulations represent potential views of the proposed transmission line, and in that sense represent the Deerfield Center Historic District KOP. However, the transmission structures are more visible in the government's and opposition group's viewpoints. It is worth noting that the structure was screened in the government's original photography (similar to the applicant's) and they returned to the site to document a viewpoint where the structure had greater visual exposure. All three viewpoints are publicly accessible, though it is to be expected that viewers at the applicant's and opposition group's viewpoints will be in vehicles. While the viewers at government's viewpoint may be standing outside (for instance taking photographs of the historic buildings), it is to be expected that there will be fewer viewers than at the other viewpoints. All of the viewpoints are within the historic district, which is a sensitive location.

FIGURE 1. Aerial photo the eastern half of the Deerfield Center Historic District. The red diamonds in the upper left corner are the visible proposed transmission structures. The three simulation views located along Church Street are identified by their Figure number.

FIGURE 2. The photosimulation of the new 345 kV transmission structure from the applicant's chosen viewpoint is colored brown and largely obscured behind a deciduous trees, even without their leaves.

FIGURE 3. The viewpoint chosen for the government agency's photosimulation of the 345 kV transmission structure provides a similar view to Figure 2, but with greater exposure.

FIGURE 4. The viewpoint selected by the opposition group is near the entrance to the Community Church parking lot. The 345 kV transmission structure will also have greater exposure from this location.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the U. S. Department of Energy and the New Hampshire Site Evaluation Committee.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

“Worst-case” view for a KOP

Statement

All things being equal, the location and direction for a simulation photograph should represent a “worst-case” view.

Explanation

A key observation point (KOP) is a localized area with potential views of a proposed project, selected to represent a particular scenic resource or landscape type.

The selection of a “worst-case” viewpoint within a KOP is based on a consideration of several criteria:

- It is the view where the project is most visible in extent and exposure.
- It is at a time of day and season when the project presents the highest visual contrast with its surroundings.
- It is a publicly accessible location chosen after considering the potential number of viewers and their sensitivity to the visual change.
- It considers the sensitivity of the viewpoint and viewed landscape to viewers and others.

The determination of the worst-case view is based on professional judgment. As such, the reasoning of the choice should be explained.

Case Study. Erie Canalway National Historic Landmark

The Erie Canalway is recognized for its role in shaping the American economy and settlement, as an embodiment of the Progressive Era emphasis on public works, and as a nationally significant work of early 20th century engineering and construction. Its navigation channels, locks, lift bridges, dams, power houses, and maintenance shops together represent a significant, distinctive, and exceptional entity. Currently, it is maintained for public recreation enjoyment as the NYS Canal System, with 524 miles of waterway and 365 miles of trails.

The New York Regional Interconnect was proposed as a 190-mile 1,200 MW high-voltage direct current transmission line from upstate New York to just outside New York City. It proposed to purchase easements within existing railroad rights-of-way, which brought it into conflict with the communities through which the railroad passed. The Erie Canalway National Historic Landmark is one of several highly significant scenic resources that it would impact. The applicant’s simulation is shown in Figure 2; a view from a parking area that focuses on a bright yellow access gate that gives no indication that the transmission line is crossing a national landmark at this location. In contrast, the community’s simulation is from a viewpoint 250 ft to the east on the Erie Canalway Trail beside a railroad bridge that provides pedestrian path over the canal. This view of the transmission line is similar to the applicant’s, but it clearly shows the relation of the transmission line to the Erie Canalway.

Discussion

Key observation points (KOPs) are selected to represent a particular scenic resource or landscape type. A simulation viewpoint must be selected to represent a "worst-case" view from the KOP. In this case, the KOP is a national landmark — the Erie Canalway — that is a significant recreation destination. A worst-case viewpoint needs to communicate why a KOP is important as well as provide a clear view of a project.

FIGURE 1. This map shows the location of the NYRI crossing of the Erie Canalway National Historic Landmark and the viewpoint locations for the simulations in Figures 2 and 3.

FIGURE 2. The applicant's simulation is from a parking area focusing on a bright yellow access gate and without a view of the Erie Canalway.

FIGURE 3. The community's simulation from the Erie Canalway Trail beside the railroad bridge that provides a pedestrian path over the canal.

Statement of Limitations. The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the New York State Public Service Commission.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

"Worst-case" view for a KOP

Statement

All things being equal, the location and direction for a simulation photograph should represent a "worst-case" view.

Explanation

A key observation point (KOP) is a localized area with potential views of a proposed project, selected to represent a particular scenic resource or landscape type.

The selection of a "worst-case" viewpoint within a KOP is based on a consideration of several criteria:

- It is the view where the project is most visible in extent and exposure.
- It is at a time of day and season when the project presents the highest visual contrast with its surroundings.
- It is a publicly accessible location chosen after considering the potential number of viewers and their sensitivity to the visual change.
- It considers the sensitivity of the viewpoint and viewed landscape to viewers and others

The determination of the worst-case view is based on professional judgment. As such, the reasoning of the choice should be explained.

Case Study. Waterville Neighborhood

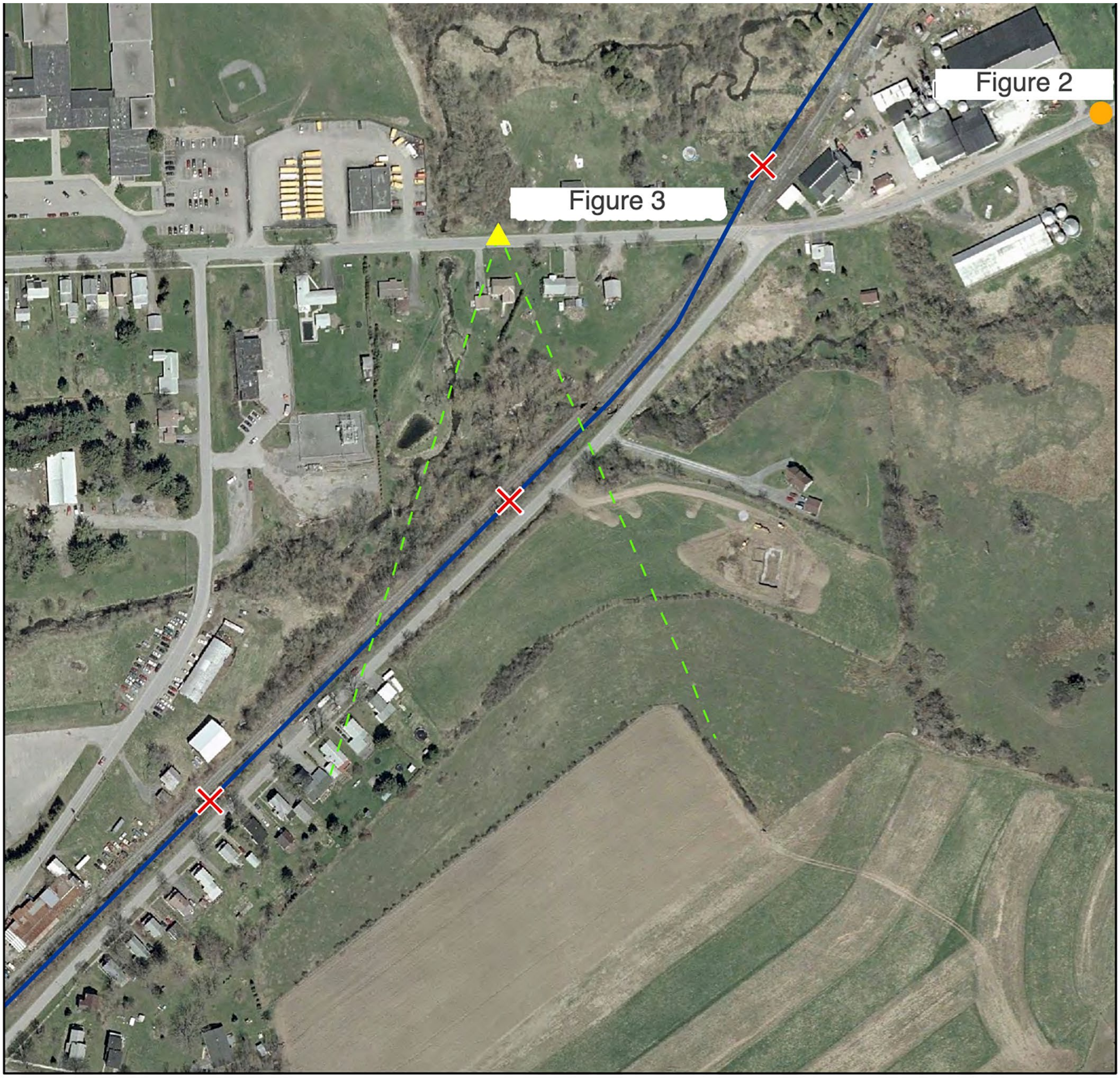
The New York Regional Interconnect was proposed as a 190-mile 1,200 MW high-voltage direct current transmission line from upstate New York to just outside New York City. It proposed to purchase easements within existing railroad rights-of-way, which brought it into conflict with the communities through which the railroad passed.

Waterville, a town with a 2010 population of 1,583 is representative of these communities. Figure 1 is an aerial photo of the northeast corner of the town. The applicant's simulation in Figure 2 shows the transmission line behind the farm and animal feed store on the right. As one continues along the road past the farm store and crosses the railroad tracks, they enter a residential neighborhood with an elementary school on the right and homes on the left. The community's simulation in Figure 3 shows the transmission line behind a house that is typical for the neighborhood. There are similar views throughout the neighborhood, including the school. For instance, at the bottom of the map in Figure 3 there are a dozen homes with the transmission line right across the street.

Discussion

The surrounding landscape's scenic quality affect the perceived visual impact — the higher the scenic quality, the greater the perceived impact. Identifying the worst-case view within a KOP must also consider this context. The farm store is both unattractive and atypical of the surrounding landscape character. It is therefore a poor choice to represent this KOPs.

FIGURE 1. This map shows the location of the NYRI passing through the Marshall neighborhood and the viewpoint locations for the simulations in Figures 2 and 3.



Visual Simulation 3

Context Map

Visual Simulation 3. View from Canning Factory Road, Town of Marshall, Oneida County. Near NYRI Viewpoint 4-7.

FIGURE 2. This is the applicant's simulation as one enters Waterville from the east. The transmission line follows the railroad tracks behind the farm and animal feed store on the right.

FIGURE 3. This is the community's simulation of the transmission line behind a house that is typical for the neighborhood.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the New York State Public Service Commission.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

Avoid foreground visual obstructions

Statement

The presence of objects in the base-photograph's foreground that effectively screen or distract from the proposed visual change should be avoided if possible, and minimized if not.

Explanation

KOPs should be located at viewpoints with meaningful views of a proposed project. This may require consideration of seasonal conditions where views of the project are unobstructed for part of the year but obstructed at other times.

Case Study. Sheldon Solar

Sheldon Solar is a 20 MW solar electric generation facility that will occupy approximately 101 acres in four fields on either side of Route 105. The fieldwork to document and photograph the study area was in early September, when the corn fields were reaching maturity as shown in Figure 1. A second trip was required in order acquire photography for a "worst-case" photosimulation, as shown in Figures 2 and 3.

Discussion

Identifying a "worst-case" view may require returning for field photography. In areas dominated by deciduous trees, it is best professional practice to document views when leaves are on the trees and after they have dropped. The Sheldon Solar project might have also benefited from a photograph with snow cover since it provides a different color contrast with the project.

It is worth noting that these photographs demonstrate additional visual obstruction problems. The truck in Figure 1 and the car in Figure 2 are passing distractions that would be overlooked by viewers but are permanently frozen in the photographs. The highway sign on the left side of Figure 2 is also an inappropriate obstruction in the photograph that could have been easily avoided.

FIGURE 1. A photograph taken in early September. The Sheldon Solar project is planned for the left side of the road.

FIGURE 2. A photograph taken in October after the corn harvest.

FIGURE 3. A photosimulation of the Sheldon Solar project.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the Vermont Public Service Commission.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

Avoid foreground visual obstructions

Statement

The presence of objects in the base-photograph's foreground that effectively screen or distract from the proposed visual change should be avoided if possible, and minimized if not.

Explanation

An important characteristic of a "worst-case" view is that the project extent and exposure are as high as possible for the KOP. One aspect of this is that the photograph should reasonably avoid foreground elements that obstruct or distract from the view of the project. While a photograph is a static record of the view, viewers will move around the KOP to better see and understand a view. For instance, the view of the project from or across a road should not be obstructed by a truck that is passing.

Case Study. Victor Head Trail

The Victor Head Trail in the Nash Stream State Forest is a short spur of the Cohos Trail, just north of Christine Lake in Stark, NH. The Victor Head overlook presents an expansive panoramic view to the south toward the White Mountain National Forest. A 345 kV transmission line is proposed to be collocated with an existing 115 kV line on the far side of Christine Lake, a bit over 4 miles away. The area is forested, but the viewpoint is at the head of a rock ledge that drops away creating the panoramic view.

Discussion

Figure 1 shows a view from Victor Head across Christine Lake. A large tree in the foreground largely obscures the existing transmission line ROW on the far side of the lake. While this photograph captures the character of the view, it does not represent the "worst-case" view toward the project. Figure 2 is approximately 25 ft to the left and shows a much less obstructed view. It is reasonable to expect viewers to walk around and settle where the view is most open. Figure 2 is a better representation of the "worst-case" condition.

FIGURE 1. The base photograph used for the developer's photosimulation from the Victor Head Trail.

FIGURE 2. The base photograph used for the agency's photosimulation from the Victor Head Trail

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the U. S. Department of Energy and the New Hampshire Site Evaluation Committee.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

Determining visibility

Statement

Photosimulations will represent views of a project.

Explanation

Visibility is normally determined by a viewshed analysis, which indicates potential visibility but not what project locations may be visible. The visible portion of a project may not be the closest to the viewer.

Case Study. Lagace Beach on Webster Lake

Webster Lake is a recognized scenic resource that is 606 acres surrounded by forest lands with two public town beaches. Lagace Beach is at the southern end of the lake, as shown in Figure 1. Its facilities include a bath house, boat ramp, picnic facilities, and paved parking. An existing 115 kV transmission line on 52 ft wooden H-frame structures runs north to south along the east of the lake. The closest structure is approximately 1,500 ft from the beach. It is proposed to add a new 345 kV transmission line on 75 ft lattice structures within the existing corridor.

The viewshed analysis indicates that there will be visibility of the project throughout most of the area in Figure 1. The applicant recognized that when looking down the lake, “the top of three structures will be visible above the trees at a distance of 1.7 to 1.8 miles, but will not break the horizon line.” However, the submitted photosimulation shown in Figure 2 is oriented along the beach to the northeast. The view description on the photosimulation states that from the “view from Lagace Beach, located on the southeaster shoreline of Webster Lake, the proposed structures are behind trees in the foreground and will not be visible from this location.”

As part of its review, the government submitted the simulation in Figure 3, which shows the visible structures looking down the lake. The approximate angle of view for the simulation is indicated by the white lines in Figure 1. The lattice towers are indicated by pink triangles. From the right, the first two will not be visible but the next three will be. Figure 4 is an enlargement to more clearly show the structures.

Discussion

It is intended that key observation points (KOPs) are at locations where the project will be visible, which was known to be the case from Lagace Beach. As a general principle, photosimulations should represent the “worst-case” view from a KOP. While the “worst-case” is often in the direction that the project is closest to the viewer, this is not always the case.

The applicant should have presented the photosimulation in Figure 3 and included the photograph in Figure 2 as part of a description of the site context, explaining that the surrounding forest will screen foreground views of the transmission structures.

FIGURE 1. Lagace Beach on Webster Lake. The red dots in the transmission line right-of-way are existing wooden H-frame structures that will remain; the pink diamonds are new lattice towers. The white lines show the cone of vision for the simulation in Figure 3.

FIGURE 2. The applicant's photosimulation looks east toward the closest proposed structures, which are heavily screened by intervening vegetation from this location.

FIGURE 3. The government's photosimulation from Lagace Beach looks north. Though not prominently visible, the tops of three proposed galvanized structures would be visible above the trees just in front of the background mountain at center-right.

FIGURE 4. An enlargement of the visible transmission line from Figure 3.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the U. S. Department of Energy and the New Hampshire Site Evaluation Committee.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

Focal length and horizontal angle of view

Statement

The simulation photograph should be taken with a "normal" lens (50mm effective focal length), which has a horizontal angle of view of approximately 40°.

Explanation

A photosimulation should be prepared so that when a person holds it in a comfortable manner the project elements are scaled as they would be if seen at the viewpoint. Said another way, the viewer should hold the photosimulations so that if it was printed on clear plastic the landscape features would all line up (i.e., it is in the perspective picture plane). For instance, when a person holds a letter sized sheet of paper it is commonly held at comfortable book-reading length — 14± inches; a tabloid sheet of paper is held at arm's length — 20± inches.

The camera sensor and focal length of the lens used to photograph the view determines its horizontal angle of view (HAoV). Because many different sized sensors are used, it has become common to describe the lens' effective focal length (EFL) or the focal length on a 35mm film camera that would have the same HAoV. Table 1 gives the appropriate viewing distance for photographs printed in landscape mode on letter (10 inch wide) and tabloid (16 inch wide) sheets for selected effective focal lengths and their horizontal angle of view. The viewing distances for photographs taken with a 50 mm EFL are most comparable with comfortable reading lengths. This indicates that a photograph — or photosimulation — will most likely be viewed at the appropriate distance.

TABLE 1. Viewing distance for photographs printed on letter and tabloid sheets for selected equivalent focal lengths and horizontal angle of views.

		VIEWING DISTANCE	
EFL	**HAoV**	**10 in width**	**16 in width**
28mm	65.5°	7.8	12.4
50mm	39.6°	13.9	22.2
75mm	27.0°	20.8	33.3
85mm	23.9°	23.6	37.8

Case Study. View of Pisgah Mountain Wind from Eagle Bluff

Silver Maple Wind is a five turbine 20 MW expansion project that will visually appear to be part of the existing five turbine 9 MW Pisgah Mountain Wind project. The photograph in Figure 2 shows the existing Pisgah Mountain Wind turbines from Eagle Bluff. It was included in the Silver Maple Wind VIA to show the existing condition and was used as the base-photograph for a simulation.

The photograph from Eagle Bluff was taken with an iPhone 8 Plus and has an EFL of 28mm. Figure 1 is an aerial photograph that shows the horizontal angle of view for this photograph in orange. Figure 3 crops this photograph to an area equivalent to a photograph taken by a 50mm EFL lens and its horizontal angle of view is represented by the white lines in Figure 1.

Discussion

The use of a 28mm EFL lens for a base-photograph has the effect of minimizing the scale of the wind turbines. As shown in Table 1, if Figure 2 is printed as formatted on letter-sized paper it would need to be held approximately 7.5 inches from the eyes — an uncomfortable distance. The viewing distance if printed on tabloid paper is similarly uncomfortable. However, if Figure 3 is printed as formatted on letter-sized paper it would be held at a comfortable reading distance — approximately 13 inches — and the wind turbines would be represented at the appropriate visual scale.

This geometry is the reason that simulation photography should be taken with a 50mm EFL, the so called “normal” lens. It is not “normal” because it most closely represents the focal length of the eye — it does not, since the eye is a very different visual system than a camera and lens. It is best professional practice to use a “normal” lens because it results in a photograph that is most natural and comfortable for us to hold at the appropriate distance when printed on standard media.

FIGURE 1. An aerial photograph showing the horizontal angle of view for Figure 2 in orange and Figure 3 in white.

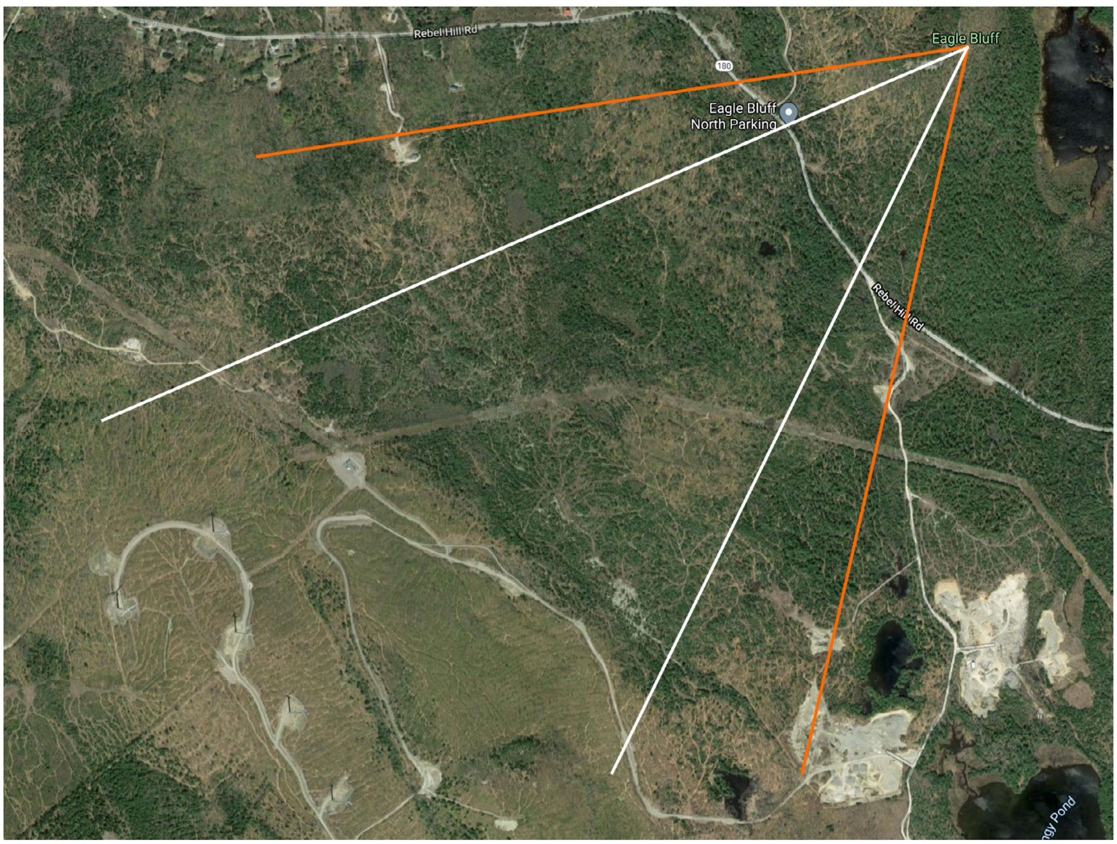


FIGURE 2. A photograph of the Pisgah Mountain Wind project from Eagle Bluff taken with a 28mm EFL.

FIGURE 3. A photograph of the Pisgah Mountain Wind project from Eagle Bluff taken with a 50mm EFL.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the Maine Department of Environmental Protection.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

Base-photograph veracity

Statement

Digital editing in photosimulations should be limited to project-related changes.

Explanation

A substantial part of a photosimulation's perceived legitimacy is derived from the expectation that the base-photograph is a truthful representation of the landscape context. We all have seen the results of powerful digital methods that create fictional photo-realistic images. Nonetheless, we are all conditioned to believe photographic evidence, which is why photosimulations with high quality and integrity are critical to accurately communicating proposed visual changes to the visual assessment experts, the public, and decision makers.

Case Study. Mountain Top Inn

Mountain Top Inn (MTI) is a four-season vacation and event destination located on 700 acres in central Vermont with sweeping views of a mountain lake and the Green Mountain National Forest. It provides diverse accommodations, including rooms in the main lodge, cabins, and guest houses.

In 2015, MTI submitted an application for an additional 34 room stand-alone lodging facility referred to as the Annex. Visual impact assessments are a normal part of the environmental permit application in Vermont. Several photosimulations were presented, included the summer view across the lake in Figure 1. After reviewing the application materials, the reviewing agency required the applicant to submit an additional "leaf-off" photosimulation. The applicant noted that it was inappropriate to stop the process for six months to obtain leaf-off photography. It was suggested that leaf-off conditions could be digitally simulated. The simulation expert made it known that this was not a best professional practice, but complied by preparing Figure 2.

The simulation in Figure 2 is created by digitally "painting" leaf-off conditions taken from digital photographs of seasonally and regionally appropriate forested hillsides. There are a variety of potential sources of error with this approach. It is unavoidable that the lighting conditions, exposure, image resolution, viewer position, etc. in the summer base-photograph are different than the fall images used for digital painting. In this particular simulation, which is probably more accurately called an illustration, the leaf-off changes did not include the cloud shadows on the hillside and use only a generic representation of a forest without leaves. As such, the illustration does not include the actual conditions around the project such as evergreen species versus deciduous species, and this may affect the apparent contrast of the proposed facility with its surroundings.

Discussion

It is possible to verify many aspects of the project's visual character in a simulation — location, scale, color, etc. However, it is much more difficult to verify the accuracy of changes to the surrounding landscape, which provides the context necessary to evaluate visual contrast and character compatibility with that context. This is why best professional practice limits changes to the base-photograph to those required by introduction of the project.

In this case study, the government asked for the additional seasonal simulation. Because it was unreasonable to delay the permit review, the seasonal condition was simulated. A better practice would be for the government to make it known that permit applications shall include leaf-off and leaf-on simulations, and not require such a submission in the middle of the permit application without prior notice.

FIGURE 1. Photosimulation across Chittenden Reservoir toward the Mountain Top Inn & Resort. The main lodge is to the left, centered on the hillside. The Annex is the less conspicuous longish structure in the center of the photograph, below the individual houses.

FIGURE 2. These fall leaf-off conditions are simulated by digitally “painting” them over the base-photograph in Figure 1.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the Vermont Natural Resources Board.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle
Scale of project elements

Statement
All elements in the simulation must be accurately scaled.

Explanation
Photosimulations are created from a composite of a photograph showing an existing view and project elements that are modeled on a computer. If the two parts are not at the same scale, then the representation of the project elements will be incorrect.

Case Study. Spruce Mountain Wind
Spruce Mountain Wind is proposed for a 2,879 acre site in Woodstock, Maine. It includes eleven 1.5 MW GE wind turbines that are 80 m (262 ft) to the hub center plus 38.5 m (126 ft) for the rotor blades for a height of 118.5 m (388 ft) to an upright blade tip. The photosimulations were created with WindPRO which includes digital models for most commercial wind turbines. These models are located in a digital terrain which is then registered to the photograph.

The photosimulation is from the shore of Shagg Pond, a designated scenic resource of statewide significance. The photosimulation originally prepared for the VIA is shown in Figure 1. Maine conducts an independent review of wind project VIAs. Figure 2 shows a visualization prepared with ArcScene GIS software as part of that review. Both the original photosimulation and the visualization were set to use the same approximate viewpoint and camera lens (50 mm equivalent lens with approximately a 40° horizontal angle of view). The order of the turbines along the ridge line appears to be correct, but the turbines appear a bit small and do not occupy the full horizontal angle of view, as represented in the visualization. The applicant was asked to check the photosimulation's accuracy. The photosimulation was corrected and the revised version is shown in Figure 3.

Discussion
In this version of WindPRO, the registration of the rendered turbines to the photograph primarily relies on matching the silhouette of the digital terrain ridgeline to the photograph. The error was caused by improper registration. One clue was that while all the visible turbines were shown, they did not occupy the full horizontal field of view as well as the visual scale shown in the visualization. ArcScene visualizations may be basic visual images, but they are geometrically accurate representations of the project's visual scope and scale relative to the terrain and forest cover. The error was easy to miss because photosimulations look so real and therefore seemed to be a reasonable ridgeline match.

Maine normally has an independent aesthetics expert review wind and other large development proposals if there is a possibility that they will affect scenic resources. This case study is an example of the importance of this type of peer-review.

FIGURE 1. The original photosimulation of the Spruce Mountain wind turbines from Shagg Pond.

FIGURE 2. A visualization of the view from Shagg Pond created in ArcScene GIS software.

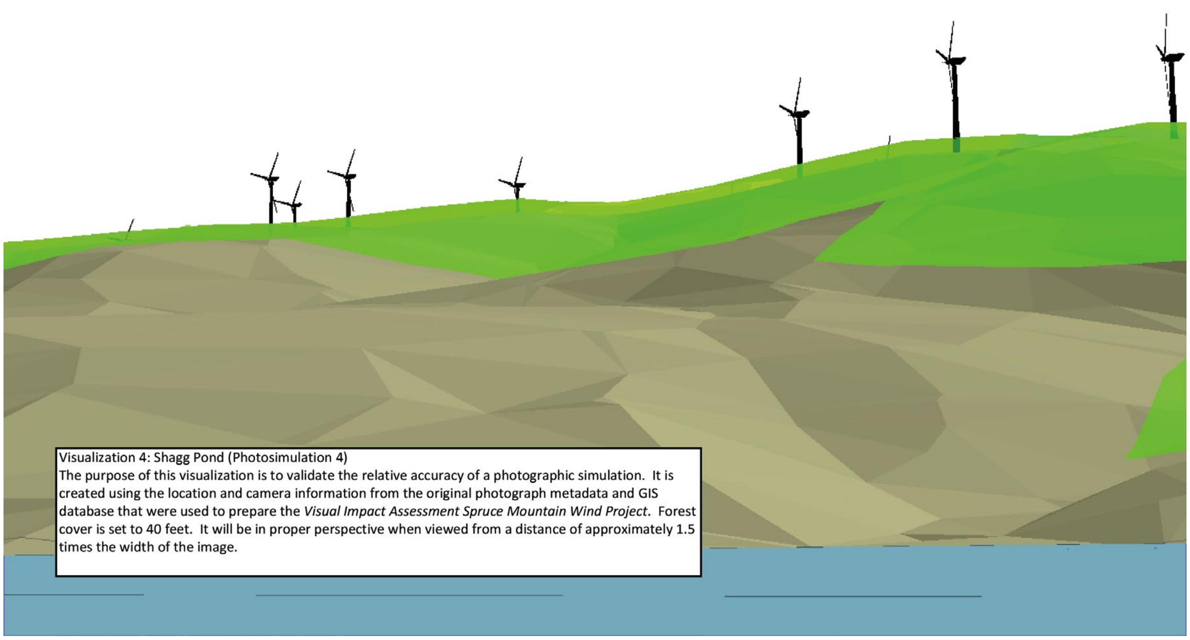


FIGURE 3. The revised photosimulation of the Spruce Mountain wind turbines from Shagg Pond.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the Maine Department of Environmental Protection.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle
Represent all projected visual changes

Statement
The simulation must include all reasonably anticipated direct and indirect project-related visual changes.

Explanation
Often there are particular elements of a project that are expected to present the primary visual impact. For instance, the focus for wind energy projects is on the wind turbines because they are so large. However, wind energy projects create other visible changes to the landscape, including roads, power lines, transfer stations, and clearings around and adjacent to the wind turbines that are required for their installation and maintenance. All of these changes must be represented.

Case Study. View of Pisgah Mountain Wind from Eagle Bluff
Silver Maple Wind is a five turbine 20 MW expansion project that is proposed adjacent to and will visually appear to be part of the existing five turbine 9 MW Pisgah Mountain Wind project. The photograph in Figure 2 shows the existing Pisgah Mountain Wind turbines from Eagle Bluff. It was included in the Silver Maple Wind VIA to show the existing condition and was used as the base-photograph for the photosimulation in Figure 3, which shows the addition of the Silver Maple Wind project turbines.

The construction of simulations for the Silver Maple Wind project focuses on the wind turbines because they will become the dominant visual elements in the landscape. The importance of the clearings associated with the existing Pisgah Mountain Wind project are plainly evident in Figures 1, 2, and 3. However, the photosimulation in Figure 3 does not represent the necessary clearings that will be associated with the Silver Maple Wind project. This is a serious omission.

Discussion
While not as prominent as the turbines themselves, the omission of these new clearings significantly underrepresents the significance of the visual change. The clearings provide a visual indication of the real “footprint” of the wind project on the ridgeline. The proposed turbines are not simply and cleanly inserted into the forest, as represented in Figure 3. A wind energy development is a massive high-technology industrial facility that affects the whole mountain. Photosimulations must portray all reasonably anticipated direct and indirect project-related visual changes.

FIGURE 1. An aerial photograph showing the horizontal angle of view for Figures 2 and Figure 3.

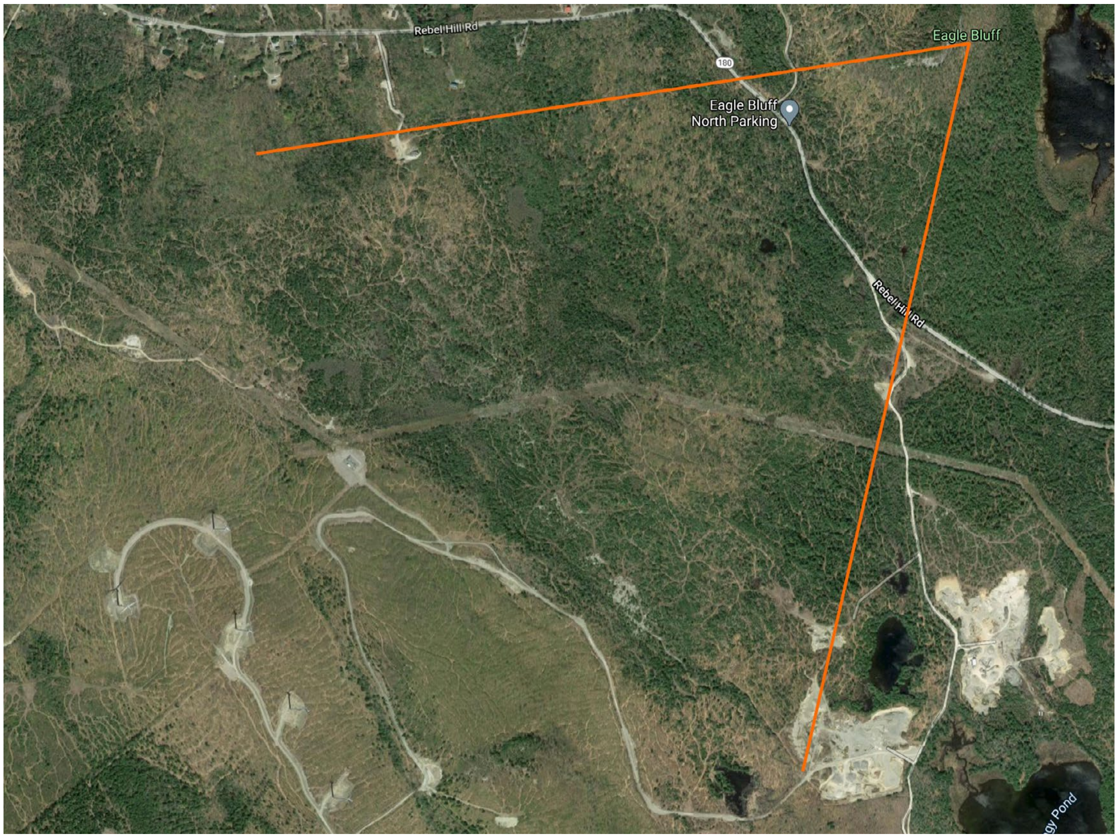


FIGURE 2. A photograph of the Pisgah Mountain Wind project from Eagle Bluff taken with a 28mm EFL.

FIGURE 3. A photosimulation of the existing Pisgah Mountain Wind and proposed Silver Maple Wind projects from Eagle Bluff.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the Maine Department of Environmental Protection.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle
Photosimulation resolution

Statement
The base-photograph and photosimulation should have high resolution and minimal compression.

Explanation
The Snellen eye-chart for “normal” vision tests our visual acuity or the spatial resolution of our visual processing system. It uses block letters that are 5 arc minutes high and composed of lines and gaps with a width of 1 arc minute. However, perception research has found that resolution acuity of a normal eye is 30 arc seconds. The horizontal angle of view of a photograph taken with a “normal” lens is approximately 40°. If the expectation is that our visual acuity is 1 arc minute then the photograph must have at least 2,400 horizontal pixels (i.e., 40° x 60’); if visual acuity is 30 arc seconds it must have at least 4,800 horizontal pixels.

In addition to matching human visual acuity, the pixels of a photograph must capture the detail as it exists in the view. Figure 1 shows a grid of squares representing the pixels of a digital camera sensor. Each pixel of a digital photograph can only be one color. The color of the wind turbine blade in the purple square will be white, but the color in the orange square will be light blue and may not be recognized as part of the turbine blade. The tower presents a problem — it is a full pixel wide but is split by the grid. The green squares represent the solution determined by the Nyquist-Shannon sampling theorem — to capture a desired resolution is sufficient to sample at twice that resolution. The green squares to the left and right will be recorded as blue and the ones in the center will be white, and the tower captured. The same rule would apply to the blade tip, the lower left quarter of the orange square would become white and the rest would be blue.

Taken together, applying the eye’s visual acuity and the sampling theorem to a digital camera requires that a photograph taken with a “normal” lens have a horizontal resolution between 4,800 (2400 pixels sampled at 2x resolution) and 9,600 pixels (4800 pixels sampled at 2x resolution), which requires a 15.3 up to 61.0 megapixel digital camera.

These resolution issues also apply to printing. For instance, 300 dpi is referred as a “retinal display,” where we no longer see the dots when held at a comfortable distance. If a photosimulation is to be printed 16 in wide on tabloid paper, that means that the image must have a minimum of 300 x 16 or 4,800 pixels. However, the pixels of the image and the printer will not match perfectly, so the Nyquist-Shannon sampling theorem suggest that the image be 9,600 pixels wide to fully print the information in the image. It is more complicated than this because printers do not print simple pixels and may use algorithms to sharpen edges or make other adjustments. However, the general principle still applies.

A further consideration is that cameras often save images as a JPEG file, a “lossy” compression format that reduces the file size of the image but reduces the image quality of the details in the process. All photographs should be saved as the highest quality JPEG file, or better yet as a RAW format file that is “lossless.” Great care may be taken to prepare simulations to maintain a high quality image, but it is not unusual that the simulation will be made available to the public as a PDF document that has been significantly compressed using JPEG to facilitate download times.

Case Study. View of from The Rocks Estate

The Rocks Estate is a 1,400-acre property listed on the National Register of Historic Places. It is owned by the Society for the Protection on New Hampshire Forests which maintains an education center and trail system for visitors. A 345 kV transmission line on 75 ft lattice structures is proposed within an existing corridor. At a distance of less than half a mile, the existing structures on 43 ft wooden H-frames are easily overlooked, the new structures will be more visually prominent.

A selection cropped from the original photosimulation representing views from The Rocks Estate as prepared for the applicant's VIA is shown in Figure 2. The details of the lattice structures and conductor wire are clearly apparent in the full resolution, uncompressed image. However, the PDF version of the photosimulation made available to the public on the permitting agency's website is significantly degraded.

Discussion

VIA reviewers must always request the original base-photograph and photosimulation in order to evaluate visual effects. Information about the last applied JPEG compression is not part of the image metadata, however, there are online tools that will provide estimates.

As this case study demonstrates, the quality of a simulation can be degraded during the process of preparing them for distribution. This can be done by the VIA authors or developer when they submit their permit application, or it can be by the permitting agency when the files are compressed to make storage and downloading more manageable. The result may be unintentional, but reviewers must always be conscious of this possibility since it has a very significant effect on the apparent visual prominence of a project and can lead to a misunderstanding of potential visual impacts.

FIGURE 1. A camera sensor records an image as pixels — represented by the squares.

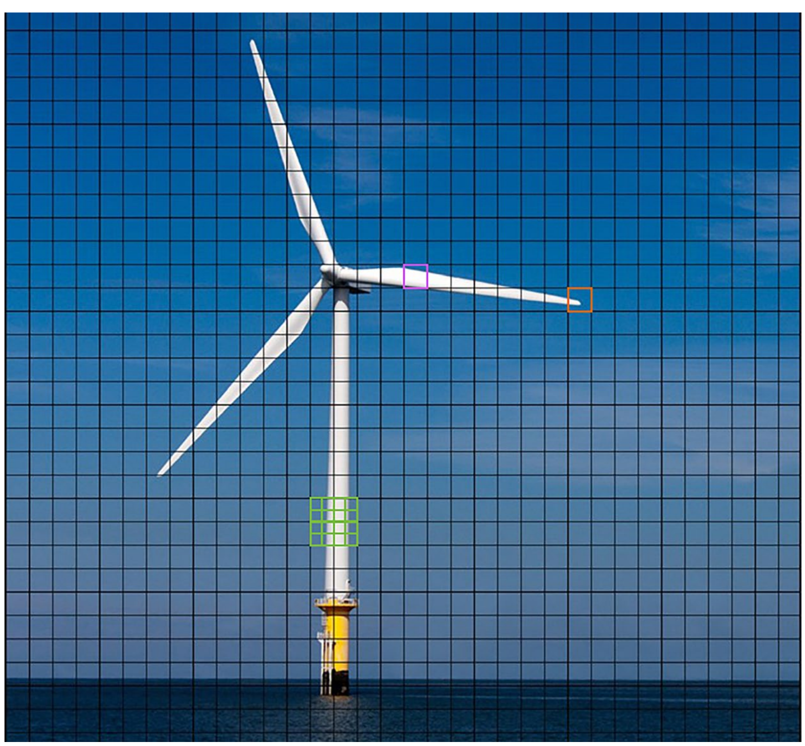


FIGURE 2. A cropped selection from the photosimulation at The Rocks Estate provided during discovery. This represents the full quality of the original photograph and simulation.

FIGURE 3. A cropped selection from The Rocks Estate photosimulation as it appeared in the VIA. The quality of the image is severely degraded from the original, as is quite apparent if one focuses on the conductor wires.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the New Hampshire Site Evaluation Committee.

CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle

Photosimulations of glare are ineffective.

Statement

Photosimulations cannot adequately represent glare because they lack sufficient light intensity.

Explanation

Glare is any continuous bright light that disturbs visual perception and causes discomfort. A glint is a similar phenomenon occurring as a momentary flash of bright light. The source may be direct or reflected sunlight or artificial light, such as oncoming headlights. The human eye can adapt to a wide range of light intensity, from starlight (approximately .01 lux) to bright sunlight (over 100,000 lux). However, it can accommodate only a small portion of this range at any time and it can take a few minutes for the eye to adjust between large changes in brightness. As a rule of thumb, glare occurs when a light source is at least a 1,000 times brighter than the average visual field (or the conditions to which the eye has adjusted).[1]

Case Study. Ivanpah Solar Energy Project

The Ivanpah Solar Electric Generating System (ISEGS) is a concentrated solar thermal plant (a.k.a. power tower) located in the California Mojave Desert. The plant consists of 173,500 heliostats that track the sun's path and focus sunlight to three solar power towers that are each 459 ft (140 m) tall. The nominal electric generation capacity is 393 MW. At the time of construction, it was the largest solar power tower facility in the world, and the first operational solar power tower facility on BLM-administered lands.

The view in Figures 1 and 2 are from KOP 6 located near the eastern edge of Ivanpah Dry Lake, almost due east of Tower 2. The KOP is located 4.1 mi (6.6 km) from Tower 1, 4.7 mi (7.6 km) from Tower 2, and 5.5 mi (8.9 km) from Tower 3. Figure 1 makes a reasonable attempt at simulating the "dust halos," but it underrepresents glare from the power tower and includes no indication of heliostat flares. Glare is apparent in Figure 2 from both the power towers and heliostats, however, it lacks the defining perceptual discomfort.

Discussion

Printed photosimulations are perceived because of reflected light which lacks sufficient intensity to produce glare. However, the photograph did record the "bloom" and "flare lines" characteristic of photographed glare. The reason for this is that the light source is overexposed relative to the rest of the image. The camera sensor is overpowered just as the human eye is, the difference being the photograph can not record the human discomfort. While glare may represent a very small area in the view, it becomes important because it is very uncomfortable to look directly at it. As a result, it influences our viewing behavior — we either avoid looking in that direction entirely or we find ourselves taking quick glances or looking with our peripheral vision. The point is that neither the simulation nor the photograph can represent these aspects of the perception.

1 *Benya, J. A. 2010. Controlling glare. Architect Magazine. https://www.architectmagazine.com/technology/lighting/controlling-glare_o*

Figure 1. Visual simulation of ISEGS facility Towers 2 and 3 (of seven proposed) as they would be seen from the Final EIS KOP 6, Ivanpah Dry Lake Bed, Eastern Side.

FIGURE 2. Photograph of the ISEGS facility Towers 2 and 3 (of 3 built) as seen from ISEGS Visibility Study SOP 6, Ivanpah Dry Lake Bed, Eastern Side.

Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the U. S. Department of Energy and the U. S. Department of Interior, Bureau of Land Management.