NCHRP 25-25, TASK 90

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS FOR HISTORIC PROPERTIES

Prepared for:

AASHTO Standing Committee on the Environment

Prepared by:

Eric Ingbar, Gnomon, Inc.
1601 Fairview Drive, Carson City, NV 89701
and
Terry H. Klein, SRI Foundation
333 Rio Rancho Drive, Suite 103, Rio Rancho, NM 87124
and
Melissa Cascella, ICF International
710 Second Avenue, Suite 550, Seattle, WA 98104

September, 2015

The information contained in this report was prepared as part of NCHRP Project 25-25, Task 90, National Cooperative Highway Research Program.

Acknowledgements

This study was conducted for the AASHTO Standing Committee on the Environment (SCOE), with funding provided through the National Cooperative Highway Research Program (NCHRP) Project 25-25, Task 90 Application of Geographic Information Systems for Historic Properties. The NCHRP is supported by annual voluntary contributions from the state Departments of Transportation. Project 25-25is intended to fund quick response studies on behalf of SCOE. The report was prepared by Eric Ingbar, Principal Investigator, of Gnomon, Inc.; Terry Klein of the SRI Foundation; and Melissa Cascella of ICF International. The work was guided by a technical working group that included:

Gail Anne D'Avino, Georgia Department of Transportation
William H. Bachman, Westat
David S. Clarke, Delaware Department of Transportation
Faisal Hameed, Parsons Corporation
Elizabeth Hobbs, Minnesota Department of Transportation
Roy Jackson, Florida Department of Transportation
Bruce D. Jensen, Texas Department of Transportation
Erin Littauer, Washington Department of Transportation
MaryAnn Naber, Federal Highway Administration Liaison

The project was managed by Crawford Jencks, Cooperative Research Programs/NCHRP.

EXECUTIVE SUMMARY

The National Cooperative Highway Research Program (NCHRP) and the Federal Highway Administration (FHWA) have conducted a variety of studies on how state Departments of Transportation (DOTs) streamline and enhance historic preservation compliance and project delivery, through the use of tools such as cultural resources Geographic Information Systems (GIS). The current NCHRP 25-25 study, Task 90 *Application of Geographic Information Systems (GIS) for Historic Properties*, is a logical extension of these previous studies, in addition to the evolution of historic preservation compliance practices within the past few years. Task 90 builds upon these earlier studies by addressing the following questions:

- What are the time and cost benefits of using a cultural resources GIS?
- What are the costs (time and money) for improving and maintaining a cultural resources GIS? What are the barriers to improving and maintaining an effective GIS program? How does one overcome these barriers?
- What lessons have state DOTs learned from using cultural resources GIS during transportation planning and project development, especially in terms of streamlining compliance with Section 106 of the National Historic Preservation Act and Section 4(f) of the Department of Transportation Act?

At the start of the current project, previous studies made it clear that most state DOTs used or had access to cultural resources GIS; but, the project team was missing information on 13 states. To fill this information gap, the project team sent a survey questionnaire to the 13 states, asking if they had a cultural resources GIS, and if they did not, were they planning to develop a GIS. The results of this survey, when combined with information on the other states, showed that virtually all states have a cultural resources GIS. These GIS are either maintained in-house by a state DOT, or DOT staff has access to the GIS, which is maintained by their SHPO or another state agency, such as a state university. A few states have both an in-house GIS and participate in a shared GIS.

After this initial survey, the project team interviewed a sample of state DOTs, including several that participated in the initial survey. The interviews focused on the use, maintenance, and improvement of cultural resources GIS. To determine which states were to be included in this sample, the project team, in consultation with the NCHRP panel overseeing this study, considered several factors:

- Length of time the GIS has been used (i.e., the maturity of the GIS)
- Ways in which the GIS is used by a state DOT (i.e., during long range planning, analysis of projects in a State Transportation Improvement Plan (STIP), and/or during project development)
- Whether the state DOT's GIS is a shared system with other agencies (e.g., the SHPO)
- The use of special applications in GIS, such as archaeological predictive modeling
- If the state DOT's GIS is currently being improved

DOTs were selected based upon the above factors, attempting to maximize the variation among the sampled states. A total of 15 states were interviewed. When possible, the state DOT's historic preservation partners were also interviewed (e.g., the SHPO, a state office of archaeology, or a university that housed and maintained the cultural resources GIS).

Based on previous NCHRP studies, and the results of the 15 interviews, the most common use of cultural resources GIS is as a research and screening tool, enabling users to identify the locations of recorded archaeological sites and historic built environment. These GIS are also used to assess the potential for as yet-to-be identified historic properties within a proposed project area. When accessible through a GIS, DOT staff also can identify locations in a project area that have been previously surveyed. These types of analyses are in turn used to assess the need for future cultural resources surveys, the level of effort associated with these surveys, the location of potentially significant Section 106 issues, and the location of potential Section 4(f) properties. They also assist in the analysis of proposed project alternatives.

These analyses are generally conducted after the initiation of the National Environmental Policy Act (NEPA) review process. A few state DOTs, however, use cultural resources GIS to conduct constraint analyses of proposed projects included in a STIP or early corridor studies, sometimes as part of long-range planning. The focus of these analyses is on the location of recorded National Register-listed and -eligible properties, as well as historic sites that may warrant protection under Section 4(f).

These cultural resources GIS have become an integral part of state DOT environmental and historic preservation compliance decision making, and transportation project delivery. In addition, almost all of the interviewed state DOTs noted cost and time savings as a result of using a cultural resources GIS, especially those systems that are accessible online. The state DOT interviews and those of their historic preservation partners, also revealed that almost all of the states are moving, or would like to move, toward the same goal. This goal is to have a single, statewide cultural resources GIS (SCRGIS) maintained by a single entity. Based on the interviews, this GIS would:

- Be housed and maintained by a state university, the DOT, the SHPO, or other entity
- Be accessible online with appropriate security measures
- Have multiple levels of access (e.g., the public; DOT cultural resources staff, environmental staff, designers, and project managers; local transportation agencies; cultural resources professionals outside the DOT; and tribes)
- Contain all recorded cultural resources locations and boundaries (e.g., archaeological sites, historic built environment, and historic districts)
- Show boundaries of all surveyed/ inventoried areas
- Contain Section 106 correspondence and associated documents from the SHPO, the state DOT, and other state and federal agencies
- Have all associated reports, property/site forms, and records
- Allow multiple contributors to upload data into the GIS
- Allow users to download data and use these data for conducting agency-specific analyses, and producing agency maps and reports

The project team, in consultation with the NCHRP panel, prepared a "road map" for implementing a single, SCRGIS. This road map examines the steps to develop the GIS, the partnerships required in building the GIS, and how to overcome the barriers that will be encountered. This road map relies on the findings of earlier NCHRP and FHWA studies, and on the interviews conducted under the current NCHRP project. The final element of the NCHRP 25-25/Task 90 study is a discussion on mechanisms for promoting and implementing these types of GIS nationwide.

TABLE OF CONTENTS

Page

Executive Summary ..... **i**

1.0 Project Goals and Methods **1**

1.1 Introduction 1

1.2 What is a GIS? 2

1.3 Study Approach 3

2.0 Business Case for Having a cultural resources GIS **6**

2.1 Common Uses 6

2.2 Benefits and Effectiveness of GIS Use 8

3.0 The Goal: A Single, Statewide cultural resources GIS **14**

3.1 What Does this GIS Look Like? 14

3.2 Common Issues to Consider 16

3.3 How Do You Get There? 18

3.3.1 Design Steps 18

3.3.2 Recommended Partnerships 27

3.2.3 How Do You Pay for It? 27

3.2.4 Tiered Approaches to Creating a Statewide Cultural Resource GIS 29

4.0 Recommendations for Future Actions **31**

References Cited **34**

Appendices

A. Interview Questionnaire

B. Examples of Current State cultural resources GIS

1.0 PROJECT GOALS AND METHODS

1.1 INTRODUCTION

The past five years of historic preservation practice have seen a marked increase in the use of cultural resources Geographic Information Systems (GIS) among state Departments of Transportation (DOTs), other state and federal agencies, and the private sector. Cultural resources include archaeological sites, the historic built environment, and properties of religious and cultural significance to tribes and Native Hawaiians. A sub-set of these resources include properties that are listed in or are eligible for listing in the National Register of Historic Places (i.e., "historic properties"). Effects on historic properties are taken into account during federally-funded or approved transportation projects, following the requirements of Section 106 of the National Historic Preservation Act (NHPA).[1] In addition, these properties may be protected under Section 4(f) of the Department of Transportation Act.[2]

The National Cooperative Highway Research Program (NCHRP) has conducted a variety of studies in the past that looked at how state DOTs streamline and enhance compliance with Section 106, through the use of such tools as cultural resources GIS. These include, but are not limited to:

- NCHRP Synthesis 347 – defines methods for mapping investigations and retaining them in GIS at a general level (SRI Foundation, 2005).
- NCHRP 25-25/ Task 49 – discusses how GIS is an important component for transportation planning and development. This report also discusses the value of models that forecast the likelihood of encountering historic properties (Cambridge Systematics, Inc., 2009).
- NCHRP Report 542 – discusses electronic methods and tools for evaluating National Register eligibility. The report makes specific recommendations about how to incorporate GIS in the evaluation process (URS Group, Inc., 2005).
- NCHRP 25-25/ Task 61 – focuses on GIS systems designed either solely by DOTs or by DOTs in collaboration with other agencies. The report discusses many aspects of GIS design, implementation, and maintenance (Louis Berger Group, Inc., 2010).

The current NCHRP 25-25 study, Task 90 *Application of Geographic Information Systems (GIS) for Historic Properties*, is a logical extension of these previous studies, in addition to the evolution of historic preservation practices within the past few years. NCHRP 25-25/Task 90 differs from these previous studies because it examines the specific value and structures of GIS use. The earlier studies looked at the context and techniques of GIS in cultural resources programs, and the general benefits of this tool. The studies cited above also address costs of GIS development and use in only general ways. For instance, Task 61 discusses how internal or shared GIS has been funded, but did not quantify the funding needed.

[1] Section 106 of NHPA now resides at Title 54 USC 3061108.
[2] Section 4(f) currently resides at Title 49 USC 303 and Title 23 USC 138.

Task 90 builds upon these earlier studies, answering such questions as:

- What are the time and cost benefits of using a cultural resources GIS, in terms of Section 106 compliance and project delivery?
- What are the costs (time and money) for improving and maintaining a cultural resources GIS? What are the barriers to improving and maintaining an effective GIS program? How does one overcome these barriers?
- What lessons have been learned from using a cultural resources GIS during transportation planning, Section 106 compliance, and project delivery?

A major goal of this current study is creating guidance for improving and maintaining a GIS for cultural resources.

1.2 WHAT IS A GIS?

When first developed, geographic information systems denoted a fairly simple combination of map ("geographic") representations, with each entity on the map having a row in an associated table of non-geographic information. For instance, a polygon on a map that shows a boundary of a site would have a row in the associated table with columns containing descriptors of the bounded area.[3] Contemporary geographic information systems still incorporate simple datasets like just described, but now also include free-standing tables in relational databases, digital files (e.g., images and documents) and are, essentially, information systems that contain both geospatial information and non-spatial data. Thus, the term GIS, as used in this study, signifies an information system and not just simple map representations.

Cultural resources elements (e.g., archaeological sites, historic buildings and structures, locations of previous cultural resources investigations) can be represented on a map within a GIS in a variety of ways. In terms of two dimensions, the most logically correct way is to represent these elements as polygons. Points are often used to represent the rough center of a cultural resources element. This is especially true for elements that are small in area; however, some systems are built to represent all elements as points regardless of their areal extent. Lines are used when an element would be better represented as vectors rather than a single point. This is a shortcut to showing actual spatial extent. How cultural resource elements are stored in a GIS can affect the ways in which they can be displayed. A set of points can never show differences in spatial extent. A very small polygon will disappear when shown at smaller map scales, whereas a point or line will not. As a result of the latter, most GIS data forms have been driven by display characteristics.

[3] A polygon in the context of a GIS is a closed shape defined by a connected sequence of x, y coordinate pairs, where the first and last coordinate pairs are the same and all other pairs are unique.

1.3 STUDY APPROACH

Originally, this NCHRP study was to develop guidance for creating a cultural resources GIS; however, as a result of an initial survey of state DOTs discussed below, and the project team's recent experiences with many state DOTs across the country, the team found that almost all states have some type of cultural resources GIS. The initial development of a cultural resources GIS was, therefore, not examined.

At the start of the current study, the project team already had information that most state DOTs had a cultural resources GIS or had access to a GIS; but, the project team was missing information on 13 states. An initial survey was used to fill this information gap. A questionnaire was sent to the state DOTs that may not have had a cultural resources GIS, or where it was unclear if they had a GIS. The questionnaire posed the following:

> 1. Does your DOT have an in-house GIS for historic properties or share a GIS for historic properties with another agency?
>
> ___ No ___ Yes – Internal ___ Yes – Shared System
>
> 2. If your DOT does not have or use a historic properties GIS, are you planning to develop a GIS for this purpose?
>
> ___ No ___ Yes
>
> 3. If you are planning to develop a GIS for historic properties will it have a specific focus and order of development?
>
> ___ Particular property types will be the focus. Specifically: _____
> ___ Legacy records will be populated in the system first
> ___ Legacy records will be populated in the system later
> ___ No particular order of development has been planned
>
> 4. May we contact you for further information?

The states responded to the questionnaire via email or during an interview over the telephone. The questionnaire was sent to the 13 states. Twelve (12) states responded:

- Alabama
- Alaska
- California
- Connecticut
- Hawaii
- Iowa
- Massachusetts
- New Jersey
- North Dakota
- Rhode Island
- Wisconsin
- Washington State

The results of this initial survey, when combined with information on the other states, showed that virtually all states have a cultural resources GIS. These GIS are either maintained in-house by a state DOT, or DOT staff has access to the GIS, which is maintained by their SHPO or another state agency, such as a state university. A few states have both an in-house GIS and participate in a shared GIS.

After the completion of this initial survey, the project team interviewed a sample of state DOTs, including several that participated in the initial survey. The interviews focused on the use, maintenance, and improvements of a cultural resources GIS. To determine which states were to be included in this sample, the project team, in consultation with the NCHRP panel, considered several factors:

- Length of time the GIS has been used (i.e., the maturity of the GIS)
- Ways in which the GIS is used by a state DOT (i.e., during long range planning, analysis of projects in a State Transportation Improvement Plan (STIP), and/or during project development)
- Whether the state DOT's GIS is a shared system with other agencies (e.g., the SHPO)
- The use of special applications in GIS, such as archaeological predictive modeling
- If the state DOT's GIS is currently being improved

DOTs were selected based upon the above factors, attempting to maximize the variation among the states.

A total of 15 states were interviewed. The list of interviewed states below includes a brief statement on the nature of each state's system, at present.

- Alabama: The DOT currently uses a GIS housed and maintained by the Office of Archaeological Research (OAR). The DOT is working with the SHPO and OAR to develop an online historic built environment GIS.
- Arizona: The DOT is currently adding legacy data to its in-house GIS portal. The portal focuses on DOT rights-of-way and locations of past DOT projects. The DOT relies on the Arizona State Museum's database (AZSITE) for new projects that occur outside of DOT right-of-way and past projects.
- Connecticut: The DOT maintains its own database, which is not complete, and also shares its data with the SHPO and the Office of State Archaeology. DOT provides the SHPO with Google Earth files of cultural resource data, as needed. No state agency has all of the cultural resources data within their respective GIS.
- Georgia: The state's GIS is housed and maintained by Information Technology Outreach Services of the University of Georgia, Athens. The GIS contains cultural resources data. Natural resource data are being added to the GIS. Georgia DOT, the SHPO, tribes, DOT consultants, the Georgia Department of Natural Resources, the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service have access to and use the GIS for project reviews.

- Iowa: The DOT has both an in-house system and hosts a GIS that is shared statewide. The shared system includes archaeological resources information from the Office of the State Archaeologist, and National Register data from the SHPO.
- Minnesota: Minnesota was one of the DOTs to pioneer the use of a cultural resources GIS in its operations. Minnesota's GIS includes resource data, inventoried/surveyed areas, and a comprehensive statewide archaeological predictive model (Mn/Model).
- Nevada: Nevada DOT maintains an internal GIS, augmented by information from the SHPO's GIS. Updates and new information are conveyed to the SHPO for inclusion in its system. Because the state is dominated by federal lands (roughly 87% of the state is federally-managed land), Nevada DOT also collaborates and shares data with several federal land-managing agencies on a project-specific basis.
- New York: The SHPO has GIS that was recently made available online and is used by the DOT. The GIS contains information on archaeological resources and the historic built environment.
- North Carolina: The SHPO has a user-friendly historic built environment GIS. The SHPO and DOT are building a GIS for archaeology.
- North Dakota: The DOT has a partial in-house GIS that is not up to date. The DOT hopes to be able to access the SHPO's GIS in the future, which is a complete database of recorded cultural resources.
- Ohio: The DOT has access to the SHPO's online GIS. The DOT maintains a historic bridge database, which is in turn provided to the SHPO.
- Oregon: The DOT has access to the SHPO's GIS and also maintains in-house a small version of the GIS that captures project-specific information. The DOT also maintains a high quality historic bridge database.
- Rhode Island: The DOT is in the process of developing a GIS to be maintained and managed by the Rhode Island SHPO. This effort has been delayed, due to a series of contractual and administrative issues. However, some data were placed into the GIS and are part of a "test version" of the system. The DOT currently uses the GIS to identify recorded properties within a project's area of potential effects.
- Texas: The DOT has a mature GIS. The DOT also uses the SHPO's GIS, which contains information on archaeological sites and the historic built environment. The DOT is currently uploading Section 106 documentation into the SHPO's GIS.
- Washington State: The DOT relies primarily on the SHPO's GIS. The SHPO data are accessed and used via their website. GIS files, however, are also provided to the DOT each quarter, and these data are placed into the DOT's in-house GIS. Archaeological site records, which are also accessed via the SHPO website, are downloaded as needed as part of the regular SHPO website service to the DOT.

The interview questionnaire can be found in Appendix A. Several of the states' GIS are maintained by a DOT's partner agency or organization (typically the SHPO or a state university). When possible, the project team also interviewed the DOT's agency/organization partner.

Appendix B includes a table showing the types of data contained within the cultural resources GIS of these 15 states. The appendix also includes discussions on a sample of these GIS, detailing how these GIS are used, structured, and funded.

2.0 BUSINESS CASE FOR HAVING A CULTURAL RESOURCE GIS

2.1 COMMON USES

As evident in previous NCHRP studies, and based on the results of the current NCHRP project interviews, the most common use of GIS is as a research and screening tool, enabling users to identify the locations of recorded archaeological sites and the historic built environment. These GIS are also used to assess the potential for encountering additional cultural resources within a proposed project area. When accessible through the GIS, staff can also identify locations in a project area that have been previously surveyed. These analyses are used to assess the need for future survey, the level of effort associated with these surveys, the location of potentially significant Section 106 issues, and the location of potential Section 4(f) properties; in addition to assisting in the analysis of proposed project alternatives.

In practice, these common uses of GIS are manifested in several ways. As discussed in their interview for the current NCHRP study, North Carolina DOT's cultural resources staff uses the state's historic built environment GIS to make decisions on whether or not a proposed project warrants further Section 106 review, as stipulated in the state's minor project programmatic agreement (PA) (see ICF International, 2015 for a description of NCDOT's PA and similar PAs from other states). Nevada DOT noted their statewide PA greatly increased their efficiency, and implementing the PA relies on data contained in their internal GIS.

A few state DOTs also use GIS during the early project development process to address the cultural sensitivity of project areas in lieu of, or in addition to, field investigations. To this end, they develop archaeological sensitivity maps or predictive models to assess a location's potential to contain archaeological sites, and to determine the level of effort necessary for archaeological surveys of project areas. Examples of these uses include models created by the North Dakota DOT and the Minnesota DOT.

With the aid of a consultant, the North Dakota DOT developed two predictive models that were limited in area, covering only the Knife River Flint Primary Source Area, but they were thorough in scope. The DOT developed both a site location model and buried site potential model that were based on slope, soil type, and access to water, among other factors. These models were then field tested and refined, using coring conducted by a soil scientist to test areas with a potential to hold intact Holocene deposits. These models have been extremely useful for a broad range of projects in the area and have ultimately saved the North Dakota DOT both time and money.

The Minnesota DOT has a very robust archaeological predictive model (Mn/Model) which, as opposed to North Dakota, covers the whole state. As noted in the Mn/Model website, the model:

> …allows planners to prepare alternative avoidance design scenarios, when possible, and to budget for survey and mitigation costs and time when avoidance

> is not possible. Mn/Model also helps prepare budget and schedule estimates allotted for individual projects and longer range management activities. It has been an important factor in streamlining the review of MnDOT projects under Section 106 of the National Historic Preservation Act.[4]

Beyond these internal uses, GIS has also been used by state DOTs to aid communication with other agencies and consulting parties, including tribes. For example, the Minnesota DOT uses their cultural resources GIS to create maps for tribal consultations, providing an interactive tool for tribes to identify properties of concern to them. The Colorado DOT, as identified during the NCHRP 25-25/Task 49 study (Cambridge Systematics, Inc., 2009), developed an overlay map tool to allow data to be shared between agencies, including the SHPO, providing an easy place both for commenting on the environmental information for a project corridor, as well as any historic resources of concern.

One of the most comprehensive online communication programs is Florida's well known Efficient Transportation Decision-Making (ETDM) process.[5] An important element of ETDM is its Environmental Screening Tool (EST), a web-accessible interactive database and mapping application. EST integrates (1) a geo-relational database of DOT projects in ETDM, (2) several environmental resource GIS data layers (including a cultural resources layer), (3) an automated and standardized GIS-based environmental screening analysis application, and (4) numerous tools for data entry, review, and reporting. ETDM users, which include multiple state and local agencies and tribes, can communicate with each other about projects and data within ETDM. Further, the system stores and reports the results of project reviews conducted by these agencies and organizations, reviews based on the use of the EST. In-state tribes and non-resident tribes have access to and use the EST, accessing the system from their respective offices. Florida DOT provided the tribes' cultural resources staff extensive training in the use of the EST. One element of ETDM that tribes value is the electronic notification they receive when the SHPO's project comments are entered into the EST. The tribes appreciate the ability to see the SHPO's comments, so the tribes can supplement these comments with their own comments (personal communications, Peter McGilvray and Roy Jackson, Florida DOT, July 13, 2015).

The above discussed common tasks and analyses are conducted using the statewide cultural resources GIS. A few state DOTs, however also conduct these analyses and tasks using desktop GIS software, such as ArcGIS, that are separate from the statewide GIS. For example, Georgia DOT's cultural resources staff conducts in-house analyses using ArcGIS, relying on data from in-house projects and also other projects conducted by Georgia DOT consultants. As one of Georgia DOT's cultural resources staff noted during their interview, "When you have to get down in the weeds, you go to your desktop." These desktop GIS analyses generally involve simple tasks such as creating graphics, plotting design files, creating shapefiles, and sharing information with DOT designers.

These common analyses and tasks are generally conducted after the initiation of the National Environmental Policy Act (NEPA) review process. A few state DOTs, however, use GIS to

[4] http://www.dot.state.mn.us/mnmodel/about/projectsummary.html
[5] http://www.dot.state.fl.us/emo/ETDM.shtm

conduct constraint analyses of proposed projects included in a STIP or early corridor studies, sometimes as part of long-range planning. The focus of these analyses is on the location of recorded National Register-listed and -eligible properties, as well as other properties that may warrant protection under Section 4(f). For example, Oregon DOT uses the state's GIS, which is maintained by the SHPO, for both long-range planning and analysis of projects in the STIP (see ICF International 2014 for information on Oregon DOT's consideration of historic preservation factors during long range planning). ETDM's EST application is also used to analyze projects during planning, before the projects are advanced into the project development phase.

It should be noted that the state DOT interviews, along with interviews of the DOT's historic preservation partners (see Appendix B), showed that different types of cultural resources data are often contained in different GIS within a state. For example, the GIS maintained by an office of the State Archaeologist will contain only archaeological site data, while the GIS for the historic built environment is maintained by the SHPO. Often, a state archaeologist's office is required to house the state's archaeological data because of state law. In addition, a state DOT may have the reports and supporting documentation associated with cultural resources identified by DOT projects, while these reports and documents are not in the SHPO GIS or within the GIS maintained by the state archaeologist's office. In Iowa, the DOT holds the state archaeologist's and SHPO systems on DOT servers because the DOT has greater capacity in GIS than state archaeologist's office and the SHPO. A few state DOTs have a separate in-house cultural resources GIS, but also participate in a shared GIS with the SHPO or a state archaeologist's office.

The interviews also showed that, in a few cases, the same type of data are contained within a state's multiple cultural resources databases, and the data held by these different entities may not all be current and up to date. Finally, in some states, the GIS and other types of cultural resources databases are not accessible online, and require going to the office holding the database, such as the SHPO, in order to access the cultural resources data.

2.2 BENEFITS AND EFFECTIVENESS OF GIS USE

As noted above, there have been several NCHRP studies on approaches and tools for improving and streamlining environmental and historic preservation compliance, and project delivery. Many of these studies highlight the business case for geospatial applications, including cultural resources GIS.

NCHRP Synthesis 347 was a national study of best practices associated with the management of archaeological investigations (SRI Foundation, 2005). The study found that cultural resources GIS were one of the most common tools used by state DOTs to streamline and enhance archaeological investigations. Use of these GIS, in addition to other tools such as statewide Section 106 programmatic agreements, reduce project costs and review time, focus Section 106 compliance on substantive issues and site types, and result in predictable project and preservation outcomes.

NCHRP Report 541 focused on the consideration of environmental factors in transportation systems planning (Amekudz and Meyer, 2005). This study included a review and analysis of state GIS databases that dealt with social, natural, and cultural resources data. The study found that GIS is,

> ...a critically important tool in that it provides an efficient means of defining potential environmental impacts. In the absence of a database that permits a quick examination of potential environmental impacts, it is likely that the "give-and-take" that so often characterizes the interactions with environmental resource agencies would be less successful (Amekudz and Meyer, 2005, page 97).

NCHRP 25-25/ Task 49 examined effective practices for considering historic preservation factors during planning and early project development (Cambridge Systematics, Inc., 2009). One of the conclusions of this study was that many of the effective practices that streamline and enhance Section 106 compliance were only possible as a result of the use of cultural resources GIS. In addition, GIS-based archaeological predictive models were seen as a powerful tool for characterizing and analyzing project alternatives, developing constraint mapping, and defining the scope and cost of archaeological surveys within proposed project alternatives.

In 2012, the Federal Highway Administration (FHWA) updated the findings of NCHRP 25-25/ Task 49, developing individual case studies on key state DOT programs discussed in the Task 49 study (Cambridge Systematics, Inc. and SRI Foundation, 2012). The most common element found among the case studies was the use of GIS to identify the location and distribution of historic properties, in addition to other environmental factors. Further, GIS was an indispensable technology for environmental and historic preservation planning. When used in planning or early project development, tools such as a cultural resources GIS,

> …can result in (1) the elimination of project alternatives that have the greatest historic property impacts, or (2) the design of alternatives that have a minimal impact to historic properties…If avoidance or minimization of impacts is not possible, mitigation options can be considered early in the project development process. This kind of fore-knowledge made available through the use of GIS reduces uncertainty in project development and delivery, and increases the predictability of project development outcomes (Cambridge Systematics, Inc. and SRI Foundation, 2012, page 39).

NCHRP 25-25/ Task 61 looked at best practices for establishing and maintaining statewide cultural resources GIS databases (Louis Berger Group, Inc., 2010). The study's team sent a questionnaire to several states, and one of the questions asked the state's to describe the catalyst behind the creation of their databases. The most common answer was to facilitate early project development. Another frequent answer was to allow users to access cultural resource data, via the GIS, from anywhere in the state, as opposed to having to travel to a state office, like a SHPO, that held the cultural resources data either in paper files or within an internal database. In the concluding section of the study's report, the authors note that having a cultural resources GIS,

> [a]llows the state DOT to design projects that avoid known cultural resources or areas where unknown cultural resources are likely to be encountered. Developing a [cultural resources GIS] takes time and capital expenditures, but the benefits of having a [cultural resources GIS]…vastly outweigh...the cost of developing the [cultural resources GIS] or the cost of a large-scale archaeological mitigation effort that causes a transportation project's schedule to fall far behind (Louis Berger Group, Inc., 2010, page 25).

Most recently, FHWA, through the John A. Volpe National Transportation Systems Center, examined geospatial tools used for data-sharing (Federal Highway Administration, September 2014). This study explored how state DOTs and other transportation agencies are developing and using geospatial tools, including GIS, to support increased collaboration. The study's report presents several case studies, including state DOT programs that use cultural resources GIS. The case studies demonstrate the benefits of geospatial "repositories" and "gateways." The former serves as "sources of geospatial data tailored to users with GIS expertise or capabilities" (Federal Highway Administration, September 2014, page 3). Gateways "offer users…the ability to visualize geospatial data or share data; examples include data viewers, screening tools, and portals" (Federal Highway Administration, September 2014, page 3). Through the use of repositories and gateways,

> ...users can consume data as soon as they are published. They can also view the same data through a common framework…Users can more easily assess data gaps to better target data collection and reduce the possibility that multiple data owners will collect the same information. Having a common data entry point also makes it easier and more efficient for users to find information and respond to data requests (Federal Highway Administration, September 2014, page 5).

This study also found that these repositories and gateways result in improved data quality, as information is more transparent and users can see where there are quality control issues, encouraging data owners to quickly address errors. Repositories and gateways also streamline project screening and development.

> Agencies access and share information more easily, allowing for earlier coordination during project development. Through visualizations, gateway users can identify relationships between transportation projects and the built and natural environments to identify potential impacts or issues (Federal Highway Administration, September 2014, page 5).

The 15 state DOTs interviews, conducted as part of the current NCHRP study, also confirm the business case for these geospatial applications. The interviews demonstrate how cultural resources GIS have become critical tools for streamlining and enhancing both Section 106 compliance and transportation project delivery. Though asked about quantitative information on cost and time savings, none of the interviewed states were able to provide these metrics. Data on these quantitative metrics are not tracked by the DOTs, and the states noted that it was extremely difficult to separate out the use of GIS from other streamlining practices, such as implementing

the stipulations of a statewide Section 106 programmatic agreement, or early consultation with Section 106 consulting parties, or the consideration of cultural resources during early planning (e.g., long range planning, analysis of projects in a STIP). Nevertheless, almost all of the interviewed DOTs noted cost and time savings as a result of using a cultural resources GIS, especially systems that were online. Georgia DOT said having an online GIS definitely saves time and money. DOT staff and its consultants no longer have to go to the University of Georgia in Athens to access archaeological site files (which were originally only accessible in Athens). For data on the historic built environment, GDOT staff had to visit the SHPO. Ohio DOT noted that time and money have been saved by retrieving most (if not all) of the site records and reports online rather than retrieving them manually at the SHPO. Also the Ohio district offices throughout the state can now view this information online, and can anticipate what the cultural resources issues will be for a project. Concerning their historic preservation portal, Arizona DOT staff remarked,

> The fact that we have this tool at all is a huge cost savings in time and money...We have come a long way quickly and have a great tool (Arizona DOT).

Digitizing paper maps and records, and building a digital repository in a GIS, clearly results in cost and time savings. Also, DOT workflows are becoming far more digital. For example, some DOTs require their consultants to submit maps, records, and reports to the DOT and SHPO in an electronic format. Another major benefit of map and record digitization is that all parties involved in a project have ready access to the same, up to date data.

Two of the states noted the benefit of providing tribes access to the GIS.

> Getting tribes access to the GIS was a big success because it streamlined tribal consultation. There are no tribes in the state, so non-resident tribes can access the GIS right at their desktops (Georgia DOT).

> Using the cultural resources GIS to create maps for tribal consultation has been very successful. Helps the tribes consult with MnDOT and FHWA (Minnesota DOT).

Having a cultural resources GIS also improves project decision making, in addition to implementation of statewide Section 106 programmatic agreements and national programmatic approaches to managing historic properties. Iowa DOT noted that the state's GIS is a very important tool for implementing their statewide programmatic agreement.

> The decision-making ability and decision-making power it gives us is phenomenal (Iowa DOT).

In terms of implementing the national Section 106 program comment on common post-1945 concrete and metal bridges,[6] TxDOT staff noted their GIS was an integral part of their use of the

[6] For information on this program comment, see: http://environment.fhwa.dot.gov/histpres/program_comment.asp

program comment. The GIS helped roll out the post-1945 historic bridge data to the public, in order to get the public's buy-in for treatment of these classes of historic bridges, pursuant to the program comment.

Minnesota DOT's use and updating of the GIS-based Mn/Model continues to be an important tool in streamlining compliance-driven archaeological investigations. The model is used to determine, very early in project development, the scope, schedule, and cost for archaeological investigations. The model is also used in early assessments of potential impacts of proposed project alternatives. These benefits have now been enhanced with the addition of a protocol for finding deeply buried archaeological sites.

In summary, these common uses of cultural resources GIS, and the business case for these GIS, demonstrate how cultural resources GIS have become, in several states, an integral part of environmental and historic preservation compliance decision making, and transportation project delivery. There are, however, several challenges to the use, maintenance, and improvement of these GIS. Section 3.0 will examine these challenges and how they can be overcome, in the context of achieving a common goal of the states interviewed during the current NCHRP study: to have a single, statewide cultural resources GIS maintained by a single entity.

The desire to have a state's cultural resources GIS maintained by a single entity was universal among the interviewed state DOTs. The reasoning behind having a statewide GIS, maintained by a single entity, is to move away from the situation within many states where there are multiple entities holding and managing different and at times overlapping cultural resources GIS, and where the data are up to date in some systems but not others. In addition, some of these systems cannot be accessed online, and therefore require visiting the offices housing these databases, or having these offices send users a Compact Disk (CD) or specific electronic file, via a ftp website for example, of the requested data.

Several of the DOTs noted they did not care who maintained the GIS as long as the DOT staff, its consultants, and local transportation agencies could access the system to obtain the data they needed for Section 106 compliance and project delivery, with the acknowledgement that different users would have different levels of access to the GIS. In addition, this single statewide GIS would need to hold data on all documented archaeological sites, the historic built environment, surveyed areas, site and property boundaries, reports, and associated project documentation. Further, this GIS needs to be web-based so users can download files onto their office computers, and also be able to upload and send new project data to the entity maintaining the GIS. The entity managing the GIS would be responsible for reviewing and screening these new data prior to placing the data into professional and public sections of the GIS; and, the managing entity would have the dedicated experts to carry out all of these tasks, in addition to continuously updating and improving of the GIS.

This goal of having a single, statewide Cultural Resource GIS is in keeping with the findings of FHWA's study on the use of geospatial tools for data sharing (Federal Highway Administration, September 2014). This study found that transportation agencies are using GIS and other

geospatial applications to address their need to more effectively "consolidate, communicate, or share information." As noted in the study, agencies are

> …focusing on dynamic, web-based tools that aggregate large amounts of geospatial data, allow users to create customized visualizations, and are easily accessible even to those without advanced GIS expertise (Federal Highway Administration , September 2014, page iv).

Section 3.0 discusses what a single, statewide cultural resources GIS might look like and how one might be developed. This discussion examines the steps for developing this GIS, the partnerships required in creating the GIS, and how to overcome barriers that might be encountered. Most of this discussion relies on the findings of earlier NCHRP and FHWA studies, as well as the interviews of the 15 state DOTs and their historic preservation partners.

3.0 THE GOAL: A SINGLE, STATEWIDE CULTURAL RESOURCES GIS

3.1 WHAT DOES THIS GIS LOOK LIKE?

As noted above, the interviews of the 15 state DOTs and their agency/organization partners revealed that almost all of the states are moving, or would like to move, toward the same goal. This goal is to have a single, statewide cultural resources GIS maintained by a single entity. The following presents the framework for what this type of cultural resources GIS (or SCRGIS for short) might look like and how it would function. No state interviewed has such a SCRGIS, though a few are close to achieving this goal (i.e., Florida, Minnesota, and Texas).

A SCRGIS would contain the following:

- Updated locations of all cultural resources and boundaries (e.g., archaeological sites, historic built environment, and historic districts)
- Updated boundaries of all cultural resources investigations (e.g., archaeological surveys, historic built environment inventories)
- Spatial extent of and links to historic and archaeological contexts for evaluating National Register eligibility
- Document images or links to the content of archaeological site records, historic built environment records, and other cultural resources documentation (e.g., National Register nominations, state and local landmark records); these data would be in a database
- Document images or links to cultural resource reports and studies
- Section 106 correspondence and documents of all federal, state, and local agencies, appropriately linked to undertakings ("projects") and recorded cultural resources

The functional characteristics of this system would include:

- A role-based security structure, limiting access to records depending upon user qualifications (individuals and organizations/agencies) and type of information contained within the records. This security structure would:
    - Allow public views of appropriate information
    - Allow non-cultural resource professionals to view appropriate information (e.g., planners and engineers, accessing information within specific project spatial envelopes)
    - Allow qualified cultural resources professionals to view information
    - Allow appropriate data creation or editing by professionals, based on record status and individual / organization roles and qualifications
- Geographic and tabular search applications (by attribute and/or keyword)
- As appropriate, depending upon user and organization/agency roles and qualifications, geospatial information that can be downloaded for localized use
- As appropriate, depending upon user and organization/agency roles and qualifications, tabular information that can be downloaded for localized use

- As appropriate, depending upon user and organization/agency roles and qualifications, documents that can be downloaded for localized use
- Applications allowing appropriate users the ability to create "core" resource records (new or updates) online, and at a minimum, requiring geospatial information for each resource record
- An application allowing appropriate users the ability to create "core" investigation records (describing surveys, inventories, other field studies) online, and at a minimum, requiring geospatial information for each resource record
- An application allowing users an easy way to report problems or discrepancies in the information system

In terms of stewardship and information technology (IT) characteristics, this system would:

- Be housed and maintained by a state university, the DOT, the SHPO or other entity
- Use contemporary technologies that allow long-term support and upgrades
- Be well-supported by the host organization's information technology staff
- Implement appropriate security and backup technologies to prevent illicit access, data theft, and data or system loss

This SCRGIS also might include geospatial datasets for predicting or assessing an area's sensitivity for both archaeological resources and the historic built environment. Models for this type of application include Minnesota's DOTs Mn/Model and North Dakota DOT's two predictive models for the Knife River Flint Primary Source Area (both of these were discussed in Section 2.1 above). Texas DOT maintains an archaeological/geomorphological predictive model within their in-house GIS, focusing on major metropolitan areas of the state, such as Houston, Fort Worth, and San Antonio. The DOT also has an in-house GIS layer of digitized and georeferenced historical maps for the eastern half of the state. This layer can be used to predict the location of historic-period archaeological resources and provide an assessment of an area's potential historic built environment. Georgia DOT has digitized and georeferenced some historic maps of Atlanta from the late 1800s, and uses the resulting data to conduct an initial historic built environment assessments for projects in the city. Other datasets can also be used for predictive models and assessments. Texas DOT, for example, uses mid-twentieth-century, urban property appraiser records since these records include build dates. These records can serve as a probability model on the number of historical properties that might be encountered in a project area, including the potential for historic districts. This dataset is especially useful in areas with large numbers of historic-period developments and helps address the fact that large areas of the state have not been subjected to historic building inventories (Bruce Jensen, Texas DOT, personal communication, June 2015).

A key characteristic of a SCRGIS is that it is a *shared* system. Regardless of the organizational host or steward (and the two could be different entities—one housing the data system, the other overseeing the data), all professional cultural resource entities can use and have access to the GIS. Otherwise, pockets of information (paper or digital) are created, which is highly inefficient because DOTs and other users would have to spend time searching multiple information sources and, as needed, getting copies of records.

This shared cultural resources GIS would function as a business information system. Business information systems are common among large corporate organizations and some government agencies. Cultural resource management, however, has moved toward such systems slowly, partly due to funding and partly due to the effort required to build the necessary interagency support that makes such systems successful (see Cambridge Systematic, 2009). A business information system can be a *system of record* or a *system of engagement* (see Moore, 2011). Systems of record are information systems that contain authoritative business data, typically controlled by a single entity that takes responsibility for data history, accuracy, and access. A well-managed, highly structured, data archive is an example of a system of record. Systems of engagement are decentralized information networks that, taken together, form a system in which information is shared in many ways and with varying levels of control. A good example of a system of engagement is business conducted by email networking, with some emails going to all parties, and other emails being restricted to subsets of these parties, with no central archive of all emails.

For a state DOT, the ideal SCRGIS is a combination of both such systems. Obviously, much of the content of a SCRGIS is a system of record—an archive of surveys, inventories, research, and other investigations, comprising reports and cultural resources observations. Within the system of engagement component of the GIS, a limited set of users can create provisional records for use and alteration, and these records are accessible to a limited set of parties. The information system allows both transactional use and, through the data steward organization(s), archival storage. This combination is an excellent fit for state DOT cultural resources managers. Further, many DOTs today use different computer systems to "track projects" that are distinct from the Cultural Resource GIS. The ideal SCRGIS combines these two needs.

3.2 COMMON ISSUES TO CONSIDER

A SCRGIS will have a single organization or entity as its principal steward. In many states, organizational history and even state law, however, may make this difficult to implement. Some states, for instance, require that a state archaeologist's office house or manage archaeological data. A historical society or a university may contain particular classes of records, per statute or charter. This issue is not insurmountable with current technology. A well-designed system can combine different data sources so that all data appear to the user in the integrated fashion described above. In the state archaeologist instance referred to above, the "system of record" at the state archaeologist's office makes its data available to the SCRGIS through network-based data services. Alternatively, the state archaeologist's office manages and controls the archaeological data but it is housed by the SCRGIS system. This is similar to how archaeological data are handled in Iowa (see Appendix B).

The state DOT interviews revealed that systems of record are the most valuable information systems overall. Systems of engagement are useful but not as essential. For cultural resources GIS, system designers need to consider having either a stand-alone SCRGIS or have the information system be part of a larger management portal or similar multi-faceted application.

Examples include Arizona DOT's historic preservation portal, Florida DOT's ETDM program, the new version of Minnesota DOT's Cultural Resources Information System (which will have a GIS component), the New York SHPO's Cultural Resources Information System, and the nascent Oregon SHPO Heritage Hub. Oregon's Heritage Hub will address Section 106 and other compliance needs; and involves the SHPO transitioning its information system from a "system of record" containing cultural resource data and reports in an archive, to a "system of engagement" in which day-to-day business is conducted, including capturing historic preservation compliance decisions. A statewide portal/application could house different sub-databases for the various agencies that will use the portal/application, since these agencies have somewhat different missions, and the types of data they need may not be applicable to the needs of other agencies.

The SCRGIS will also need to have a secure funding base that includes stable annual support for operating costs, in addition to funding sources for periodic system upgrades. In reality, of course, the mechanisms for funding a SCRGIS will be different from one state to another, and might also change over time. The SCRGIS will have initial development and operating costs. Even if the initial development and deployment costs can be funded with one-time monies, on-going costs must still be covered. As shown in the interviews of some state DOTs, this can result in a fractious discussion concerning use or query fees, subscriptions, and other costs. Furthermore, state law or agency policies may limit the ways in which access to a system can be charged to its users. In many states, DOTs (and FHWA) have funded significant portions of the development of a shared cultural resources GIS. DOT administrations may subsequently question paying maintenance fees for systems developed with DOT support because there is a sense that the agency has already paid for use of the system. We will discuss funding issues in more detail in Section 3.3.3 below.

One further common consideration is the mixture of technology components within a SCRGIS. A shared GIS is much more complicated than a desktop GIS application, or even a workgroup installation of desktop GIS, all of which share the same set of data files stored on a local server. A SCRGIS would consist of four related, but distinct, technologies, and would be an "enterprise" geospatial data system:

- GIS software (server-based, desktop, and combinations of the two)
- Data storage and access software (databases, general user interfaces)
- Computer hardware
- Data networks

An enterprise geospatial data system integrates GIS information throughout an organization so many users can view, query, share, and create spatial data, including related information that may be in forms other than GIS. Information resources within the enterprise are shared via the integrated system, eliminating pockets of data held by users and shared idiosyncratically. Enterprise geospatial data systems also make their information available to other software systems through a variety of mechanisms.

Enterprise geospatial data systems are complex to create and operate. The common issue is how and even whether, different organizations can share the implementation and maintenance of an

SCRGIS. All four of the above technologies must be brought together to build the desired information system.

3.3 HOW DO YOU GET THERE?

As noted above, almost every DOT cultural resources program uses a GIS. Fewer DOTs, however, participate in a shared cultural resources GIS. This section considers how one puts in place a shared cultural resources GIS. It does so from the perspective that general design steps are followed in every contemporary enterprise information system, but these steps must be tailored to be appropriate for each state. We will also examine, as discussed below, the barriers to GIS creation and effective use. These include, but are not limited to, statutory barriers to single organization management and stewardship, integration of Cultural Resource GIS into information portals, and funding. We also discuss potential ways of overcoming these barriers.

3.3.1 Design Steps

The steps toward a shared cultural resources GIS below are generalized. Every state DOT operates in a different situation when it comes to data stewardship, agency relationships, and technology. Yet, as noted above, DOTs nationwide face the same work needs and usually, the DOT cultural resources programs conduct their business similarly from one state to the next. The kinds of cultural resources they must consider and the other agencies with whom the DOTs interact are different from place to place, but the general work needs and workflow are approximately the same. For these reasons, implementing a statewide shared GIS can follow fairly similar steps in any state.

Many states have parts of a fully-shared statewide GIS, as discussed above and in Appendix B. So, the steps described here may have already been completed, in whole or in part, by any given DOT.

Step 1—System Vision. A system vision is a conceptual description of the shared GIS. Just as an organization may have a mission statement, most information systems have a vision or prospectus. The vision can be conveyed to the cultural resources and appropriate GIS and IT community in many ways. The most common way a vision is created is by a small group either sharing dissatisfaction with current conditions or desiring a new approach for achieving project or process outcomes. Alternatively, there may be a small group that would like to champion the improvement and enhancement of their existing GIS. A system vision may be shared at professional meetings, in informal conversation, or become part of a DOT cultural resource unit's work goals.

At some point, a system vision gathers enough interested participants that it transitions from just an idea to a concept in which individuals and organizations will invest time and money. System visions can persist for a long time in a professional community without advancing very far. The "proposed system" gains development momentum by being publicized at every opportunity, to current and potential users, state DOT agency partners, and especially senior managers within

the state DOT and partner federal and state agencies. This can be difficult for cultural resource professionals who are, generally, not experts at information technology. Further, IT staff may see the system vision as naïve. Fellow professionals may see the system as too limited or too tailored to one specific set of needs. These barriers are best overcome by including a cross-section of needs, and some information / geospatial technology experts in the core group responsible for creating and moving the system vision towards a concept for development.

Perhaps one of the best forms of creating a system vision is by building on the work of other states, agencies, or even other DOT/regulatory realms. Cultural resource professionals from other states can provide examples of how their information systems work. Similarly, a wildlife biologist, for example, may be able to demonstrate a system that has worked well and has analogous functions to those needed by cultural resources professionals. This gives potentially interested parties an excellent sense of why a new system (the system envisioned) will be useful and beneficial in terms of historic preservation and environmental compliance, and overall project delivery.

Step 2—Organizational Recruitment and Sponsorship. Once a community of interest or core group has been created, the proposed SCRGIS project goes from an idea to something that needs a guiding structure and sponsorship. There is no single or optimal pathway toward establishing sponsorships. In a few states, a single organization has sponsored and implemented the shared GIS components. Most states have multiple agencies involved in their existing cultural resources GIS. In addition, organizations responsible for the creation and maintenance of a SCRGIS tend to have two roles, both of which can be present in one organization or agency: an archival role, serving as the system of record for cultural resources of one or more types; and a role as a user and/or creator of cultural resources information.

Organizations that use and create cultural resources records are a major category of organizational sponsors for statewide systems. State DOTs are always among the important organizations in this group. DOTs have a statewide mandate to deliver transportation projects that address issues of mobility and safety. DOT cultural resources units have to work throughout a state and interact with individuals in the private sector, and agencies at every level. Geospatial information has long been created and maintained by state DOT programs (see SRI Foundation, 2005).

Land-managing agencies, both state and federal, are almost always interested in statewide GIS systems. In the western U.S., the Bureau of Land Management is responsible for vast tracts of some states, and the U.S. Forest Service has significant holdings in almost every state. State forestry agencies and state land offices in the western part of the country are also often interested in cultural resources GIS due to state law and the federal nexus for actions on state lands. Agencies that issue permits for land-use actions, including actions on private land, are also potential partners in implementing a SCRGIS. The Federal Communications Commission is a good federal example, as are state permitting authorities acting under state law (e.g., Vermont's Act 250 regulations requiring cultural resources consideration on all land use projects).

Agencies and government entities are the strongest advocates for SCRGIS plans, but early involvement of non-government organizations can also be helpful. For example, the Wyoming Association of Professional Archaeologists (an organization that includes many consulting archaeologists as well as agency professionals) was a major advocate for a statewide, integrated, information system for cultural resources in that state.

As noted in Section 2.2 above, some state DOTs highlighted the benefit of providing tribes access to the cultural resources GIS. Remote access to a GIS helps tribes more fully participate in the project review process. Tribes, therefore, should be provided an opportunity to participate in the development of a SCRGIS. Issues of concern for tribes might include, but will not be limited to (1) access to sensitive cultural resources data, and (2) their staff's ability to access the GIS. The latter will most likely involve training, and making sure that tribes have the appropriate technology to access and use the GIS. Given tribal funding constraints, any training will need to be at no cost to the tribes. The type of GIS application used in the statewide system will also be important to tribes, and other users. Georgia's statewide system is a more user-friendly web-based GIS platform than ArcGIS, for example. As a result, Georgia's non-resident tribes have no problem in using the state's GIS as a tool for providing comments on proposed DOT projects.

The important outcome of this step is the creation of a coalition of organizations that will drive the creation or evolution of a statewide system, and identify the mechanisms for funding the system. A guiding council of representatives from these sponsor organizations will take the overall development process forward. Arizona, for example, has followed this pathway through the development of AZSITE. The system is still evolving, but it does so under the guidance of a formal board and advisory committee with regular meetings.[7] A coalition of organizations for the SCRGIS should include representatives from a number of agencies and organizations, including, but not limited to, the DOT cultural resources staff, the SHPO, FHWA, state and federal land managing agencies and permitting authorities, tribes, and private sector cultural resource professionals. Additional members would include planning, design, and IT staff from the DOT and local governments. Tribes should also have an opportunity to participate. A more complete list of these agencies and organizations is presented in Section 3.3.2 below.

Information security and limiting data access are common issues that can become barriers to participation in the coalition needed to create a shared information system. These issues need to be confronted directly, and the best way to do so is to keep organizations with such concerns in the process. This is especially important in the early stages of gathering interest and support for a large-scale information system because appropriate mechanisms for security, information access, or other issues can then be incorporated into the basic architecture of the system.

Step 3—Needs Assessment and Priority Setting. As discussed above, the SCRGIS contains many components: electronic archives of documents, database tables, and GIS datasets, in addition to a potentially endless variety of different kinds of user interfaces (e.g., desktop, web-

[7] http://azsite3.asurite.ad.asu.edu/azsite/about.html

based, mobile phones, and tablets). The point of a SCRGIS is to have a *useful*, *functional*, and *maintainable* information system.

Useful systems meet the work needs of those who rely upon it. For instance, if the system users need the most current National Register status of all resources in an area, the system offers the capability to outline an area on a map and return information on a resource's eligibility status in an appropriate and useful format.

A *functional* system is not only useful, it operates well, meshing with the workflow and work styles of its users. State DOTs, for example, may need cultural resources GIS implementations that can be incorporated into DOT-specific planning portals so that cultural resources information is readily conveyed to designers and engineers. A tangible example of a system being functional is that it offers an appropriate technology for its interface; this is often done through web browsers in today's IT environment.

Maintainable information systems are those that do not require extraordinary effort to input new data or update existing data, as well as allow easy management of the system as a set of technologies. Today, this often means that data enters the information system as part of routine work. The system retains the routine work data and, through a well-designed process, transforms the system of engagement information values into system of record information values. Maintainability is one of the most important attributes of a cultural resources GIS, because users will quickly stop using a system if the information in it is stale or incomplete.

The organizing coalition for the SCRGIS must take responsibility for conducting user needs surveys. These should be as inclusive as possible, including not only cultural resources professionals but also planners and engineers, as well as members of the interested public. The goal of the needs-gathering process is to have a long list of functional requirements, each of which can be assigned a priority. Priorities may be altered as the planning team considers the needs of major sponsors. Also, the nature of a state's cultural resources and the most common modes of management can, and should, drive the assignment of priorities to the different needs. For instance, the historic built environment comprises most cultural resources in the northeastern states, while archaeological sites are the overwhelming majority of cultural resources in western states. Common field investigation modes differ between states with and without large tracts of federal lands, and between those with state laws about cultural resources and those with few or none. In short, there is no single list of needs and priorities that would fit every state and meet the needs of each state DOT.

Step 4—System Design. Designing the SCRGIS (or designing an improved SCRGIS) is the next step. The planning coalition must determine the cutoff point in the list of user needs. This decision should involve a consideration of what is feasible to implement. Feasibility means meeting the priority needs in a way that is affordable and retains the necessary functional features and maintainability. Specific technology choices usually crop up at this point because the sponsoring / hosting organizations will likely have preferences that they can support.

The criterion of feasibility may dictate that the SCRGIS is more than one software implementation. For instance, a SHPO may intake, maintain, and serve historic built environment resource and investigation data while the state's archaeological office does the same for archaeological sites and investigations. The design of an integrated information system recognizes the practical realities of differing jurisdictions, IT support, and staff resources, and integrates these into the blueprint for an overall system.

The practical reality is that funding will determine what is feasible at any given stage in the evolution of a statewide cultural resources GIS. The ideal SCRGIS design will identify what is feasible today and the priorities the SCRGIS will address in the future. The design is, then, a strategic planning document as well as a plan for the current effort. Just like a blueprint for a building, the SCRGIS design should specify the longer term goals and implementation ideas for future expansion.

SCRGIS design will also take the concerns and issues expressed by coalition members into account (see discussion in Step 2, above). For instance, system design may address whether users are allowed to download information for use outside of the SCRGIS software itself and, if so, whether such actions are governed by classes of users, data "owners," or the kind of data being extracted.

Step 5—Funding. Finding funds to develop, maintain, and/or improve a SCRGIS is an obvious necessary step in the overall process. Given the critical nature of this issue, we will discuss funding in a separate section below (Section 3.3.3).

Step 6—System Development and, Data Population, and Implementation. The SCRGIS development and implementation step is inherently complicated. In general, this step consists of the technical development of the system, loading existing information in to it, and implementing the system.

System development (as a set of software, hardware, network protocols, etc.) will vary tremendously depending on the defined functions of the system, the system's sponsors, and their IT resources. One of the most important determinants of system development is, obviously, funding. However, there are also other determinants too such as supportable technologies, information technology standards of the hosting organization(s), and system governance mechanisms.

Loading information into the SCRGIS ("data population" in industry terms) is a substantial endeavor. Most states have between 100,000 and 300,000 cultural resources recorded in some form or another. These are often paper records consisting of a form for each site, building, structure, object, or district. As the discussed SCRGIS specifies, these forms need to be scanned to become digital documents, entered into a database, and digitized as to their geospatial boundary or point location. Then, each data category needs to be integrated with the other so that from a given interface (e.g., an on-screen map), one can get to the other modes in which information is stored (e.g., database entries, scanned document). Project-related correspondence,

historic preservation compliance findings, and investigation reports (surveys and inventories) must also be entered and linked.

The order in which the system is populated can be geographic, source-driven so that each office with archives is a step in populating the system, time-driven so that newer or older records are entered first, or any combination of these approaches. Population order will be determined by the system design and plan (Step 4 above), based on needs and feasibility.

Implementation puts the system into operation for its users and maintainers. Users have to be introduced to the SCRGIS and trained on how to use it. A staged implementation can be beneficial, so that only certain groups are given access in the first round of implementation, additional groups of users are added in a second round, and so forth. Staged roll-outs allow early detection of problems and evaluations of system performance, providing opportunities to fix shortcomings swiftly and with the least impact to all system users. Implementation is never really complete, because new users will always appear with concomitant needs for training and support (see Step 7, below).

Step 7—Use and Maintenance. This step is the final part of a SCRGIS evolution. There are, however, several barriers to successful use and maintenance:

> ***Maintenance.*** The majority of SCRGIS maintenance is intake of new data. Data maintenance is the single largest challenge for every system. Many cultural resources are newly recorded or updated each year. At a statewide level, hundreds or even thousands of field investigations may occur with attendant report documents. Since most investigations are conducted as a result of federal, state, or local historic preservation statutes, regulations, or ordinances, an equal or greater number of undertakings ("projects") and their chain of correspondence and regulatory findings are generated in a year.
>
> The only effective way to cope with this flood of information is to have data entry occur within the SCRGIS through the uploading of electronic records and documents, rather than having it trail the work by months or even years. The alternative is to have a sufficiently large staff on hand to enter paper records. This is a funding challenge for most systems (shared or not). Also, waiting until a paper record is complete can mean that a large, multi-year undertaking's information is not in the SCRGIS until years after the resources were first recorded.
>
> Software design and platforms evolve. Older technology platforms with wide utilization will, eventually, migrate to newer technologies. Therefore, another element of system maintenance is the ability to upgrade as new software and hardware come on line. The entity hosting and maintaining the GIS will need to monitor the need to migrate the GIS to new platforms, as appropriate. In addition, there will need to be a funding mechanism to implement the required upgrades.

Training. Several of the DOT cultural resources offices noted that a lack of staff training was a barrier to effective use of GIS. Cultural resource staff with GIS expertise often had this skill prior to joining the DOT, or obtained this skill on their own while on the job. The senior supervisor of one state's DOT cultural resources office said they make sure that at least one individual within their group has the GIS expertise needed to use and maintain their in-house GIS; and, if this person leaves, GIS expertise is one of the skill sets required for replacing this individual. Another state DOT noted that even though funding for GIS training was available within their Department, staff did not have the time to take the training, as this training would take away from staff's regular workload. North Carolina was the only interviewed state that has regular internal training in GIS use. At times, staff from the North Carolina Office of State Archaeology and the Historic Preservation Office participates in this training with North Carolina DOT staff. A regular system of training, therefore, is clearly a wise investment in a system's usefulness. In addition, especially for state DOTs, this training must help cultural resources staff become proficient in the use of desktop GIS software.

Further, DOT cultural resources staff need to be able to bring in data from appropriate field tools like GPS, to "clean up" spatial data before it enters the SCRGIS, to work with other DOT data and geospatial formats (e.g., spreadsheets, CAD files, imagery, remote sensing such as LiDAR), and to create working maps. These capabilities are all very important in DOT operations and require staff training. Ready, easy, interchange of geospatial information between GIS and CAD software is especially important.

Other DOT staff needs complementary training in using and interpreting cultural resources GIS information appropriately. For example, non-cultural resources DOT staff may need to understand that archaeological site boundaries are approximations, based on a best professional estimate of where surface artifacts and features were observed, and/or where subsurface artifacts and features may be present. DOT planners might need training to understand that "low probability" areas in a cultural resource predictive model might still require some level of field investigation. Training and a support network for SCRGIS is also a requisite for non-DOT users and information consumers, though perhaps at a less intense level.

Correcting System and Information Errors. As an information system is used, flaws are found in its design and implementation. These may be design oversights, software or hardware issues, or may be induced by changes in historic preservation policy and field practices. The prevalent use of GPS in the field is a good example of this last change. Systems implemented 20 years ago are now being updated to incorporate geospatial information uploaded directly as GPS-gathered data, rather than typed in or drawn on a computer screen or digitizing tablet. A well-regulated system must have a capability for its users and hosts (e.g., IT staff) to suggest improvements. These suggestions should be reviewed by the system's governing body or management team.

Information errors are common in cultural resources information systems. They stem from many sources: poor maps, older records in different formats and with maps at

different scales, changes in field technology so that older resources can be located more accurately, and a myriad of other factors. A SCRGIS should have a way to report errors in information content, and include an effective work flow to make. As noted in FHWA' study on geospatial data-sharing, GIS can be structured to improve data quality, as information is more transparent within a GIS and users can see where there are quality control issues, encouraging data owners to quickly address errors (Federal Highway Administration, September 2014).

During the interviews, one state DOT noted that when their statewide GIS was first introduced, SHPO staff quickly input data into the system without much consideration of standards, and how translating a hand drawn boundary on a piece of paper to a digital system introduced errors. Currently, their SHPO has come to rely heavily on the statewide GIS system and has been extremely reluctant to update existing spatial data, even though ground-truthing (through surveys) shows that a site boundary needs adjustment, for example, or a previously recorded historic building had been demolished. New data are regularly added to the system, but updating data on existing resources is met with extreme resistance and requires copious documentation to prove the necessity for the change. As a result, the system has evolved into a static representation of recorded cultural resources. Similar challenges were reported by other state DOTs. The way to overcome this issue is to include an efficient process for correcting information errors as part of the system design (Step 4 above). This issue would be discussed and resolved by the coalition of organizations responsible for the creation or evolution of a statewide system. An additional topic of discussion would be the process for correcting information errors during future cultural resource investigations. Identifying and making these corrections might increase the level of effort associated with these investigations. It should be noted, however, that these initial increased costs will save time and money by ensuring that future project decisions are based on correct data.

GIS and CAD Conversion/Interface. A few of the state DOT cultural resources staff noted difficulties in linking GIS data and CAD (computer-aided design), which is used by DOT designers and engineers. One DOT noted their designers and engineers had the perception that GIS lacked precision, and this was an excuse to consider the GIS unreliable. As a result, the CRM staff had to convert their data to a CAD format for the engineers and designers. A second DOT stated they had problems getting CAD files into the GIS so they could see the relation of project limits and elements to the location of cultural resources. The cultural resources staff at this DOT said it was not worth putting cultural resources information into CAD given the imprecise information on site boundaries. Staff from another DOT noted there were only a few staff members within the DOT who were good at both systems, so it was somewhat difficult to link the two systems. Their engineers, however, were realistic about the level of data precision in the GIS (e.g., in terms of site boundaries), and seemed to know how to appropriately interpret boundaries as shown in the GIS.

As discussed above under the steps to create or evolve a shared system, SCRGIS development has to include other constituencies in its design and, especially, in its

training. This is less of a problem of file format (CAD vs. GIS) than it is the nature of cultural resources themselves. Educating users of the data stored in a cultural resources GIS about the nature of cultural resources and the recording process can help users, and thus the DOT, work more efficiently. There may even be other benefits to the DOT's cultural resources office. For example, the Nevada DOT cultural resources unit discussed ways to improve mapping structures and natural features with non-cultural resources staff in the agency. The result was the cultural resources unit using a terrestrial LiDAR station (normally used by their bridge inspection group) to map buildings, rock shelters, and even cave interiors.

IT Support. Many of the interviewed state DOTs noted that cultural resources staff do not have the time to support and improve their state's cultural resources GIS due to their regular project workload. To address this problem, several of the interviewed states said they wished they had a dedicated, full-time GIS expert within the cultural resources office in order to maintain their in-house GIS. As highlighted in Appendix B, some DOTs have a dedicated IT staff person supporting their cultural resources unit, or the larger office in which the cultural resources unit is located.

Some of the interviewed state DOTs identified problems associated with IT support when the GIS was housed and managed by a DOT division other than the cultural resources office, or when managed by another state agency. Maintenance and improvement of a cultural resources GIS can be viewed by these other divisions or agencies as a low priority. A state DOT's IT division might also not relinquish control of the data or allow data stewards outside of the IT division to facilitate updates or make improvements to the data sets and overall system. As a result, the cultural resource staff is often left to use desktop tools and is compelled to create local data sets that are not accessible to others within the DOT. These data sets are then maintained outside of the DOT's agency-wide data management system; and, the data are not standardized, backed-up, or updated for general DOT use.

This is a difficult barrier to overcome. Addressing this barrier may require a champion within each of the organizations involved in the SCRGIS, a champion who has the authority to break down this barrier. Another approach is to openly discuss this potential problem, creating protocols for addressing this issue as part of establishing system priorities (Step 3) and system design (Step 4).

IT support also inevitably includes upgrades and changes to operating systems, SCRGIS software, hardware, and networking. Funding and support mechanisms must be in place for these quite predictable changes.

Step 8—System Governance. The creation and continued operation of a SCRGIS clearly involves many interested parties. A system of on-going governance is important both to create policy and to ensure funding. In Arizona, for example, the AZSITE system is governed by a board, who are assisted by an advisory committee (See Appendix B for a description of AZSITE). AZSITE users participate in regular meetings (held in-person and on-line

simultaneously) where the governing board presents plans for future enhancements and can field comments from the system's users. Funding the system is always a topic at meetings, and this allows system sponsors and users to air their thoughts on the value of the AZSITE system in relation to its cost. In the AZSITE case, the system of governance creates an avenue of communication for both continued use of the system and on-going funding of the system.

When a SCRGIS is included in a larger portal, as in Florida's EDTM program, funding and operations may become easier. The ETDM portal is where the Florida DOT conducts its business, so there is no question of whether the cultural resources component should be supported. This is another mode in which a shared cultural resources GIS can be both governed and funded effectively.

3.3.2 Recommended Partnerships

The discussion in Section 3.3.1, Steps 1 and 2, showcases the need for DOT partnerships with other agencies, organizations, and groups of system users. These partnerships include:

- FHWA
- The SHPO
- Tribes
- Repository (archive) organizations for historic built environment records and archaeological records
- Appropriate land-managing agencies, both federal and state
- The consulting / contractor community of cultural resources professionals
- DOT IT and GIS staff, even if the DOT will not be the hosting organization
- DOT project managers and transportation planners
- Universities with archaeological, historic architectural, and historic preservation programs

In addition to these required partnerships, state DOTs seeking to create, improve, or collaborate upon a SCRGIS should also consider partnerships with Metropolitan Planning Organizations, Regional Planning Organizations, and other local governments.

3.3.3 How Do You Pay for It?

As a statewide system is developed, or evolves, funding is a perpetual challenge. The interviews of the 15 state DOTs and their historic preservation partners, demonstrate the variety of funding sources used for developing, maintaining and improving a system (see Appendix B for specific state examples, along with costs and funding amounts). These include the use of regular state DOT operational funds and State Planning and Research (SPR) funds. In some cases, when these funding sources are used, GIS users may not pay a fee or subscription for accessing the GIS or downloading records and documents from the GIS. In other situations, there are various types of user fees or subscriptions. These include:

- Free to use online information, but charged for receiving printed reports or accessing electronic versions of the reports
- Annual fee/subscription per organization/agency
- Annual fee/subscription per organization/agency plus per user fees
- Annual fee/subscription per organization/agency plus "filing fee" to process documents into the system, with filing required by statute
- Annual fee/subscription per user

In most cases where a state DOT (and FHWA) has paid for the development of a cultural resources GIS, and/or supports the maintenance and/or improvements to the GIS, the DOT does not pay any fees to access and use the GIS.

State and agency fiscal policies may determine what funding mechanisms can be considered in terms of a fee or subscription system. For example, New Mexico's statewide system, managed by the Historic Preservation Division (i.e., SHPO), cannot charge for access to records per state law. The Historic Preservation Division (HPD) can charge a single access fee for use of an automated system (since one could get to the paper records for free by going to the HPD's office in Santa Fe), and the HPD can charge a processing fee to file reports and associated cultural resources records (as required by state permits for archaeological investigations). The filing fees are scaled because large field investigations are likely to have extensive sets of records, necessitating a lot of staff processing time.

The New Mexico example makes clear a distinction that may be useful in funding the ongoing operations of a SCRGIS: there is a cost difference between querying the SCRGIS and putting data into the GIS. Query, usually done through a web browser interface, costs the system very little because once data are in the system the costs are essentially electricity, networking, and software licensing, but very little labor. Data input and clean-up is expensive because of the labor cost. This is why it is so important to have a system in which primary information generators create their records digitally, as part of their work flow. This results in reduced costs and project schedules.

As noted above, federal, state and agency fiscal policies will most likely determine how the SCRGIS is funded, be it for building a statewide system, maintaining the system, or improving and expanding an existing system. One important option to consider is to have all federal, state, and local agency users of the system fund the SCRGIS. How much these agency fund the system and when, would be determined during implementation of Step 2 above—Organizational Recruitment and Sponsorship. This option might eliminate the need for a user/access fee structure since sufficient funds would come through these agencies to develop, maintain, and improve the SCRGIS.

One approach that might reduce the costs of a SCRGIS is for the GIS to be a component of a larger, comprehensive transportation project delivery system, such as Florida's ETDM program. Another is to have the cultural resources GIS as an element within an overarching Environmental GIS. The latter contains not only cultural resources data, but also natural resource data, in addition to land use, social, economic, and community data. Virginia DOT's Comprehensive

Environmental Data and Reporting System (CEDAR) is an example.[8] Having a SCRGIS as a component of a larger GIS would save costs on hardware, software licensing, and IT support.

Finally, the need to "sell" the value and benefits of a SCRGIS is critical to any discussion on funding. This issue is examined in the following section.

3.3.4 Tiered Approaches to Creating a Statewide Cultural Resources GIS

Based on the experiences of many of the interviewed states, one can create and implement a SCRGIS following a stepwise or tiered approach. Which tier is implemented first, and which tier is then added to the initial tier, would be based on the practical issues of funding and organizational capabilities (e.g., staffing, staffing expertise, and staff workloads).

Regardless of the incremental steps used in creating the SCRGIS, it is important to begin with a holistic plan and design. This includes organizing a coalition of interested organizations, as noted above, even if the needs of only some will be met in the initial tiers of system deployment. Assessing statewide needs as a whole is similarly critical, even if only some of those needs will be met. Logically, one *must* tally needs completely in order to determine priorities.

After having a holistic plan and design in place, there are two possible tiers. This involves deciding whether the SCRGIS should focus first on cultural resources "content" or cultural resources management "transactions." Content refers to cultural resources records (e.g., site and building inventory forms, investigation reports); in other words, building a digital archive within the GIS. Transactions are the cultural resources management business processes around this content (e.g., results of resource inventories, decisions about National Register eligibility, and assessment of project effects on resources).

A transactions system is a tracking system into which data are loaded incrementally, over time. This type of system meets the basic business needs of routine management of cultural resources, and might include one or more of the following elements:

- Cultural resources locations as a point within the GIS rather than using polygons to represent boundaries. [It should be noted that using only points is not very useful at a detailed project-design or -assessment level.]
- Information on National Register eligibility status, along with a short description of each resource (evaluated and non-evaluated).
- Images of cultural resource records (e.g., in PDF format), linked to the GIS so that users can readily view inventory forms and other documents.
- General polygons showing the location and boundaries of previously surveyed areas. To save time and money, the SCRGIS at this stage would only include recent investigations that meet contemporary standards.

[8] https://www.environment.fhwa.dot.gov/histpres/va_cedar.asp

- A project table containing general information about the project and cultural resources within the project area. The latter might include data on National Register status of identified resources.

These and related elements would be placed into the system on an as-needed basis. For example, for a specific project, DOT staff would populate the system with data on known cultural resources and previously surveyed areas within and near the project area. Taking this approach, the system is built and expanded over time.

A "content" system does not consider day-to-day business, but is essentially an archive of cultural resource records and investigations. Such a system might contain the following:

- Data on each individual cultural resource, including location (point, polygon, and line), data tables, and electronic copies of inventory forms.
- Electronic copies of cultural resources reports, and all associated documents and forms.
- As new cultural resource information is generated by projects, this new information is added to the system. All new data are generated electronically.

Another approach is to implement one or both of the above systems, but focusing on a specific geographic area or areas within a state. For example, one or both of these types of systems would be created for areas within the state that will have (1) the majority of future transportation projects (as indicated by a STIP, for example), and (2) projects that will require some type of cultural resources investigation or assessment. The latter would include assessing whether or not further consultation under Section 106 will be required for a project (as stipulated in a statewide programmatic agreement, where projects are screened by a DOT cultural resource management professional). This geographic approach focuses on where the needs will be greatest in a state. In addition, where these proposed projects are located might dictate the types of cultural resources data to be entered into the system. For example, if the GIS is for a western U.S. state, and the projects will occur outside of highly urbanized areas, then data entry might focus on archaeological resources as opposed to the historic built environment. If the projects are within metropolitan areas in an eastern U.S. state, the focus might be on the historic built environment. In addition, this data entry can also be tiered, starting with cultural resources information collected after a certain year. Data for earlier years would be entered into the system as funding and resources become available.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

As discussed in Section 2.0, the FHWA, through the John A. Volpe National Transportation Systems Center, explored how state DOTs and other transportation agencies are developing and using geospatial tools, including GIS, to support increased collaboration (Federal Highway Administration, September 2014). FHWA's study notes that over the past several years,

> State DOTs and other transportation agencies have become increasingly interested in geospatial tools to support more streamlined access to information. This interest has dovetailed with desires to promote information transparency and more open communications (Federal Highway Administration, September 2014, page iv).

The FHWA study found that agencies are focusing on "dynamic, web-based tools that aggregate large amounts of geospatial information, allow users to create customized visualizations, and are easily accessible even [to] those without advanced GIS expertise (page iv)." In addition, geospatial data-sharing tools play an important role in addressing state DOT efforts in cost-savings and streamlining, in an economic environment of doing more with less. These findings and observations are reflected in the results of the current NCHRP 25-25/Task 90 study, especially in terms of the states' movement toward the creation of a single, statewide cultural resources GIS, maintained by a single entity.

State DOTs as a whole have similar cultural resources information needs, driven by common work processes. These data needs include, but are not limited to:

- Cultural resources characteristics: age, type, and location/areal extent (spatial data)
- Field investigation characteristics: type of field investigation, date performed, and location/areal extent (spatial data)
- Undertaking (project) information: type of project, project year(s), project location (spatial data)
- Federal historic preservation compliance decisions and findings (e.g., National Register evaluations, assessment of effects)
- Linkage between these categories of information (e.g., DOT undertakings are linked to information on cultural resources characteristics and correspondence/documentation on Section 106 decisions and findings)

These common information needs could form the basis for a core, shared, SCRGIS architecture across states (Figure 1). This core architecture can be used as a template, with each state adding to the core architecture to meet their particular needs and organizational relationships. The creation of this shared architecture can save each state development effort and time, allowing a state to focus on determining what information to include outside of the core architecture.

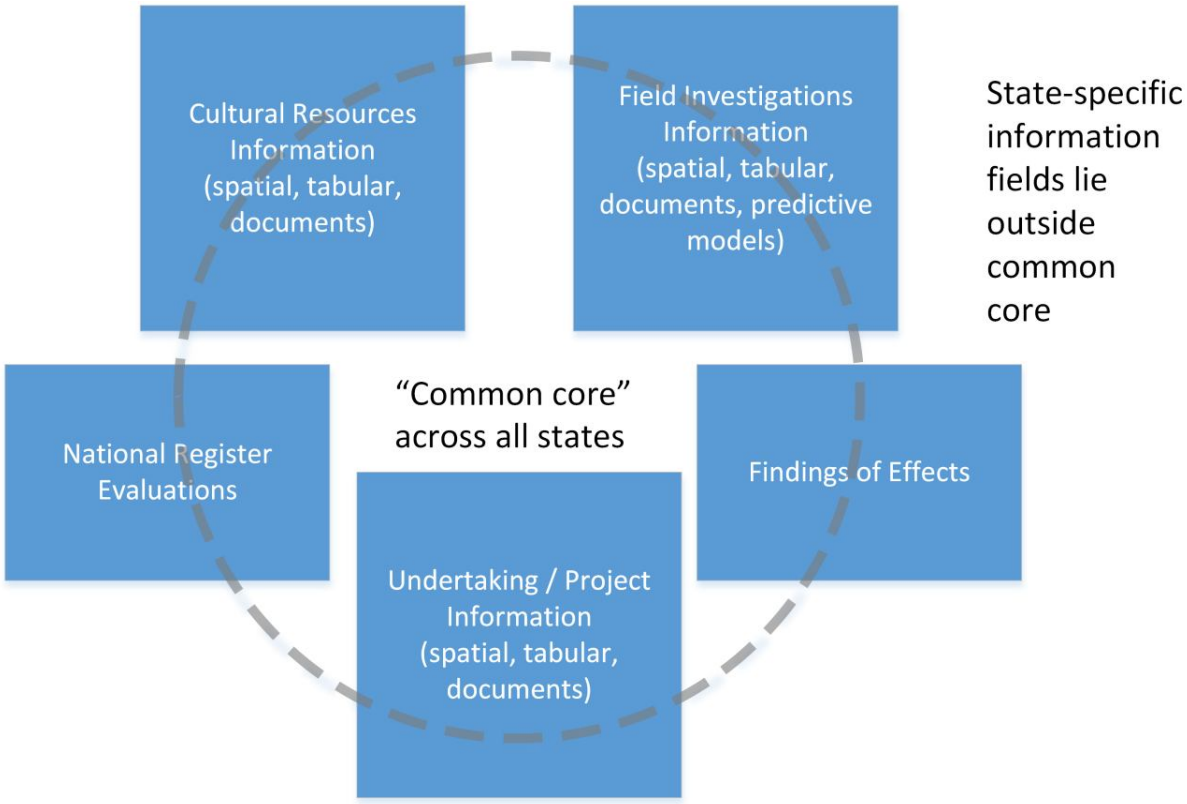

Figure 1. "Common Core" concept.

To facilitate the development of SCRGIS, it may be useful for a coalition of state DOTs and their historic preservation partners to meet nationally or regionally, to create this core architecture. Individual states can then use this core architecture, as noted above, to focus on determining what information to include outside of the core for their specific state. These meetings (or workshops) would be similar to the peer exchanges associated with FHWA's study on geospatial data-sharing (Federal Highway Administration, May 2014). FHWA, the American Association of State Highway and Transportation Officials, the Transportation Research Board, the National Conference of State Historic Preservation Officers, and the Advisory Council on Historic Preservation might serve as co-sponsors for these meetings/workshops.

As noted in Section 3.3.1, and as discussed in previous NCHRP studies (e.g., Amekudzi and Meyer, 2005; Cambridge Systematics, Inc., 2009; and Federal Highway Administration, May 2014), successful implementation of any new or innovative approach to streamlining and improving environmental compliance and project delivery requires the presence of a champion within a state DOT, and also within a DOT's partner agencies and organizations. This also applies to the implementation and funding of a single, SCRGIS. The peer exchange component of FHWA's geospatial data-sharing study found that having a strong champion within an

agency's executive level is essential to developing and sustaining a GIS and data-sharing program.

> An executive-level GIS champion should have a firm understanding of geospatial concepts and their many potential applications to the transportation field…A GIS champion also recognizes the value of sharing data both internally and beyond the agency (Federal Highway Administration, May 2014, page 11).

An agency champion will need to promote the value of a single, SCRGIS to agency decision makers. An important tool for promoting this value will be examples from other states and agencies, and even from non-cultural resources offices within the DOT that use GIS (e.g., state and national GIS on natural resource systems). These examples provide decision makers an excellent sense of why the system envisioned will be useful and beneficial in terms of historic preservation and environmental compliance, and overall project delivery. The current NCHRP study can also be used as a resource for promoting, developing, and sustaining a SCRGIS that focuses on data-sharing, agency cooperation, and streamlining project delivery.

Additional platforms for promoting the development, expansion, and improvement of a SCRGIS include national and regional conferences. These venues can provide opportunities for a dialogue on the need for these data systems. These national and regional conferences include, but are not limited to, the meetings of appropriate committees of the Transportation Research Board, the American Association of State Highway and Transportation Officials, and the National Conference of State Historic Preservation Officers. These opportunities for dialogue among the federal, state, and local agencies and private sector practitioners who attend these meeting should not be restricted to the presentation of papers or panel discussions, but should involve working sessions that address the issues raised in this current NCHRP study. A product of these working sessions might include action plans for advancing SCRGIS and improving and expanding those systems which are already in place.

REFERENCES CITED

Amekudzi, A., and M. Meyer, *Consideration of Environmental Factors in Transportation Systems Planning*, National Cooperative Highway Research Program, Report 541, Washington, D.C., Transportation Research Board, 2005.

Cambridge Systematics, Inc., *Effective Practices for Considering Historic Preservation in Transportation Planning and Early Project Development*, National Cooperative Highway Research Program, Project 25-25, Task 49, Washington, D.C., Transportation Research Board, 2009.

Cambridge Systematics, Inc. and SRI Foundation, *Planning and Environmental Linkages for Historic Preservation*, Federal Highway Administration, Washington, D.C., 2012.

Federal Highway Administration, *Geospatial Tools for Data-Sharing Peer Exchange*, prepared by U.S. Department of Transportation John A. Volpe National Transportation Systems Center, Cambridge, MA, May 2014.

Federal Highway Administration, *Geospatial Tools for Data-Sharing: Case Studies of Select Transportation Agencies*, prepared by U.S. Department of Transportation John A. Volpe National Transportation Systems Center, Cambridge, MA, September 2014.

ICF International, *Synthesis of Transportation Exclusions to Section 106 Review*, National Cooperative Highway Research Program, Project 25-25, Task 91, Washington, D.C., Transportation Research Board, 2015.

Louis Berger Group, Inc., *Best Practices for Establishing and Maintaining Statewide cultural resources GIS Databases*, National Cooperative Highway Research Program, Project 25-25, Task 61, Washington, D.C., Transportation Research Board, 2010.

Moore, Geoffrey, *Systems of Engagement and the Future of Enterprise IT*. Association for Information and Image Management, 2011. (http://www.aiim.org/~/media/Files/AIIM%20White%20Papers/Systems-of-Engagement-Future-of-Enterprise-IT.ashx, accessed on June 25, 2015).

SRI Foundation, *Managing Archaeological Investigations*, National Cooperative Highway Research Program Synthesis 347, Washington, D.C., Transportation Research Board, 2005.

URS Group, Inc. and SRI Foundation, *Evaluating Cultural Resource Significance: Implementation Tools*, National Cooperative Highway Research Program Report 542, Washington, D.C., Transportation Research Board, 2005.

APPENDIX A

INTERVIEW QUESTIONNAIRE

1. How is your state's GIS currently used during the transportation project development process? For example, creating maps, creating shape files, conducting analyses? If the GIS is used for conducting analyses, what types of analyses do you do? What program(s) is used to perform these tasks and analyses (e.g., ArcGIS)?

2. Is the GIS used in planning (e.g., long range planning, analysis of projects in a Transportation Improvement Plan [TIP] or State Transportation Improvement Plan [STIP])? If so, how is it used? Have there been any issues with the melding/linking of data in GIS and CADD (i.e., in the export of your data to DOT engineers and designers)?

3. How, and by whom, is the GIS maintained?

4. What is the source of funds used to maintain the GIS (e.g., the DOT's annual budget for the cultural resources management office/division, funding from federal or other state or agencies, and user fees)?

5. What are the costs for GIS maintenance and improvements? Does the cost of maintenance and improvements affect data quality and the ability to input legacy data, and thus the value of the system in meeting your agency's needs? Are there cost savings and/or time savings that have resulted from the use of cultural resources GIS?

6. What barriers exist to GIS use? Are these internal to your agency, external, both? How does your agency and your agency's partners address these barriers?

7. Do private sector consulting firms utilize the same GIS used by your office to accomplish work on behalf of your agency? Are consultants able to/encouraged/ required to provide GIS compatible data with their project deliverables? Are there barriers to outside consultants' use of the GIS, such as access to certain types of information/data? Do they utilize the GIS independently or interact with your office when they use the GIS? Do you think consultants are using the GIS to its greatest affect, and thus providing the most value to DOT planning and project delivery?

8. Have there been notable successes associated with GIS use (i.e., specific projects, successful programs)?

9. If your agency could change or add two things about your existing GIS, what would they be?

10. What vision does your agency have for improving or expanding the cultural resources GIS? Centralization? Improved cooperation and sharing with other agencies and partners? Other actions?

11. We would also like to interview your state agency or university partners involved in the maintenance of your state's cultural resources GIS. Can you provide us contact information for your state partners?

The project team would like to acknowledge and thank the following individuals who participated in the interviews:

Alabama DOT: William Turner
Arizona DOT: Ruth Greenspan, Shearon Vaughn, and Jeff Wilkerson
AZSITE–Arizona State Museum: Rick Karl
Connecticut DOT: Mandy Ranslow and Mark McMillan
Connecticut State Historic Preservation Office: Catherine Labadia
Connecticut State Museum of Natural History: Brian Jones
Georgia DOT: Jim Pomfret and Sandy Lawrence
Iowa DOT: Brennan Dolan
Minnesota DOT: Elizabeth Hobbs and Michael Bergervoet
Nevada DOT: Charles (Cliff) Creger
New York State DOT: Stephanie DeLano
New York State Museum: Christina B. Rieth
North Carolina DOT: Brian Overton
North Dakota DOT: Robert Christensen
Ohio DOT: Erica Schneider and Jason Watkins
Oregon DOT: Christopher Bell and Carolyn Holthoff
Rhode Island DOT: Barry Simpson
Texas DOT: Bruce Jensen, Jason Kord, and Summer Chandler
Washington DOT: Scott Williams and Elizabeth Lanzer

APPENDIX B

EXAMPLES OF CURRENT STATE GIS

Table 1 below shows the types of data in the cultural resources GIS of the 15 interviewed states.

Table 1. Data Contained within State DOT cultural resources GIS

	Archaeological Sites	**Historic Built Environment**	**Historic Districts**	**Surveyed/ Inventoried Areas**	**Documents**
State	**GIS Form**	**GIS Form**	**GIS Form**	**GIS Form**	
Alabama	Polygon	None	None	Polygon	Survey reports, site forms
Arizona	Polygon	Point	Polygon	Polygon	Reports, site forms, historic building forms
Connecticut	Polygon, Point, Line (partial)	Point (historic bridges only)	Polygon	Polygon (50% complete)	National Register forms (via National Park Service web site)
Georgia	Point	Point (partial)	Polygon	Polygon (historic resource survey only)	Survey reports, site forms, historic resource survey reports
Iowa	Polygon	Polygon, Point	Polygon	Polygon	Reports, site forms, historic building forms
Minnesota	Polygon	Point	Polygon	Polygon	Phase I and II survey reports, site forms
Nevada	Polygon	Point	None	Polygon	Survey reports (partial), site forms, historic building forms
New York	Polygon, Point	Polygon, Point	Polygon	Polygon	Survey reports, site forms, historic building forms, National Register forms

	Archaeological Sites	Historic Built Environment	Historic Districts	Surveyed/ Inventoried Areas	Documents
State	**GIS Form**	**GIS Form**	**GIS Form**	**GIS Form**	
North Carolina	Polygon, Point	Polygon	Polygon	Polygon (digitization in progress)	Historic building forms and documents, scans of USGS maps showing archaeological site locations and surveyed areas
North Dakota	Polygon, some feature data in point	Polygon	Polygon	Polygon, line-line segment	Survey reports, site forms, historic building forms
Ohio	Point	Point	Polygon	Polygon	None
Oregon	Point	Point	Point	None	Site forms, historic building forms, survey reports
Rhode Island	Point (incomplete)	Point (National Register-listed properties only)	Polygon (incomp.)	None	None
Texas	Point	Point	Polygon	Polygon	Site forms, National Register-listed properties, some reports, Section 106 documentation
Washington	Polygon, Point, Line	Point	Polygon	Polygon, Point, Line	Survey reports, site forms, historic building forms, National Register forms, Section 106 documentation

As noted above, different entities often manage and maintain different GIS within a state, and these GIS hold different types of data, and at times, overlapping data. Given these complexities, Table 1 does not indicate the agency or organization maintaining the GIS, and combines the data sets in different GIS within a state.

Below are more detailed descriptions of a sample of these cultural resources GIS. These descriptions are based on the interviews of the state DOTs and their historic preservation partners.

Alabama

The Alabama Office of Archaeological Research (OAR) maintains a web-based GIS containing the state's archaeological site files. OAR also has a separate GIS that includes Phase I archaeological survey reports and an interactive map showing the locations of the surveys. There is no link between these two databases. Alabama DOT (ALDOT) does not maintain its own GIS with these data, but uses the OAR databases for project reviews. Information on the historic built environment is housed at the Alabama SHPO, in paper files and maps.

Arizona

Arizona DOT (ADOT) maintains a GIS-based historic preservation portal for all ADOT projects and for lands within the DOT's right-of-way (ROW) and adjacent to the ROW. The portal contains both archaeological and historic built environment data and associated records, including Section 106 correspondence, from projects conducted within and adjacent to the DOT's ROW. Information and consultation protocols for agency and tribal contacts are also listed in the portal. Currently, the portal does not include a layer showing surveyed/inventoried areas. The portal does include an "avoidance" layer; and when a project is proposed in an "avoidance" area, the DOT's cultural resources staff is to be consulted prior to initiation of the project.

The portal is used by ADOT's historic preservation team and by approved ADOT consultants. The state of Arizona's primary cultural resources data system is AZSITE. This statewide GIS includes archaeological site data and locations of surveyed areas. AZSITE has links to archaeological reports, but a user contacts AZSITE to obtain the report and then pays a fee to download the report. The Arizona State Museum at the University of Arizona in Tucson, Arizona manages AZSITE. This GIS is separate from the ADOT portal, and there are overlapping data between AZSITE and the ADOT portal.

AZSITE and ADOT are working toward a formal data sharing agreement where ADOT consultants will not have to upload data into both systems (which is the current practice), but will only have to upload into AZSITE. Currently, there are data transfers from AZSITE into ADOT's portal; the new arrangement will make these unnecessary. Under the new arrangement, the improved linkage between ADOT and AZSITE will permit AZSITE staff to review data from consultants in "AZSITE form" and then move relevant data from AZSITE to the ADOT portal, where DOT-specific information can be added by ADOT staff. Historic built environment data within AZSITE is incomplete and focuses on National Register properties. Most of the historic built environment data are currently housed at the Arizona SHPO, in a database that is not accessible through the web.

The Arizona DOT historic preservation portal took nine (9) months to develop, involving one full time IT staff person, and additional IT staff devoting 30% to 40% of their time to the project. One historic preservation staff person dedicated 25% of their time to the portal's development, with around 10% of additional time from other historic preservation staff. Currently, ADOT IT staff devotes about a half an hour per month on portal maintenance and addressing issues as they arise. AZITE has one full-time employee (FTE), with support from university students at about 0.5 FTE each. A ZITE also pays the university's Institute of Social Science, where the GIS is housed, $23,000 per year. As noted above, AZITE is mostly funded through subscription fees. There is no line item in the state's budget for AZSITE. Some agencies, such as the Bureau of Land Management (BLM), pay AZSITE an agency-wide fee for global agency use. BLM's support, which it sees as part of a data-sharing partnership, ranges from $20,000 to $30,000 a year for maintaining and housing BLM data. AZSITE also receives small grants to fund maintenance of some state agency and city data. AZSITE's total annual revenue from these fees and grants ranges from $125,000 to $150,000 per year.

Information on AZSITE can be found at:

http://azsite3.asurite.ad.asu.edu/azsite/

Georgia

Georgia's cultural resources GIS is within a natural and cultural resources database maintained by the University of Georgia' Information Technology Outreach Services (ITOS). Georgia's Natural, Archaeological, and Historic Resources GIS (GNAHRGIS) is a web-based system containing archaeological site data, in addition to historic built environment data. Archaeological data include site locations, site forms, reports, and boundaries of surveyed areas. Historic data includes information on buildings, structures, and districts listed in the National Register and properties in the SHPO's Historic Resources Survey. Georgia DOT is currently working with GNAHRGIS to update data from past historic resources surveys. ITOS is currently adding shape files of historic districts boundaries and boundaries of other types of historic properties. ITOS will also be adding historic maps into GNAHRGIS in the next phase of GIS improvements. ITOS and Georgia DOT are also in the process of reaching out and capturing existing natural resource data from both state and federal natural resource agencies. Maintenance of Georgia's GIS is around $20,000 annually, with an additional $40,000 per year for future planned improvements.

Information on GNAHRGIS can be found at:

https://www.gnahrgis.org/gnahrgis/index.do

Iowa

In Iowa, historic built environment data are maintained by the SHPO. The SHPO GIS includes polygons for historic districts and points for standing structures. This GIS generally includes information on the National Register status of historic resources. The SHPO GIS also tracks survey polygons which carry a review and compliance number issued by the SHPO. The SHPO does not hold archaeological site information. These data are maintained by the Office of the State Archaeologist (OSA), by state law. OSA is at the University of Iowa in Iowa City. The archaeological GIS includes site polygons. Iowa DOT hosts I-Sites, a web-based application that houses the OSA and SHPO GIS, as well as various background layers. Iowa DOT holds the OSA and SHPO systems in I-Sites on DOT servers because the DOT has greater capacity in GIS than OSA and the SHPO; however, most decisions involving the GIS are done collaboratively among the three agencies. I-Sites is updated monthly or quarterly. The data transfers from the SHPO and OSA into I-Sites take place through an FTP site, and the data are ultimately placed in an Oracle database maintained by the DOT, and then moved into I-Sites.

Iowa DOT's cultural resources consultants gain access to OSA data through I-Sites, and must be designated as a qualified user. They also pay a subscription fee to OSA to access data in the GIS. The fee for accessing the state's archaeological database, housed within I-Sites, is $1,500 a year. These fees are retained by OSA. I-Sites has three levels of access: professional, government agencies, and the public. The public interface can be used by county engineers and local governments as an initial way to screen projects.

There are two full time GIS coordinators in Iowa DOT's Office of Location and Design, devoting about 20% of their time to supporting the cultural resources staff. In addition, there is an overall DOT GIS coordinator in the agency's Office of Performance and Technology. The Iowa SHPO has a full-time GIS specialist and the state's archaeological office has a full-time person, in addition to part-time staff, to manage their database.

Information on I-Sites can be found at:

http://archaeology.uiowa.edu/i-sites

Minnesota

Minnesota DOT (MnDOT) is well known for its Mn/Model, a statewide archaeological predictive model. MnDOT's Cultural Resources Unit (CRU) also maintains an in-house GIS. This GIS has data on archaeological sites and the historic built environment. The most complete and up-to-date version of historic built environment data is in a non-GIS format at the SHPO, and the data held by MnDOT in their in-house GIS is out of date and contains incomplete shapefiles for which many locations are not reliable. MN.IT Services (MN.IT), a state agency, maintains all Minnesota state agencies' GIS software and hardware. MnDOT's CRU develops their cultural resources data and then stores the data on a MN.IT server. CRU staff uses the GIS data for conducting project analyses. MnDOT's CRU, in conjunction with MN.IT and a private consultant, also maintains a web-based Cultural Resources Information System (CRIS)

application that is the front-end of a database to track MnDOT and FHWA-funded local projects. The data in CRIS include project numbers, names of project proposers (e.g., MnDOT engineers), CRU project managers (those who review the project), project location, project status, etc. The CRIS application allows MnDOT CRU, project proposers, MnDOT's cultural resources consultants, SHPO, Tribal Historic Preservation Officers (THPOs), and the Office of the State Archaeologist (OSA) to access the information about project reviews. Its GIS interface provides users with views of background layers (e.g., transportation infrastructure, hydrography, terrain, aerial photographs), project locations, and MnModel (depending on permissions), but not archaeological sites or the historic built environment.

In Minnesota, OSA is the agency that maintains the paper archaeological site files and a non-GIS database of sites. MnDOT recently scanned archaeological site forms and Phase I and II survey reports, and digitized site and survey location information (i.e., polygons). MnDOT is now working with OSA to develop a web-based portal to make the archaeological data accessible. The State Archaeologist and SHPO will use the OSA portal for reviews and approvals of archaeological site form submittals. Going forward, all digital archaeological data will be submitted through the portal. OSA will determine who is authorized to use the portal for submitting and/or viewing archaeological site and survey data. OSA and MN.IT will manage the portal, and OSA will review incoming materials before they are placed in the archaeological database. MnDOT's CRIS will access the archaeological data directly from the portal. This accomplishes the goal of having only one up-to-date version of the archaeological database. The Minnesota SHPO maintains data on the historic built environment in an *Access* database. In the future, MnDOT will work with the SHPO to move this database into a GIS and to create a portal similar to the one being developed for OSA.

Minnesota DOT's cultural resources office has two full-time staff maintaining the office's GIS and other databases. One of individual manages the development of the office's CRIS application, and has recently assumed responsibility for maintaining the archaeological site, survey, and historic built environment data that will go into the state archaeologist's portal. The second staff person is in charge of updating Mn/Model.

Minnesota DOT has two FTEs on staff to maintain and develop their GIS and CRIS system, totaling around $150,000 in salaries per year. Phase 4 of Mn/Model, which is in progress, involves environmental and archaeological data updates statewide, applying new statistical methods to the program, and creating a statewide prehistoric/historic surface hydrography component to the model. The cost for this phase to date is $1.8 million. CRIS development costs are around $1 million, and the cost for scanning and digitizing archaeological site data for the Office of State Archaeologist's portal is anticipated to be around $1.25 million. Cost for developing the portal will be another $180,000. These costs do not include the digital conversion of all historic built environment data currently maintained by the SHPO, mapping property locations in the GIS, or development of the SHPO portal. These efforts are expected to cost another $2 million.

Information on Mn/Model can be found at:

http://www.dot.state.mn.us/mnmodel/

New York State

New York State DOT (NYSDOT) maintains an internal historic bridge GIS. Historic bridge locations are in a point layer, which provides information on the bridge's National Register eligibility. All other cultural resources data are maintained by the SHPO in its Cultural Resources Information System (CRIS), which is accessible through the web. CRIS includes data on historic buildings and districts, archaeological sites, New York City landmarks, surveyed/inventoried areas, and archaeological sensitive areas. The GIS also includes PDFs of survey reports and site forms. NYSDOT does not maintain a separate GIS, and conducts its analyses and creates project-specific shapefiles (e.g., the area of potential effects for a project) using CRIS and the resulting data and analyses are stored in the database.

All maintenance of CRIS is the responsibility of the SHPO, except for the historic bridge GIS which is maintained by NYSDOT. The cost for maintenance of, and continued improvements to, New York State's GIS, is around $150,000 per year. Development of a public app to access the public portions of the GIS, and transitioning legacy data into the GIS is costing around $2.2 million.

Information on CRIS can be found at:

https://cris.parks.ny.gov/Login.aspx?ReturnUrl=%2f

North Carolina

In North Carolina, the Office of State Archaeology (OSA) maintains all archaeological resources data. OSA, using funding from the North Carolina DOT (NCDOT), is in the process of digitizing archaeological site and project areas/environmental review areas currently on paper maps, creating shapefiles for the GIS. Digitization is about 75% complete. The plan is that all of these data are going into one database—probably with two sub-datasets (one for site locations, one for project areas/environmental review areas). There is currently no plan to place site forms, reports and other documents into the GIS. These records are in a database maintained by OSA or are in hard copies in OSA's library. NCDOT's Archaeology Group stores digital archaeological data from DOT projects in an in-house system that is not in a GIS. As of the summer of 2015, NCDOT is moving forward with georeferencing all of their new environmental review areas and archaeological sites.

The North Carolina Historic Preservation Office (HPO) maintains a historic resources GIS, using points and polygon boundaries. In some cases, historic district data include the names and locations of properties in the districts. The HPO GIS has multiple data layers, including state listed properties, and National Register-eligible and -listed properties. NCDOT funds a position within HPO to maintain this GIS. This individual has pulled legacy data into the GIS, inputs new data, and assists in expedited review and data analysis for NCDOT projects.

Information on HPO's GIS can be found at:

http://gis.ncdcr.gov/hpoweb/

North Dakota

North Dakota DOT (NDDOT) maintains an in-house GIS that contains archaeological site and survey data, as well as data on the historic built environment. These data, however, are incomplete and are housed in several different formats and files, making reviews cumbersome. As a result, NDDOT staff uses the SHPO's GIS database, which is more complete and comprehensive. The SHPO GIS has archaeological site and historic built environment data sets.

The NDDOT does not currently have direct, online access to SHPO's GIS database due to security concerns. NDDOT, however, is working on and negotiating to get online access to the SHPO database, which is behind a firewall. They anticipate having access to the SHPO data within a year. In the meantime, NDDOT cultural resources staff physically goes to the SHPO to access their database. In some cases, the DOT can ask for a selection of the GIS data for a specific project; and, the DOT must sign an agreement that that the information will not be made available to the public.

Texas

Texas DOT (TxDOT) has an in-house cultural resources GIS. TxDOT uses an outside vendor, NTT- DATA, to maintain and house all of the Department's databases. NTT- DATA provides GIS support staff, maintains servers, and creates the database standards for the DOT. The DOT also uses the Texas Historical Commission's (THC) GIS, which contains information on archaeology and historic resources (i.e., the Texas Historic Sites Atlas). The Texas Atlas has all archaeological site forms, National Register-listed properties, some reports on sites and properties, neighborhood surveys, state archaeological landmarks, and other state-designated properties. The THC's GIS currently does not have Section 106 compliance data (the head of the THC is the State Historic Preservation Officer). TxDOT's cultural resources staff currently maintains a separate, in-house historic bridge web-based GIS, in addition to a GIS layer of digitized and georeferenced historical maps for the eastern half of the state, and an archaeological/geomorphological predictive model focusing on major metropolitan areas of the state, such as Houston, Fort Worth, and San Antonio.

Each TxDOT division has its own GIS coordinator, including the cultural resources division. The cultural resources division also has two GIS technicians who work with the GIS coordinator. These two technicians are contracted positions.

TxDOT is currently uploading data from THC's GIS into TxDOT's in-house GIS. TxDOT's Section 106 information is maintained in the in-house GIS. This GIS currently does not include Section 106 reports. The in-house system is shared with THC, and TxDOT is in the process of uploading TxDOT's Section 106 information into THC's GIS. TxDOT is also providing THC

funds to upload into THC's GIS, Section 106 data from other state and federal agencies, so TxDOT can access all Section 106-related documentation that may be relevant to future TxDOT projects. TxDOT is also in the process of improving the Texas Atlas by adding data on contributing properties within historic districts. The DOT is focusing first on districts where the transportation management need is greatest or can be anticipated based on proposed future projects.

Information on THC's Texas Historic Sites Atlas can be found at:

http://atlas.thc.state.tx.us/

Washington

Washington State DOT (WSDOT) has a centralized GIS department, located at the DOT's headquarters. The GIS is maintained by the DOT's GIS staff in the headquarters office. The DOT's centralized GIS contains all of the data in the SHPO's database (the Washington Information System for Architectural and Archaeological Records Data [WISAARD]). The DOT receives data from WISAARD on a quarterly basis, so the resource data in the WSDOT GIS is not always up to date. As a result, WSDOT staff generally use the SHPO's GIS for project reviews. The SHPO's GIS includes an archaeological predictive model for the state, in addition to historic shoreline maps used to assess the potential for Native American sites. WSDOT's in-house GIS includes an application where tribes can delineate areas of concern to them, and where they need to be consulted if there is a WSDOT project in the area. The DOT is also working on adding to the in-house GIS a historic bridge layer and historic roads layer, with information on National Register eligibility status. The DOT will provide this new layer to the SHPO to manage, once it is complete.

Information on WISAARD can be found at:

https://fortress.wa.gov/dahp/wisaard/