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International Research on Permanent Authentic Records in Electronic Systems

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A. Case Study Overview

Archaeological Records in a Geographical Information System: Research in the American Southwest, was accepted as a case study by the International Team at Workshop 5 in February, 2003. The case study was pursued because of the continued increase in use of complex, interactive and often dynamic electronic systems, such as Geographic Information Systems (GIS), and other modeling applications in the social sciences congruently with no significant amount of funding set aside to develop, manage and preserve the important data and outputs stored and created with these systems.

In support of the InterPARES 2 Project research objectives, this case study investigated archaeologists' attitudes towards recordkeeping, especially in terms of what they consider to be authentic and reliable records and the value of these attributes for records created and used in the course of archaeological research. In particular, this case study hoped to gain insight into the creation processes of these types of records within the field of archaeology, with an emphasis on better understanding how archaeologists themselves view, and subsequently treat, their data and the records resulting from the use of those data. The immediate objective of this research was to help answer questions about the nature of electronic archaeological records in general, about how the increased reliance on GIS-supported research is impacting the archaeological community, and, especially, how both of these issues are playing out in the recordkeeping habits of archaeologists. It is hoped that by addressing these questions and concerns, this research can contribute to the longer-term goal of developing an appropriate records management framework in which archaeologists can approach the long-term preservation of the complex datasets and outputs that are commonly associated with a GIS, so as to maintain their authenticity. The long-term preservation of such datasets and outputs has become a critical issue with regard to enabling the kind of multidisciplinary research crucial to modern scientific knowledge.

To this end, this case study investigated the Coalescent Communities Database and Geographic Information System (hereinafter, CCD when referring only to the database component of the GIS and CCD-GIS when referring to the entire GIS) that has been created by the Center for Desert Archaeology (CDA) in Tucson, Arizona, in support of its National Science Foundation grant-funded research project entitled "Precontact Population Decline and Coalescence in the Southern Southwest" (also known as the "Coalescent Communities Project"). More specifically, this case study examined how the records found within, or closely associated with, the CCD-GIS are created, maintained and preserved, and the corresponding impact of these processes on the records' authenticity, accuracy and reliability.

The Coalescent Communities Project, the larger research project surrounding the CCD-GIS, is a two-year (2004-2006) project investigating the causes, tempo and spatial variability of the conspicuous population decline noted in prehistoric pan-Southwestern cultures of North America beginning circa A.D. 1300 and continuing into the early 15th century.[1] The CCD is populated with pre-recorded archaeological site data (some collected by archaeologists more than one

[1] For further details about this project see, "Media Releases: $200,000 National Science Foundation Grant Awarded to the Center for Desert Archaeology" at http://www.centerfordesertarchaeology.org/pages/articles.php?req=read&article_id=65 (accessed 24 October 2006), and the CDA's *Coalescent Communities* Web page at http://www.centerfordesertarchaeology.org/pages/heritage/coalescent.php (accessed 24 October 2006).

hundred years ago) compiled from datasets contributed by individual researchers and various repositories, as well as from data extracted from published sources held by libraries and related institutions. It is anticipated that this database will eventually contain size, temporal, and locational data for every known settlement in the pan-Southwestern region of the United States and northwestern Mexico with more than twelve rooms, dating between A.D. 1200 and 1700.

Both prior to, and following ingest into the CCD, the datasets, which exist in various formats, including paper site forms and reports, digital spreadsheets and other pre-existing computer databases, are routinely checked for data redundancies, errors and omissions by a volunteer who is a retired archaeology professor. The conceptual and technological framework for the CCD-GIS was created, and is maintained, by a Preservation Archaeologist at the Center for Desert Archaeology. This archaeologist, who sometimes refers to himself as the "GIS Program Manager because [he] was hired to take care of all of the [CDA's] GIS needs,"[2] is responsible for producing all of the outputs from the CCD-GIS, which include digital and hardcopy maps, graphs and statistical data for publications, digital and hardcopy maps—along with their accompanying tabular data—for other researchers, and geospatial analyses relevant to different research projects.

In a larger context, the Coalescent Communities database is similar to other databases relating to archaeological site information from the American Southwest. AZSITE is one of the larger databases of this kind in the region. It consists of three layers: archaeological sites, archaeological survey projects and archaeological and historic districts. The Coalescent Communities project received a large amount of initial data for its database from AZSITE. Issues that have arisen during the creation and management of the AZSITE database have affected the way the Center for Desert Archaeology designed its CCD-GIS.

In the initial grant proposal for the Coalescent Communities project, the CDA explains its concerns regarding the accuracy of the data that it will use for analysis as follows:

> The central element of this project is information management. The current AZSITE program has very large amounts of legacy data that were collected long ago. Furthermore, the process of incorporating data from diverse institutions into a single database can be a source of introduced error. David Wilcox and Geo-Map Inc. have been working diligently to compile data from this time period. In addition, these data are being incorporated into maps that can be plotted in 50-year time intervals. We plan to meet with many archaeologists across the state to review these maps and to obtain input regarding "missing sites," sites that may not be properly plotted, and sites that may have been recorded by more than one person over the years. This information will be provided to the AZSITE Consortium in order to upgrade the quality of the data contained in that statewide database for sites from this key time interval.

[2] Interview B, lines 707-708.

B. Statement of Methodology

The primary method of data collection throughout the case study was intensive, semi-structured interviews with two individuals involved in the planning, creation and maintenance of the CCD-GIS, as well as other experts in relevant professional areas, such as GIS, Southwestern archaeology and information management of archaeological datasets. Interview questions were developed from the Project's initial 22 core research questions, the Authenticity and Modeling sub-questions and the re-worded cross-domain research questions.

Approximately one week before the interviews, the subjects were given a copy of the Peter Hirtle article, "Authenticity in a Digital Age," and a few mock scenarios that discussed issues of authenticity, reliability and accuracy in a contextualized and meaningful format for the subjects. This allowed the interviewers to begin with a discussion of these issues without too much discrepancy of the meaning of the terms. This step also allowed the interviewers to witness the vocabulary that the subjects used when discussing issues of authenticity, reliability and accuracy.

The interviews were recorded on analogue tapes and later fully transcribed. These transcriptions served as the basis for the initial responses to what are now the Project's 23 core research questions. The human-subject interaction and interview questions were approved by the University of British Columbia Behavioural Research Ethics Board in the spring of 2003.[3]

An annotated bibliography was another form of data collection that the case study team used. Sources were gathered relating to the history and development of archaeological theory and methods, especially in the American Southwest; information management as it relates to archaeology; GIS; and case study methods. This is an ongoing activity that has grown to be a great resource for the research team during many stages in the research process.

Attention is drawn here to a complimentary InterPARES 2 study, general study 09 (GS09), *Web-based Survey of Electronic Recordkeeping Practices of GIS Archaeologists Worldwide*. This survey, which investigated the recordkeeping behaviours and attitudes of archaeologists from some thirty countries worldwide, was initially conceived to help assess the representativeness of case study 14's findings with respect to its characterization of the recordkeeping habits of the archaeological community as a whole. In fact, the initial goal of the survey was to collect data that could be used to help determine whether the electronic recordkeeping activities of the GIS archaeologist at the CDA could in fact be used as a general template for the analysis and development of preservation guidelines for electronic records within the broader archaeological community. Although originally developed and administered as a sub-component of case study 14, a decision was made in September 2005 to extract the survey from case study 14 and reclassify it as a distinct general study, as defined within the broader research framework of the InterPARES 2 Project. A summary of the GS09 findings in relation to this case study is provided in Appendix A.

[3] University of British Columbia, Office of Research Services, Behavioural Research Ethics Board #B03-0273.

C. Context of Creation and Management

Juridical Context

The actions of archaeologists in the United States are governed and influenced by a complex landscape of legal and regulatory instruments and by ethical and professional guidelines or standards. Within the juridical context, a host of federal, state, and municipal regulations and policies outline the general operational procedures archaeologists are expected to follow. In many cases, the regulations establish minimum standards of professional competency that must be met to qualify for field survey, sampling and excavation permits. Within the administrative context, archaeologists often find their actions further governed by the professional codes of conduct and standards of research performance guidelines promulgated by the professional associations to which they may belong, as well as by the organizations for whom they may be employed.

In the United States, laws and regulations govern various aspects of the conduct of archaeologists and other cultural resources managers in relation to the preservation and management of archaeological resources. Often, the preservation and management of these resources depends on who owns the land on which they are located and whether there is a legal basis to assert a public interest in their protection. Because of the clear distinction that is made in the United States between what is private property and the various lands that are held in the public domain, land ownership is an important yardstick by which legal protection for archaeological resources often is measured. Thus, who can use land, how, and for what purpose are legally defined, as are the circumstances under which government at all levels can condition the use of land, both public and private. Archaeological resources are part of this land use equation because, legally, they exist as part of property of one kind or another. Thus, an examination of how preservation law applies to archaeological resources is an important element to consider when assessing the juridical context within which archaeologists in the United States are required to operate. Knowing this will help in determining the extent to which the creation, use, dissemination and long-term preservation of archaeological GIS projects (and the sensitive information that they contain) are effected, either directly or indirectly, by federal, state and municipal archaeological resource preservation regulations and policies.

History of Archaeological Resource Protection Legislation in the United States

In the United States, archaeological resources on federal lands have the highest legal protection of any lands, while those on state and municipal lands are protected as a matter of both law and policy to varying degrees. Beginning in the early 20th century, the federal government recognized the importance of preserving the record of the past and its own responsibility for doing so. The *Antiquities Act* of 1906 was the first piece of preservation legislation passed by Congress providing a legal means for protecting archaeological sites on federal lands. Created in 1935 as part of the newly enacted *Historic Sites Act*, the National Historic Landmark program established a program whereby places of national historic importance could be officially recognized. However, it wasn't until the mid 1960s that the degree of protection now afforded archaeological resources was established with the adoption of the *National Historic Preservation Act* (NHPA) of 1966, as amended. The NHPA is the premier cultural resources preservation law in the United States and is the model for most state preservation laws. It created the National

Register program as a means by which archaeological and other cultural resources can be evaluated for their significance and recognized for their historical importance at the local, regional, and national levels. Perhaps more important is the fact that it also required all federal agencies to take into account the effects of their actions on places deemed to be significant, regardless of whether they are located on public or private property. As a result of the NHPA, all federal agencies are required to include archaeological and other cultural resources in their planning and to be both pro-active and reactive in meeting their legal responsibilities to preserve these resources.

More recently, the *Archaeological Resources Protection Act* (ARPA) of 1979, and the *Native American Graves Protection and Repatriation Act* (NAGPRA) of 1990, have provided additional protection of archaeological sites on federal land. In addition, it is worth mentioning that the *Environmental Policy Act* of 1966 links compliance with its provisions with those of the NHPA, and further requires consideration of impacts to a wide variety of social and cultural resources, including archaeological, in the planning of federally sponsored actions. Finally, the *Wilderness Act* of 1964 establishes guidelines for federal lands that meet specific conditions to be set aside for conservation purposes protecting natural and cultural resources for the future.

In summary, it is important to note that the protection and management of archaeological resources in the United States is achieved by various federal regulations and policies belonging to a category of laws which address the broader issue of the preservation of historical, cultural and natural values. This category of laws is unique in that nonfederal resources, such as archaeological resources on private lands, must be considered when involved in any federal undertaking. With respect to archaeological and other cultural resources, an undertaking is defined as an action that can result in changes in the character or use of historic properties, if such properties are located within the area to be affected by the action. More specifically, a federal undertaking entails: (1) a project, activity, or program carried out by or on behalf of a federal agency; (2) a project wholly or partially carried out with federal financial assistance; (3) a project requiring a federal permit, license or approval; or (4) a project subject to state or local regulation administered pursuant to a delegation or approval by a federal agency. The broad scope of what constitutes a 'federal undertaking' notwithstanding, it is significant to note that the system of archaeological resource protection, as it has evolved in the United States, asserts a national interest in preservation while at the same time privileging private property rights. Thus, in the absence of a federal undertaking, these regulations usually apply only to archaeological resources on public lands.

Role of Federal Land Managing Agencies in the Protection of Archaeological Resources

In the United States, the federal land managing agencies all have equivalent responsibilities under law, although, for some, the protection of cultural resources is closer to their primary mission than for others. For example, with the National Park Service, protecting cultural resources is often a significant part of the very reason for creating a park or monument, whereas the primary purpose for the establishment of wildlife refuges by the U.S. Fish and Wildlife Service is habitat protection, with archaeological and other cultural resources being protected as a result only indirectly. The Bureau of Land Management (BLM), the largest federal land owner in the United States (and in Arizona, with control over 14 million acres, or about twenty percent of the state), is a multiple use agency that has as one of its many responsibilities the proper management of archaeological and other cultural resources on lands under its control. The BLM

requires that all public and private users of BLM lands mitigate effects to all significant cultural resources in compliance with the reactive provisions of the NHPA. However, the BLM is also mandated to designate Areas of Critical Environmental Concerns (ACEC) setting them aside to protect natural and cultural resources, giving the agency a pro-active means of achieving resource conservation. The U.S. Forest Service has been granted similar controls over land under its administration, and can set aside and conserve lands that contain high value resources, including archaeological and other cultural resources, by designating them as "Special Interest Areas." For example, National Register Historic Districts can be designated as special interest areas and protected as such. Under the *Wilderness Act* of 1964, lands under the control of both the BLM and the Forest Service can also be set aside for conservation purposes. In summary, it is clear that the federal land managing agencies are responsible for protecting archaeological and other cultural resources to a relatively high degree and have the legal means of doing so.

Arizona State Regulations and Policies Affecting Protection of Archaeological Resources

In many instances it is the states that take the lead in recognizing and nominating sites or areas for protection and overseeing the federal agencies and the implementation of federal regulations. Indeed, most states have enacted cultural resource protection legislation which closely mirrors its federal counterparts.

In concert with the federal regulations outlined above, archaeological and other cultural resources on state and municipal lands in Arizona are further protected from both public and private actions by various Arizona state and municipal laws and policies. The *Arizona Historic Preservation Act* (AHPA) of 1982 is modeled after the federal NHPA. The AHPA enables the Arizona State Land Department (ASLD) to require mitigation of effects to archaeological and other cultural resources on state lands when, for instance, state trust lands are sold to a private developer. The state *Antiquities Act* of 1973 requires the Arizona State Museum to control and monitor archaeological investigation on all state lands. Finally, the state's *Burial Protection Act* of 1990, modeled after the federal NAGPRA**,** further protects unmarked human graves and their contents against unauthorized disturbance.

In Arizona, as in most other states, archaeological and other cultural resources on private lands are not protected by state or municipal law, with but two exceptions. One exception involves the *Arizona Burial Protection Act* of 1990, which makes it unlawful to disturb an unmarked human grave on both public and private land without authorization. The only other exception involves cases where local governments have included such protections in their local law, invariably in the form of reactionary mitigative measures, as opposed to pro-active conservation measures.

In summary, major Arizona state regulations and policies that address the protection and management of archaeological resources are embodied in the following laws:

- *Arizona Antiquities Act* of 1973
- *Arizona Historic Preservation Act* of 1982
- *Arizona Burial Protection Act* of 1990
- Arizona Revised Statutes

For a more detailed description of the juridical context, see Appendix B.

Administrative and Provenancial Contexts

The Center for Desert Archaeology (CDA) is a private, nonprofit organization whose primary mandate is to promote "the stewardship of archaeological and historic resources in the American Southwest and Mexican Northwest through active research, preservation, and public education."[4] To this end, the CDA has initiated and sponsored numerous research and community preservation projects, as well as educational workshops and exhibits. In addition, the CDA has an active publications program to disseminate information to a wider audience. Included in their publications program is the quarterly journal, *Archaeology Southwest*, the goal of which is to provide "timely, synthetic treatments of some of the most current topics and issues in Southwestern archaeology."[5]

Although officially founded in 1989, the CDA grew out of the former Arizona Division of the Institute for American Research, a nonprofit organization founded in 1982 for the purpose of studying Tucson Basin prehistory through contract archaeology, research grants and private donations. At the time this case study was initiated, the CDA's employee pool included seven Preservation Archaeologists who managed the Center's day-to-day operations, and three Preservation Fellows who assisted in research.

In addition to private funding, the CDA has received significant state and federal funding, including a 1997 Arizona Humanities Council grant, a 1999 National Science Foundation grant, and a 2001 National Endowment for the Humanities grant. As discussed above under the juridical context, the acceptance of state and federal funding carries with it various administrative responsibilities with regard to the protection and management of the archaeological resources falling within the CDA's purview.

Also of relevance here is the CDA's CCD-GIS initiative. The CDA employs one preservation archaeologist, referred to as the GIS Program Manager, whose primary function is "to develop and manage a Geographic Information System (GIS) incorporating a variety of archaeological and environmental data from the southwestern U.S. and northwestern Mexico."[6] The stated goal of the CCD-GIS project is "to assist the Center's staff and partners in integrating our growing archaeological knowledge of the region with recent computer advances in the analysis of attributes such as terrain, hydrology, and land-ownership."[7] Moreover, it is emphasized that "[i]ntegrating these data in a regional GIS provides a valuable tool for the Center's goals of improving management of our archaeological heritage, and of understanding how people in the past lived and used the landscapes around them."[8]

For a more detailed description of the administrative context, see Appendix C.

[4] Center for Desert Archaeology, "About Us." Available at http://www.cdarc.org/pages/about/.
[5] Center for Desert Archaeology, "Archaeology Southwest." Available at http://www.cdarc.org/store/index.php?main_page=index&cPath=67.
[6] Center for Desert Archaeology, "Staff Biographies: J. Brett Hill, Preservation Archaeologist." Available at http://www.cdarc.org/pages/about/bhi.php.
[7] Ibid.
[8] Ibid.

Procedural Context

There are no formal business or documentary procedures within the CDA that would lead us to describe them in great detail here. In addition, there are no procedures manuals that outline, guide or otherwise impact the creation, management or preservation of the CCD-GIS. Instead, the CCD-GIS was created, and is maintained, under sole authority of the CDA's GIS Program Manager, and it is this person's idiosyncratic procedures that form the procedural context. These procedures are usually decided ad hoc and are not documented except through notes that are occasionally created or the transitory documents that are created during the course of creating records within the CCD-GIS. On occasion, the GIS Program Manager will document certain steps within various analyses to speed the time it takes to replicate the analyses, especially for 'generic' analytic processes that are likely to be required for other analyses in the near future. This reiterates the fact that this type of documentary process is ad hoc in nature, and is done for other reasons than the traditional need for procedures. With only one full-time employee dedicated to the creation and maintenance of the CCD-GIS, formally documenting every procedure is viewed by the GIS Program Manager as both excessive and unrealistic in relation to other business needs.

Documentary Context

The records in question are part of the CDA's fonds. The majority of the fonds is organized around specific projects and grants that have been awarded to the organization. The fonds still has a large volume of records in the active and semi-active phase of their lifecycle. The Coalescent Communities Project is a series within the CDA's fonds. This series consists of the Coalescent Communities Database, the original researchers' datasets, the AZSITE dataset, the GIS Project Manager's own dataset, government geospatial data, NSF grant records, records documenting analysis and various administrative records.

Technological Context

Before discussing the technological context specific to the case study's CCD-GIS, it may be helpful first to summarize the general characteristics of a typical GIS, bearing in mind, nevertheless, that the specific technological context in which a GIS operates can vary widely from one system to the next.

At its most fundamental level, a GIS may be defined as a spatially referenced dataset incorporating a database management system with a graphical display. In particular, a GIS dynamically links geospatial data and descriptive attribute data from a wide variety of sources such as maps, graphs, photographs, remotely sensed data, tabular data and text. Typically, data from each of these sources are stored in separate data stores and are manipulated via complex interactive queries. It is their capacity for storing, mathematically manipulating, and visually displaying spatially referenced data that distinguishes GIS from Computer Aided Design (CAD) and Computer Aided Mapping (CAM) systems.[9]

[9] H.D.G. Maschner, "Geographic Information Systems in Archaeology," in H.D.G. Maschner (ed.) *New Methods, Old Problems. Geographic Information Systems in Modern Archaeological Research* (Carbondale: Southern Illinois University Center for Archaeological Investigations, Occasional Paper No. 23, 1996), 2.

According to Marble, the technological aspect of a GIS can be described by a model consisting of four interrelated subsystems, including:

1. A data entry subsystem that transfers both analog and digital data to a storage device;
2. A data storage and retrieval subsystem;
3. A data manipulation and analysis subsystem; and
4. A data visualization and reporting subsystem.[10]

A data entry subsystem can employ a host of devices, such as digitizers, scanners, CD-ROMs and global positioning devices. A data storage and retrieval subsystem typically consists of a computer and any number of data storage devices such as hard drives, DVD drives, tape drives, etc. The data manipulation and analysis subsystem includes the software application(s) that enables a user to query the data, create new data, and perform statistical and spatial analyses. Finally, the data visualization and reporting subsystem, composed of any number of output devices such as high resolution graphic monitors, plotters and printers, facilitates graphical display and provides print results of a spatial analysis or query.

The typical data structure of a GIS consists of two primary data formats; vector and raster. Vector data structures define the geo-spatial locations of features on the basis of Cartesian co-ordinate pairs. Such systems use what is termed a topological structure in which the vector data are displayed in the form of discrete points (i.e., point or node data), open linked points forming discrete sections of line (i.e., arc or line data), or closed linked points forming closed boundaries encompassing and area (i.e., area or polygon data) (Figure 1). With vector data, the co-ordinates of each point, as well as the direction of the lines, connections and adjacent polygons are explicitly stored.[11]

In contrast, raster data are delineated by a grid or matrix of rectangular cells or pixels, each with an inherent value stored as a unique row and column co-ordinate within the overall grid (see Figure 1). Here, spatial data are not continuous, but are divided into discrete units where a point is represented by a cell of a certain value, a line is represented by a number of connected cells, and a polygon is delineated by grouping cells in such a way as to represent the actual area.[12] With raster data, various spatially-referenced data categories might be attached to each grid cell, depending on the size of the individual cells and the particular type of raster model employed. Ideally, the size of the cells (or grid resolution) is determined by the research question(s) being examined, but more often cell size is determined by external factors such as software and hardware limits, or the quality of the original data. Grid resolution is an important factor since the finer the resolution (i.e., the smaller the cell size), the more detailed and potentially closer to 'ground truth' a raster representation becomes.[13]

[10] D. F. Marble, "Geographic Information Systems: An Overview," in D.J. Peuquet and D.F. Marble (eds.), *Introductory Readings in Geographic Information Systems* (London: Taylor and Francis, 1990), 12.
[11] K. Gourad, "Geographic Information Systems in Archaeology: A Survey" (unpublished Masters thesis, Hunter College of the City University of New York, Department of Anthropology, 1999), 9. Online PDF version available at http://khalid.gourad.com/thesis/.
[12] Ibid.
[13] See M. Gillings and A. Wise, *GIS Guide to Good Practice* (London: Arts and Humanities Data Service, 1998). Online version available at http://ads.ahds.ac.uk/project/goodguides/gis/.

Raster and vector GIS data are organized into what are commonly referred to as layers or coverages, and may include such features as topographic contours, hydrology, artifact finds, soil types and archaeological sites (Figure 2). As Maschner points out, "[o]ne of the most important features of a GIS is the ability to construct new data layers from those already associated with maps…[such as] aspect, slope or grade, view, or other features generated from a contour

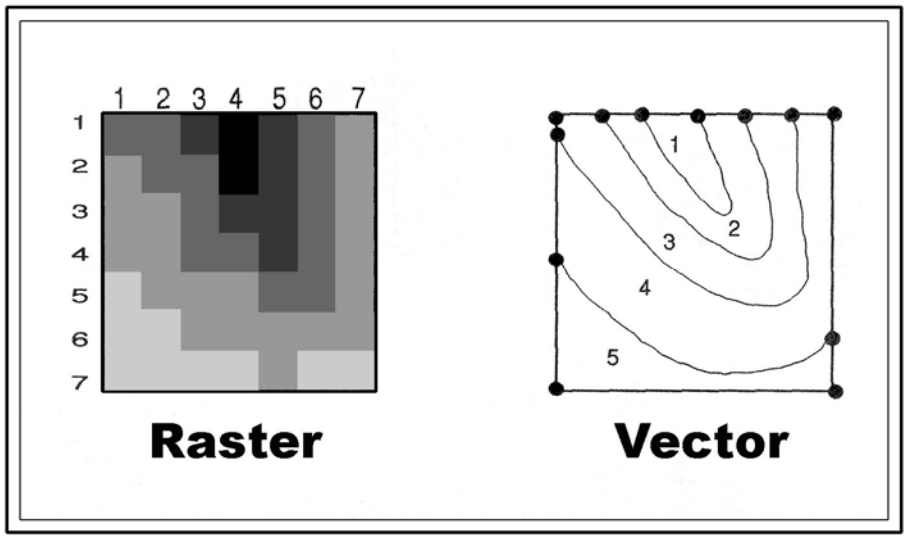

Figure 1. Difference in raster and vector data representation

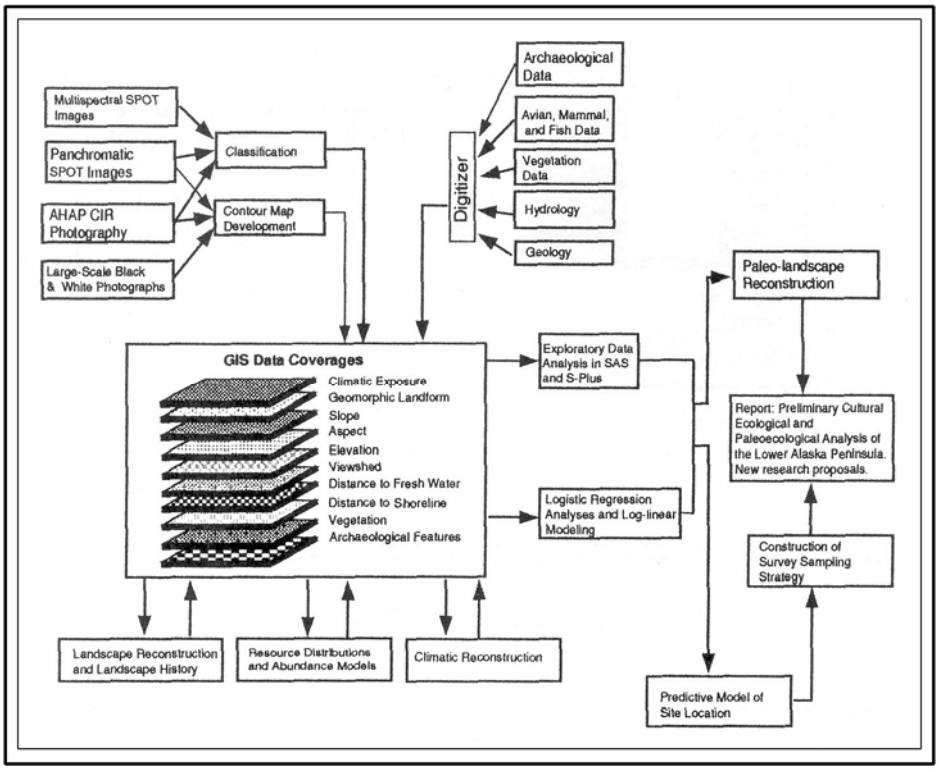

Figure 2. Hypothetical archaeological GIS model

coverage."[14]

Data may be incorporated into a GIS in numerous ways. One technique is to manually enter point co-ordinates of the area or feature of interest, collected using either traditional field methods or with the aid of GPS (Global Positioning System) receivers. Another option is to convert pre-existing databases that already have spatial data embedded in them. Existing paper map data are perhaps the largest source of raw GIS data, and are converted into digital data through a process of scanning, digitizing or a combination of the two. An increasingly important GIS data source is remotely sensed data obtained via aerial photography and satellite imagery.

Specific Technological Context

Most components of the CCD-GIS operate within the CDA's LAN (Local Area Network) server system, which incorporates technology commonly used in offices, including workstation computers networked together via a central file server. The CDA currently uses Windows 2000, version 5.0, throughout the LAN. The LAN system uses two types of secondary storage; hard disks and CD-R/W disks. Although final versions of the GIS files are stored on the LAN server and/or burned onto CDs, interim working copies of the GIS files typically are downloaded from the server onto the GIS technician's computer hard disk where he manipulates them before uploading the modified (updated) versions back onto the LAN server.

Neither the LAN nor the CCD-GIS includes any custom hardware. Peripheral devices attached to the LAN include inputting devices such as mice, keyboards and a flatbed scanner (specifics not available at this time), and outputting devices such as high resolution colour monitors and a b&w laser printer (specifics not available at this time). Currently, there is no digitizing tablet or printer-plotter attached to the LAN.

The project has occasional need for a plotter, and uses plotters located at another facility outside the Center's LAN by transferring files on CD-ROM. Similarly, the server's Microsoft network and operating system software is typical of what is found in many office LANs. Data typically are stored both on the central file server and on the GIS Program Manager's personal computer. Data are also sometimes saved on CD-ROMs, either to facilitate transfer of data to a user or facility outside the LAN, or for the purpose of backing up system data.

The primary application software used includes: ESRI ArcView 3.2 and 8.2 (GIS software)—including a number of unspecified analytical (primarily statistical) add-ins downloaded from the ESRI Web site, EndNote (bibliographic software), Adobe Acrobat, TOPO! (topographic map software), Notepad (basic text editor software), Microsoft Office Suite—including, in particular, Access (database), Excel (spreadsheet) and Word (word processor)—and unspecified basic Microsoft image editing/analysis software (whatever comes bundled with Windows 2000).

The primary file formats used include: ESRI ArcView's seven proprietary formats (SHP, SHX, SBN, SBX, FBN, FBX, PRJ), Adobe's Portable Document Format (PDF), ASCII text (TXT, RTF), Microsoft's proprietary Access (MDB), Excel (XLS) and Word (DOC) formats, TOPO!'s proprietary (TQP) format, and EndNote's proprietary (LIB) format. See question 4b for further discussion of these file formats.

[14] Maschner, op. cit.

D. Addressing the 23 Core Research Questions

1. What activities of the creator have you investigated?

The primary activities of the creator can be divided into four major activities or functions, including:

1. *Administration*: includes financial and human resources management activities, infrastructure management activities, grant writing and oversight activities, etc.
2. *Research*: includes activities directly related to increasing knowledge and understanding of human prehistory in the American Southwest
3. *Preservation*: includes partnership activities between the CDA and private landowners on whose land archaeological sites are found
4. *Education*: includes publication and public outreach activities[15]

This study focused generally on the CDA's research activities, and, more specifically, on the research activities of the CDA's GIS Program Manager and his assistant as they relate to their duties with respect to administering the creation, maintenance and use of the CCD-GIS. As such, this study investigated only a very limited, and to some degree, highly specialized, subset of the creator's overall activities. Consequently, it was necessary, in most cases, to focus on the GIS Program Manager as though he was the creator, and on his CCD-GIS activities as though they were the creator's only activities, rather than attempt to situate both the GIS Program Manager and his specialized activities within the totality of the CDA and its more generalized and diverse activities.

In particular, the key CCD-GIS research activities investigated include: (1) system and database administration and maintenance, including such sub-activities as data input, data error and gap assessment, file management, system access control, and data backup; (2) data transformation (e.g., via algorithms); (3) data isolation, extraction and/or conflation; (3) data analysis; and (4) data output.

Because the generation of new 'raw' or 'base' data is outside the scope of the CDA's Coalescent Communities research project (as noted earlier, the project relies solely on pre-existing archaeological site data), the activities that created the base data used in the CCD-GIS were, for the most part, excluded from consideration in this study.[16] However, activities related to the collection and/or compilation of datasets that were directly carried out by the GIS Program Manager and/or his assistant were included in this study. For the most part, these activities involved either the solicitation of datasets from other researchers and research institutions, or the compilation of datasets using data extracted from published resources.

[15] The latter three functions are explicitly identified on the "About Us" page of the CDA's Web site at http://www.centerfordesertarchaeology.org/pages/about/ (accessed on 23 October 2006).

[16] It is noted, however, that the case study interviewees were questioned about data creation/collection issues in archaeology on a general level, primarily as a means to help assess how these activities might impact on the way archaeologists, in general, view the issues of data accuracy and reliability. More importantly for the purposes of this report, this line of questioning was also used to help gauge the level of importance the interviewees placed on data creation/collection issues vis-à-vis the impact of these issues on the authenticity and reliability of the CCD-GIS and its components.

2. Which of these activities generate the digital entities that are the objects of your case study?

Although all of the above activities are incorporated into and/or impact the design and use of the CCD-GIS, and therefore impact, to varying degree, the creation of the digital entities in question, the activities that directly result in the creation of the entities include the data input, output and backup activities, and certain of the data manipulation activities, such as data isolation, extraction and conflation. Certain other activities, such as those related to administrative processes like deciding who can and cannot access and/or manipulate the data in the system, or deciding which analytical test or approach to use, indirectly influence the creation of the digital entities.

3. For what purpose(s) are the digital entities you have examined created?

The primary purpose of the digital entities examined here is to support archaeological research into the causes, tempo and spatial variability of the conspicuous population decline noted in prehistoric pan-Southwestern cultures of North America beginning circa A.D. 1300 and continuing into the early 15th century. At present, the majority of the research activity that is supported by the CCD-GIS is conducted by archaeologists directly affiliated with the CDA. On occasion, data from the CCD-GIS are also made available upon request to qualified researchers external to the CDA and, as is discussed in more detail in question 7, there are plans to provide greater external access to the CCD-GIS upon completion of the two-year Coalescent Communities research project.

Secondary purposes for the digital entities examined include support for the CDA's education and public outreach activities, primarily in the form of reference material for dissemination activities aimed at both the professional archaeological community (e.g., via conference presentations, scholarly publications, etc.) and the general public (e.g., via the CDA's Web site and its quarterly magazine, *Archaeology Southwest*, as well as via local meetings attended by avocational archaeologists).

4. What form do these digital entities take? (e.g., e-mail, CAD, database)

The digital entities examined consist of database and spreadsheet files, word processing and text files, map and image files, and GIS project files (and their component files).

4a. What are the key formal elements, attributes, and behaviour (if any) of the digital entities?

For the most part, the digital entities studied appear to possess few non-generic[17] (i.e., entity-specific) formal elements and attributes; that is, characteristics considered integral to the validity and completeness (intrinsic elements), and the material make-up and

[17] "Generic" is here used in the sense presented by Duranti and Thibodeau in their discussion about digital document "interactions that are generic possibilities offered by the computer and not specific to a particular document…[which] include selection of documents for retrieval and output, variation in the size of the window in which a document is viewed, magnification, viewing of one or more pages within a window, and accessibility features such as ones that change the size of text or render text aurally rather than visually" (Duranti, Luciana and Kenneth Thibodeau (2006), "The Concept of Record in Interactive, Experiential and Dynamic Environments: the View of InterPARES," *Archival Science* 6(1): 30-31).

external appearance (extrinsic elements) of the entities in question. As well, few, if any, entity-specific behaviours[18] are associated with the entities studied. Instead, the behaviours identified tend to be limited to system-specific, entity-generic behaviours (i.e., those established by, and inherent to, the functional parameters of the software applications that are used to create the entities). That is to say, the behaviours associated with the entities studied tend to be more an expression of the nature of the system(s) in which the entities are created (and, hence, tend to be associated with all entities of the same type or class created by the system, irrespective of their relationship to one another, or entities in other classes created by the same system, vis-à-vis their archival bond) than an expression of an entity-specific behaviour that can be used to help distinguish one entity (or group of related entities that share an archival bond) from other similar entities (or entity groups) not sharing the same archival bond.

Within the ArcView application, the key, non-generic, intrinsic elements noted include:

- the name and extension of the open project file(s), which, while a project is open in the application, are displayed in the title bar of the Project Window (Figure 3 and Figure 4);
- the names/titles of individual component "documents" comprising each project (see question 4b for further description of these component "documents"), which are displayed both in list form in the Project Window (grouped and displayed according to project component), and in the title bar of their corresponding Document Window (when open) (see Figure 3); and
- various elements specific to each open project component such as, for example: map, view and chart legends, keys, titles, orientation elements (e.g., directional arrows), themes (i.e., layers) and labels; table and script fields; and institutional logos.

At a less granular level, it is noted that the digital entities associated with the CCD-GIS consist of basically only two key element types: textual and graphic. The core dataset, which resides in a Microsoft Access database, is represented in text and numeric characters, while the individual project components and their outputs that are associated with the ArcView application are either textual (e.g., tabular data in tables, script files), graphic (i.e., maps, charts and views), or textual and graphic in nature (e.g., layouts depicting both graphic and textual elements, or output maps that may include graphic elements alongside tabulated data elements).

As for non-generic, extrinsic elements, it is noted that within the archaeological site entry form in the Access CCD, there is a special sign that takes the form of the CDA's organizational logo. The GIS Program Manager views this special sign as one that denotes authorship and intellectual ownership of the unique collection of data brought together in

[18] As used in this report, entity behaviour refers to the general manner in which an entity, or related group of entities, interacts with: (a) the system in which the entity resides, including the hardware and software responsible for its creation and/or use; (b) systems external to, yet interacting on some level with, the system in which the entity normally resides; (c) human users of the entity; and/or (d) other related entities within the system in which the entity resides. As a more restrictive subset of this, an entity-specific behaviour refers to a non-generic behaviour that, when assessed in combination with the entity's other elements and attributes, can be used to help distinguish the entity from other entities within the creator's fonds.

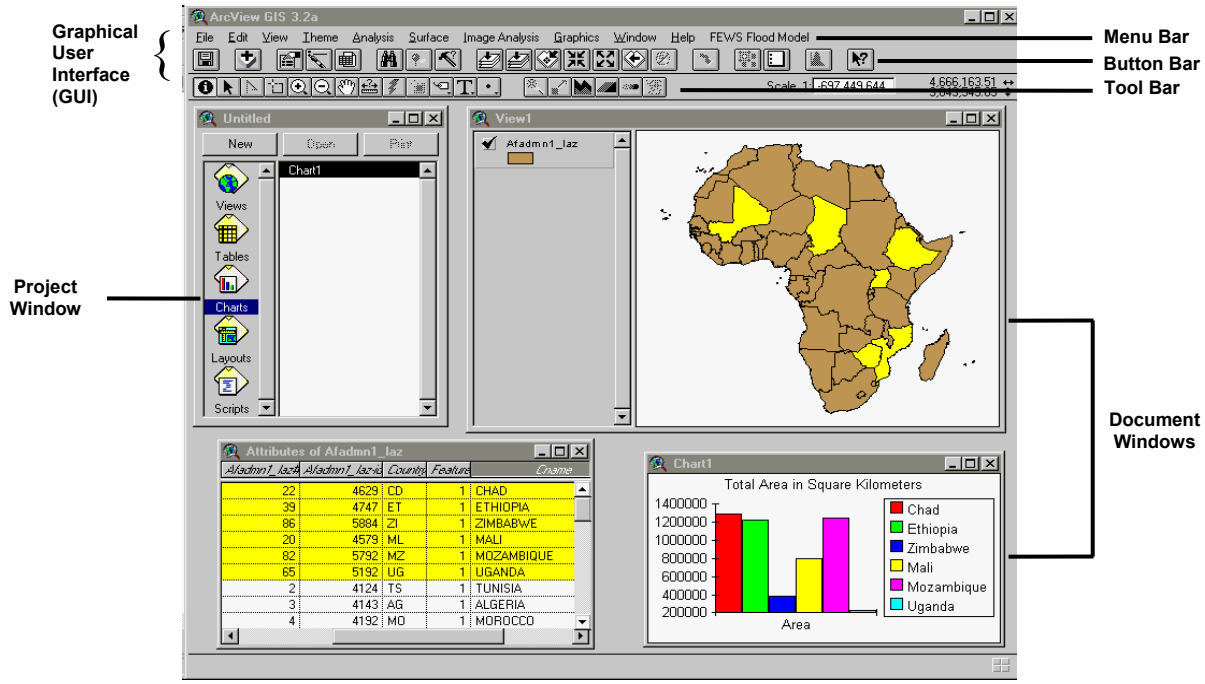

Figure 3. ArcView GIS version 3.2 interface elements

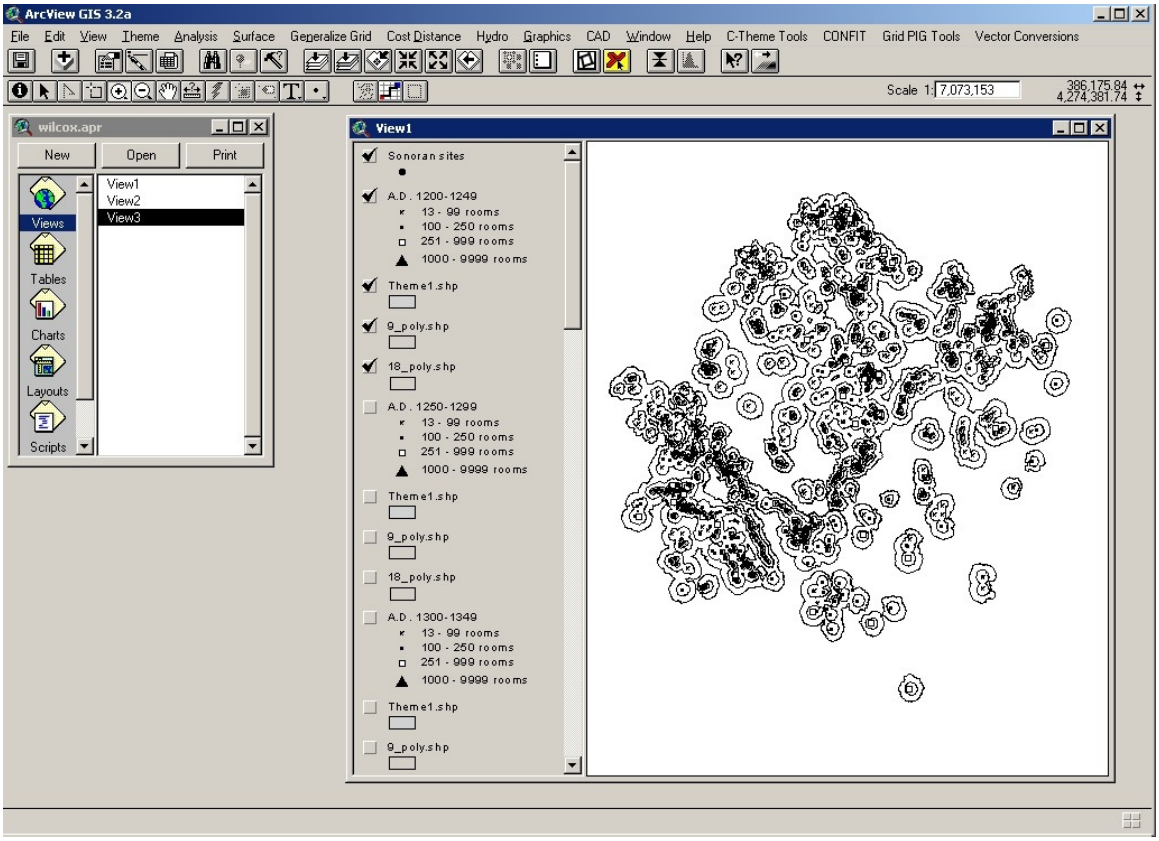

Figure 4. Example of a CCD-GIS project open in ArcView

the CCD.[19] The creator and author is the CDA, but the name of the originator is the GIS Program Manager (who is also the writer). The only other extrinsic elements noted, including medium, script and language, can, to a large degree, be considered generic elements in that they are largely if not entirely pre-determined by the system in which the applications that generate the entities reside, as well as by the inherent (or default) operational parameters of the applications themselves. Thus, for example, English is the only language available in the version of ArcView used by the CDA.

With respect to the behaviour(s) associated with the digital entities, these too tend to be more application-specific than entity-specific and, as such, cannot generally be used to distinguish one digital entity from another, at least not entities within the same type or class (e.g., charts, tables, views). It is worth noting that although individual 'projects' or 'workspaces' (see discussion of project/workspace files in question 4b) reopen in identical form and layout to when they were last closed, that does not necessarily mean nor guarantee that what is presented to a user upon reopening a project/workspace file is identical to what the last user saw. In fact, depending on the exact architecture of the system, the actual content presented to a user each time a project is opened can conceivably vary considerably. For example, because ArcView is capable of supporting an SQL connection to interface directly with an MS Access database via the ArcView Dialog Designer Extension in concert with Avenue script, the data used to generate the visual representations of each project component (e.g., charts, tables, views, etc.) can reside in a database that is external to the ArcView application, but which is dynamically linked to the various project components via the SQL connection. In this scenario, the results of an SQL query against the Access database are stored in an ArcView virtual table that can be joined, linked and summarized in relation to any other project component just like any 'standard' ArcView table. Thus, if any of the corresponding data in the external database are modified while an ArcView project is closed, those changes will be immediately and automatically reflected in any and all corresponding project components that are linked to those data the next time the project is opened, resulting in a different instantiation of the project than existed the last time the project file was closed. It also appears possible for users to alter the subsequent presentation of a closed project simply by modifying the individual project component files (e.g., the .dbf file, which stores the attribute data of features in dBASE format—see question 4b).

However, in the system examined for this report, the Access CCD was not directly linked to the ArcView application via an SQL connection. Instead, data required for analysis purposes in ArcView were exported from the Access CCD and subsequently imported into ArcView, often after being subjected to an intermediate step involving algorithm manipulation inside an Excel spreadsheet. Thus, a project should reopen in identical form and layout, and with the same content, as when it was last closed, unless the GIS Project Manager (or his assistant) were to modify the individual component files of the project directly while outside of the ArcView application.

[19] It is important to emphasize that this attribution of authorship and intellectual ownership refers specifically to the totality of the CCD, as opposed to the individual data values or datasets within the CCD, since it is the individuals and institutions associated with the original creation/collection of the data who are still considered the authors and intellectual owners of those data even after they is imported into the CCD.

Two key things to note with respect to the above-noted relative absence of formal and consistently utilized or applied elements, attributes and behaviours associated with the digital entities in question are that the procedural context for their creation is neither rigid nor always predetermined, and that the overall level of systematization of the GIS Program Managers' activities is low, resulting in a process for creating and maintaining these entities that is most accurately characterized as both idiosyncratic and ad hoc. These procedural realities are largely due to the fact that only one individual (with limited assistance from a volunteer) is responsible for the creation and day-to-day maintenance of the CCD-GIS, coupled with the fact that this activity takes place within the context of a relatively small, private, non-profit organization with identifiable financial and human resource constraints.

4b. What are the digital components of which they consist and their specifications?

The digital entities examined consist of the following digital components:[20]

ArcView 3.2 GIS project file components

All activity in ArcView 3 takes place within *project* (sometimes also referred to as *workspace*) files, which are used to manage the creation and storage of the various individual files related to a particular undertaking or 'project.'[21] A project file organizes its component files and stores the unique settings for each file in an ASCII format ODB (object database) file with the extension .apr. Because the project file is stored in ASCII format, it can readily be opened and modified using a text editor such as Notepad or WordPad. In ArcView, each project uses several basic types of component "documents" to organize project information, including:

- Views: Essentially a map, based on one or more *themes*, that the system presents to the user.
- Themes: Sets of spatial and attribute data about related geographic features (e.g., prehistoric trails, stream beds, etc.). Themes in ArcView 3 are similar to *layers* in ArcGIS 8.
- Table: Tabular data organized by rows and columns. Usually, each row corresponds to a specific geographic location, linked by a unique ID to specific theme features, while each column describes an attribute (i.e., characteristic) of each geographic location.
- Charts: Business-type graphics used to display geographic and/or tabular data.
- Layouts: Graphic outputs and/or screen displays of views, tables and charts.
- Scripts: Instructions used to provide customization and/or automation of various aspects of a project.

Figure 3 shows the various elements of the basic ArcView GIS version 3.2 interface. Figure 4 provides an actual example of an open project from the CCD-GIS. In this case,

[20] For the purposes of this report, a 'digital component' is defined as "a digital object that is part of one or more electronic records, including any metadata necessary to order, structure, or manifest the content, requiring a given preservation action" (InterPARES 2 Terminology Database http://www.interpares.org/ip2/ip2_terminology_db2.cfm, accessed 24 October 2006).
[21] As used in the context of ArcView, a project is synonymous with what is sometimes referred to as a "workspace."

the file name for the project's .apr file is "wilcox.apr," as in indicated in the title area of the Project Window.

In reality, each of these "document" components actually functions as a pointer to data stored in one or more of the following individual shapefiles[22]:

- .dbf—stores the attribute data of features (dBASE format)
- .shp—stores the feature geometry data
- .shx—stores the index of the feature geometry
- .sbn, .sbx—stores the spatial index of the features for read-write shapefiles
- .fbn, .fbx—stores the spatial index of the features for read-only shapefiles
- .prj—stores the coordinate system data (projections definition file)

Data are retrieved from these files in real time whenever the user selects a 'document' (e.g., Views) and 'sub-document' (e.g., View1) and clicks the 'Open' button in the Project Window (see Figure 4). In fact, all digital components in a project are dynamically related such that whenever a user changes one part in one of the components, all other related parts in the corresponding component files are automatically updated accordingly.

Text Components

Outside of the Microsoft Access database and ArcView GIS application, text is generated in up to four different formats, including: (1) MS Word's proprietary .DOC format, (2) Adobe's proprietary Adobe Portable Document Format (.PDF) and (3) two types of ASCII (American Standard Code for Information Interchange) text—rich text (.RTF), which are ASCII files that include certain formatting instructions related to screen-display and printing, and plain text (.TXT), which does not include formatting instructions. The ASCII text files typically are generated using the Notepad application that is part of the Windows operating system.

Database Components

The GIS Program Manager uses Microsoft Access (version not specified), a commercially-available relational database software application, to store the core CCD dataset in the proprietary Access ".mdb" file format.

Spreadsheet/Flat File Components

As noted earlier, data extracted from the Access CCD for analysis purposes are often subjected to an intermediate step involving algorithm manipulation inside a Microsoft Excel (version not specified) spreadsheet, resulting in a proprietary Excel ".xls" file format, before being imported into ArcView.

EndNote (version not specified), a commercially-available bibliographic software application, is used "quite a bit"[23] by the GIS Program Manager, resulting in a proprietary ".lib" file format.[24]

[22] Shapefiles are vector format files that store various characteristics of the geometric location and attribute data of geographic features.
[23] Interview B, line 1392.

Graphic/Image Components

It appears that most, if not all, image files are rendered in jpeg (Joint Photographic Experts Group) format, a lossy compression format for images. The jpeg format is now ISO standard *Digital Compression and Coding of Continuous-tone Still Images, Part 1: Requirements and Guidelines* (ISO/IEC IS 10918-1). The jpeg format appears to have a baseline specification, from which additional extensions are added, which may or may not be supported by supporting applications.[25]

A commercially-available map viewing and manipulation software application called TOPO! Interactive Maps (version not specified),[26] is used "fairly often"[27] by the GIS Program Manager. This software allows users to view and manipulate pre-scanned or digitized USGS and National Geographic maps supplied by the software vendor on separate CD-ROMs. Manipulation functionality includes adding custom routes, waypoints, icons and text as map overlays that can be saved in a proprietary TOPO! file. The maps and overlays can be viewed or printed at any of the supplied scales. Apparently, it is also possible to copy selected maps or views to the clipboard or to a file for use with other programs.

The maps on the TOPO! CD-ROMs are stored in a proprietary ".tpq" file format that utilizes true 24-bit colour imaging and a 3-layer system that incorporates the topographic map along with hillshade and DEM elevation data georeferenced to the map at the pixel level. A separate TOPO! add-in or extension is available that allows ArcGIS users to import the proprietary .tpq format into an ArcGIS project and treat it just like any other raster image format, such as .tif or .jpg. This extension also allows users to access the three layers in the .tpq files as separate layers.[28] However, it is not clear whether this separate TOPO! ArcGIS extension is, in fact, available to and used by the GIS Program Manager.

4c. What is the relationship between the intellectual aspects and the technical components?

The record creator forms this relationship in an ad hoc and personal fashion. It is a dynamic relationship that cannot be thoroughly described. More specifically this interaction relates to a researcher interacting with technology to augment the complexity and accuracy of the results to their research questions.

4d. How are the digital entities identified (e.g., is there a [persistent] unique identifier)?

Digital entities are identified through file naming conventions (for both the files themselves and the folders in which they reside) that are idiosyncratic and often ad hoc.

[24] For more information about EndNote, see http://www.endnote.com/.
[25] See "JPEG Compression" at http://netghost.narod.ru/gff/graphics/book/ch09_06.htm#JPCO and "JPEG File Interchange Format" at http://netghost.narod.ru/gff/graphics/summary/jfif.htm.
[26] This software application has since been acquired by National Geographic. For more information about Topo!, see http://www.natgeomaps.com/topo.
[27] Interview B, line 1395.
[28] For more information about Topo! Pro for ArcGIS, see http://www.topopro.com/arcgis.asp.

No systematic or documented file naming process exists. For the most part, file names are descriptive with different versions identified through the use either of a date (e.g., the date that a file was created or last modified) or a sequential number appended to the end of the descriptive file name (e.g., Coalescent Communities 171703.mdb, site XX slope file_1.xls, site XX slope file_2.xls). Aggregations of files within certain folders can also create an associative identity of their own.

4e. In the organization of the digital entities, what kind of aggregation levels exist, if any?

Aggregations usually form at the file level and relate to specific analyses or projects. The Coalescent Communities Database is also an aggregation itself at the series level.

4f. What determines the way in which the digital entities are organized?

The digital entities are organized with regard to projects that utilize the CCD-GIS for purposes of archaeological research. The database is a problem- or project-specific database that answers research questions. Within these projects, the raw data are organized by 50-year time intervals. For example, all of the site location files are organized into folders by their corresponding time interval. This temporal organization eases analysis in terms of patterns observed over time.

5. How are those digital entities created?

This answer presents difficulty because of the ad hoc nature of the system and the variety of activities that are carried out through the GIS. Provided below is a general process of creation for the different entities in question.

Creation of the Coalescent Communities database in MS Access

The Coalescent Communities database was first created with information from three archaeologists' core datasets. These datasets represented research and work conducted over many years and the information came from a variety of sources (publications, archaeological fieldwork, site records in repositories and from several archaeologists' datasets). In addition to these datasets a large portion of the data came from AZSITE,[29] a preexisting GIS. Once the datasets had been placed into the Coalescent Communities database in Microsoft Access, the issue of accuracy, redundancy and patchiness needed to be addressed. These datasets were created for different purposes and therefore did not create a holistic picture of the archaeological setting of the Southwest between A.D. 1200-1540. To fill in gaps, a volunteer conducted extensive research at different repositories to obtain archaeological site information in spots that were not represented in the current database. The volunteer also weeded out any information that seemed inaccurate. Once the database was acceptable, the analysis of the site information could begin. To conduct specific spatial and temporal analysis, the data had to be copied and segmented into 50-year time intervals for each type of file.

[29] AZSITE (http://www.azsite.asu.edu) is a consortium made up of the Arizona State Museum, Arizona State University Department of Anthropology, the Museum of Northern Arizona, and the State Historic Preservation Office. These four agencies have created this a statewide GIS regarding archaeological sites, surveys and archaeological districts. The main goal was to create a shared form of management and use of the large amount of cultural resource information within the state of Arizona.

Creation of the GIS in ArcView

To conduct analyses within ArcView, spatial data about the geographical extent needed to be gathered from government Web sites. Digital Elevation Models (DEMs) were downloaded to obtain the elevation of the area in question.

Use of the GIS is usually dictated by a specific question or project, so a specific problem will be addressed and a Project file will be created within ArcView. Within these Project files, you can import data that can be viewed in multiple Views within each Project. Data from the Coalescent Communities database is converted into a Microsoft Excel .xls file and imported into ArcView as a .shp file. Once the data are present, they can be manipulated and viewed in different ways. Usually there is an analytic part of the project where different extensions that can be downloaded into ArcView can be used to conduct statistical and other mathematical analysis. The resulting data create a map that can be printed and attached to tabular data which are then exported out of ArcView back into a Microsoft Excel .xls file.

5a. What is the nature of the system(s) with which they are created? (e.g., functionality, software, hardware, peripherals, etc.)

The Coalescent Communities Database is maintained in Microsoft Access. Tables, or portions of data extracted from tables in the database, are sometimes exported into Microsoft Excel for further manipulation before being imported into ArcView.

ArcView, an ESRI product, is the software platform for the GIS. This software creates .shp, .shx, .dbf, .sbn, .sbx, .fbn, .fbx and .prj files.

Peripherals include plotter printers that are sometimes used to print large scale, color maps from the GIS. A digitizer tablet, which digitizes archaeological sites from paper-based maps, is also sometimes used.

5b. Does the system manage the complete range of digital entities created in the identified activity or activities for the organization (or part of it) in which they operate?

No. The GIS is a system that is not comprehensive in its management of information. The GIS consists of a database within Microsoft Access, image files, word processing files, flat files in Microsoft Excel, and files created in the GIS application software that are all managed separately due to their separate computing environments, file formats and formal differences in content, context and structure.

6. From what precise process(es) or procedure(s), or part thereof, do the digital entities result?

This is difficult to answer precisely because the procedures that go into creating these digital entities are not clearly defined or delineated by the creator. Generally speaking, they result from inquiries regarding the archaeological record relating to the specific time and place relevant to the GIS. The process of conducting research and analyzing findings from the archaeological record are the core processes relating to the creation of the GIS.

7. To what other digital or non-digital entities are they connected in either a conceptual or a technical way? Is such connection documented or captured?

The Coalescent Communities database is related to the AZSITE database, which has tried to digitize all archaeological sites and surveys in the state of Arizona that are held in federal, state and tribal repositories. AZSITE is a GIS that has been created to store information relating to archaeological sites documented in the state of Arizona. The two databases are related because the CDA obtained a lot of the raw archaeological data from AZSITE in the beginning stages of the project and "cleaned up" a lot of the data by comparing them to other researcher's data and eliminated the introduced error that was present in the AZSITE database. This introduced error consisted of gaps in data, duplicates, incorrect locational information and assemblages and analyses that were inconsistent with those of the Center. Once the Coalescent Communities Project is at a somewhat completed state, the CDA will share the database with AZSITE. Thus, AZSITE's very large GIS is connected to the CCD-GIS. This connection is not formally documented and not particularly significant except as a comparison of methods of approach to geospatial data management within archaeology.

The Coalescent Communities database is also connected to the core datasets of three researchers. Each of these senior archaeologists has collective datasets from his/her extensive archaeological field research in the American Southwest. These datasets are both digital and non-digital and are quite varied in form and detail. These three datasets are very crucial to the development and refinement of the GIS. The documentation of this relationship is in its formative stages. The CDA is beginning to link the archaeological data to its source (repository, researcher, project, etc., for each archaeological site entry in the database).

The organization will indicate these source relationships within the Coalescent Communities database in its own separate field which would indicate what repository or researcher generated the data. In addition to the core datasets of these three researchers and the spatial data uploaded from the AZSITE database, there is another component: the (primarily paper) archaeological site information from old site records and publications that the volunteer for the GIS has gathered separate from the other datasets. This information is usually acquired for two reasons: (1) either there is missing data that the volunteer knows should be there and goes looking for it in different repositories (usually the Arizona State Museum), or (2) that there is current site information in the database that is suspect and needs to be corrected. The volunteer will find documentation that resolves the discrepancies and will replace the data with any new findings.

This database is also linked to federal spatial data that the GIS Program Manager obtains mainly from the World Wide Web. These are usually Digital Elevation Models (DEMs) or other large core layers of data that are needed to accompany the archaeological spatial data (things like jurisdictional boundaries, waterways, vegetation cover, etc.).

8. What are the documentary and technological processes or procedures that the creator follows to identify, retrieve, and access the digital entities?

This consists of the process of indexing the files by their specific time period and project. The files are either stored on the GIS Program Manager's personal computer or the organization's server and are retrieved as needed for various projects.

9. Are those processes and procedures documented? How? In what form?

These processes are not documented right now. If the database and resulting GIS grow larger in the future, then the record creator will create a procedures manual. Currently, there are only two people who use the data regularly; consequently, in the opinion of the GIS Program Manager, a procedures manual does not seem necessary at this point.

10. What measures does the creator take to ensure the quality, reliability and authenticity of the digital entities and their documentation?

The GIS Program Manager attempts to use the most reliable sources of information possible, such as published government spatial data and research data that are the most reliable in the field. The research data's reliability is based on professional authority and verification from experts in specific areas of archaeology.

Throughout the process of creating the database, spot checks are being conducted on the dataset to ensure that data are being entered accurately. In general, it is difficult to deduce if the record is authentic in some sense of the word. Archaeological data that are used are usually coming from trusted sources where the records are held in a repository. Other times, the records are coming directly from a researcher's personal computer. There is usually a preliminary audit stage where the GIS Program Manager checks the dataset as a whole to see if it is generally reliable and authentic. In addition, the volunteer checks these aspects of the dataset in a more thorough manner with his expertise in the field being a strong factor in effectively probing the dataset. Archaeologists know that their data are not 100% reliable to fact, due to the nature of the archaeological record, so there is a degree of reliability that needs to be met before the data are considered "usable."

11. Does the creator think that the authenticity of his digital entities is assured, and if so, why?

"Spatial information in the United States has given more attention to data quality and spatial accuracy than to authenticity."[30]

The GIS Program Manager discerns that the records are authentic, to an acceptable degree for the research that is being conducted. There is more concern over the reliability and accuracy of the records than their authenticity. Authenticity is assumed to a reasonable degree since records are coming from a state repository or from datasets contributed by researchers who are trusted as professionals to maintain their data. There is skepticism to these sorts of qualities due to the nature of archaeological activities. Many archaeologists never see their work complete because the archaeological record is viewed as a compilation, not discrete units of information and as a group becomes knowledge.

12. How does the creator use the digital entities under examination?

The GIS Program Manager uses the digital entities to make conjectures relating to archaeological research and site management questions. For example, he uses the archaeological data in the

[30] Patrick McGlamery (2001), "Issues of Authenticity of Spatial Data," *INSPEL* 35(2): 139.

CCD-GIS, and the maps generated from those data, to predict the location of other archaeological resources as well as to track and or predict archaeological site vandalism and the possible need for site preservation.

13. How are changes to the digital entities made and recorded?

There is a basic versioning process that is used on the Coalescent Communities Database, but it is not entirely systematic. Once there is a large upload of corrections or newer data from researchers, the GIS Program Manager will save a version of the old database and start working with the newer database. There is no audit trail that tracks who enters what data into the database (however, there currently are only two individuals who perform this activity). According to the GIS Program Manager, the current system is "too low-tech" to be able to accommodate the means for tracking these sorts of data manipulations.

14. Do external users have access to the digital entities in question? If so, how, and what kind of uses do they make of the entities?

External researchers can see the CCD-GIS data; however, in most, if not all cases, external researchers are only provided with a fixed copy of the information they request (e.g., a printed map and associated tabular data or a locked database). Due to the sensitive nature of the data (archaeological site location), use is limited to competent persons that need to use the data for purposes relevant to the dataset. Currently, no one else has access to the actual application, only hard copies of the data.

15. Are there specific job competencies (or responsibilities) with respect to the creation, maintenance, and/or use of the digital entities? If yes, what are they?

Yes, but they are not mandated in a specific policy document. Both the GIS Program Manager and the volunteer have PhD's in archaeology. In addition, they both possess specialized knowledge necessary for their tasks and responsibilities relating to these records. This level of expertise in the field would be required for the activities relating to the records in question.

16. Are the access rights (to objects and/or systems) connected to the job competence of the responsible person? If yes, what are they?

No. Access privileges to the system and the data in the system are ad hoc and are decided on a case-by-case basis. In most cases, if someone in the organization wants to see the dataset(s), they are allowed to as long as they have a valid reason to do so. However, only the GIS Program Manager and the volunteer are able to both view and manipulate the data in the system.

17. Among its digital entities, which ones does the creator consider to be records and why?

The GIS Program Manager believes that the GIS is a record once the findings and data in it are published in a journal article or monograph. To come to the point of publication, the creator has

to "come to a meaningful anthropological conclusion about something…when I write that up and send it away and hopefully it gets published that would be my definitive answer."[31]

In addition, the GIS Program Manager treats the various versions of the Coalescent Communities database as records when they are purposely set aside during the course of business. These set-aside versions of the database fulfill both a backup function (e.g., for system recovery in the event of a disaster or to recover from a corrupted file) as well as "roll-back" function that enables the GIS Program Manager to return to a previous version of the database should it later be discovered that new data that have been added to the database in the interim are inaccurate or corrupt.

18. Does the creator keep the digital entities that are currently being examined? That is, are these digital entities part of a recordkeeping system? If so, what are its features?

The GIS Program Manager retains the digital entities, but not in a separate, formal recordkeeping system; rather, the documentary procedures mirror the business procedures and the recordkeeping system is ad hoc in its formation and maintenance. The entities are maintained on either the GIS Program Manager's personal computer, the organization's server and/or copied onto CD-ROMs.

18a. Do the recordkeeping system(s) (or processes) routinely capture all digital entities within the scope of the activity it covers?

No. There are voluminous intermediary files that are created during the course of the research that are discarded once the calculation is completed or the research question has been fully answered. In part, the rationale for not preserving the intermediary files is because they are easily recreated, if needed, and in part because they embody a function of the analytical process that the creator goes through, a process that the creator suggests will invariably change over time. The essence of this latter point is best expressed in the following interview excerpt by the GIS Program Manager in response to a question about the intermediary files he creates and their relationship to the outcomes of his GIS research:

> I guess I don't ascribe a lot of value to those intermediary documents for the most part, because they're easily recreated...Whenever I'm trying to teach somebody about GIS, people will say, here's the data I have and here's what I want to get to. And the first [thing] that I always [say]—my first caveat that I offer them is, if you ask ten different GIS people, they'll tell you ten different ways to get there. Each one of those different ways will produce different intermediary files, and so I don't think, for the most part, that those things have much value. Like I said, they're easy to reproduce, if I did want to, I could always make another slope file, if I lose one or something.[32]

[31] Interview B, lines 2109-2111.
[32] Interview B, lines 1472-1480.

Moreover, in so far as these intermediary files are used to customize the GIS application—for example, creating a cost surface algorithm macro to calculate how many joules it takes to walk *x* amount of distance—the creator feels that it is pointless to try to preserve these types of files because, as he notes, "any of the other [customization] stuff we did that was dependent on the GIS is no longer valid, is no longer useful because we have a different system that won't read those files. So, the raw data is still there and it's still useful, but the GIS in a sense that these things were integrated in some way and we could press a button that would show how far a person could walk—that's no longer useful."[33] "The techniques that I went through and the fallacies of my data are going to be irrelevant because 50 years from now, 100 years from now, somebody is going to tell their computer to calculate cost surface. So that I really doubt anybody is going to care [if I bothered to preserve my intermediary cost surface file]."[34]

Finally, it is important to note that the recordkeeping environment is dispersed and so some entities may go unaccounted for due to the nature of the system.

18b. From what applications do the recordkeeping system(s) inherit or capture the digital entities and the related metadata (e.g., e-mail, tracking systems, workflow systems, office systems, databases, etc.)?

There is no recordkeeping system external from the applications, so there is no formal capture activity. There are numerous capture activities within the GIS. Other than other elements of the Microsoft Office Suite, there are no collective capture tools for the information within the GIS. Groups of data are captured temporarily within the GIS application, ArcView while analysis is being conducted, but then is exported to its appropriate areas outside of the GIS application (usually Microsoft Excel or Access files).

18c. Are the digital entities organized in a way that reflects the creation processes? What is the schema, if any, for organizing the digital entities?

The digital entities are usually organized by project, which does mirror the majority of the creation process, which is project- or problem-focused. Data are usually created in relation to a project and the filing schema is not significantly altered once the project has been completed.

18d. Does the recordkeeping system provide ready access to all relevant digital entities and related metadata?

No. As mentioned earlier, the recordkeeping environment is a dispersed one that does not provide organized access. The GIS Program Manager is the intermediary between the files when access is needed, especially because the majority of the files are in the file directory or on the hard drive of the creator.

[33] Interview B, lines 1730-1735.
[34] Interview B, lines 1503-1506.

18e. Does the recordkeeping system document all actions/ transactions that take place in the system re: the digital entities? If so, what are the metadata captured?

No. There is no audit trail. The GIS Program Manager is in the process of creating metadata relating to the source of the data, including the original author, date of recording, etc.

19. How does the creator maintain its digital entities through technological change?

The organization is actively migrating the files to newer versions of software (primarily Microsoft suite software as well as a newer version of ESRI ArcView). This is the most that they are addressing in terms of software and hardware obsolescence.

19a. What preservation strategies and/or methods are implemented and how?

Besides burning data to CD-ROMs, there are no systematic preservation strategies in place.

19b. Are these strategies or methods determined by the type of digital entities (in a technical sense) or by other criteria? If the latter, what criteria?

The reason they are migrating data is for reasons of usability. Sometime soon, the records would not be useable if they were maintained and manipulated only in ArcView 3.2 and Windows 98. Thus, at the time of the interview, migration was being conducted solely to address current usability concerns and not long-term preservation concerns.

20. To what extent do policies, procedures, and standards currently control records creation, maintenance, preservation and use in the context of the creator's activity? Do these policies, procedures, and standards need to be modified or augmented?

Not to a great extent. Due to its size, structure and organizational culture, the organization does not rely on procedures in a formalized sense—they are inferred. The inferred processes probably do persuade the way records are created, but it is hard to document this relationship.

21. What legal, moral (e.g. control over artistic expression) or ethical obligations, concerns or issues exist regarding the creation, maintenance, preservation and use of the records in the context of the creator's activity?

On a daily basis, there are not overwhelming ethical issues that arise in this research activity, but there are many overriding professional ethical concerns that govern certain practices within the North American archaeological community. Practicing culturally-sensitive archaeology and protecting archaeological site location information are two of the most important issues within these ethical concerns. There can be legal ramifications relating to archaeological research that would include things such as land claims (including resources on that land), cultural heritage claims (including repatriation of artifacts).

For a detailed description of the legal issues facing the case study, see the discussion of the juridical context, above, as well as Appendix B.

22. What descriptive or other metadata schema or standards are currently being used in the creation, maintenance, use and preservation of the recordkeeping system or environment being studied?

None right now. They are interested in using ArcCatalogue, a metadata tool that is in the new version of ArcView.
The GIS Program Manager's main goal relating to metadata capture at time of the interview surrounded source information relating to the data in the Coalescent Communities database. The metadata would be used to indicate from what sources (publication, repository, Web site, database, etc.) the data were obtained.

23. What is the source of these descriptive or other metadata schema or standards (institutional convention, professional body, international standard, individual practice, etc.?)

Within ArcCatalogue, the user could create, manage and edit metadata based on the Federal Geographic Data Committee (FGDC) Content Standards for Digital Geospatial Metadata or the ISO 19115 Metadata Standard. These metadata would be stored in XML.[35]

The capture of archaeological site source information is just an in-house decision that is not based on any metadata standard. The GIS Program Manager hopes that capture of this information will improve the reliability of the database as a trusted source of archaeological information.

[35] ESRI. (2003). Spatial Data Standards and GIS Interoperability, 3.

E. Bibliography of Relevant Sources

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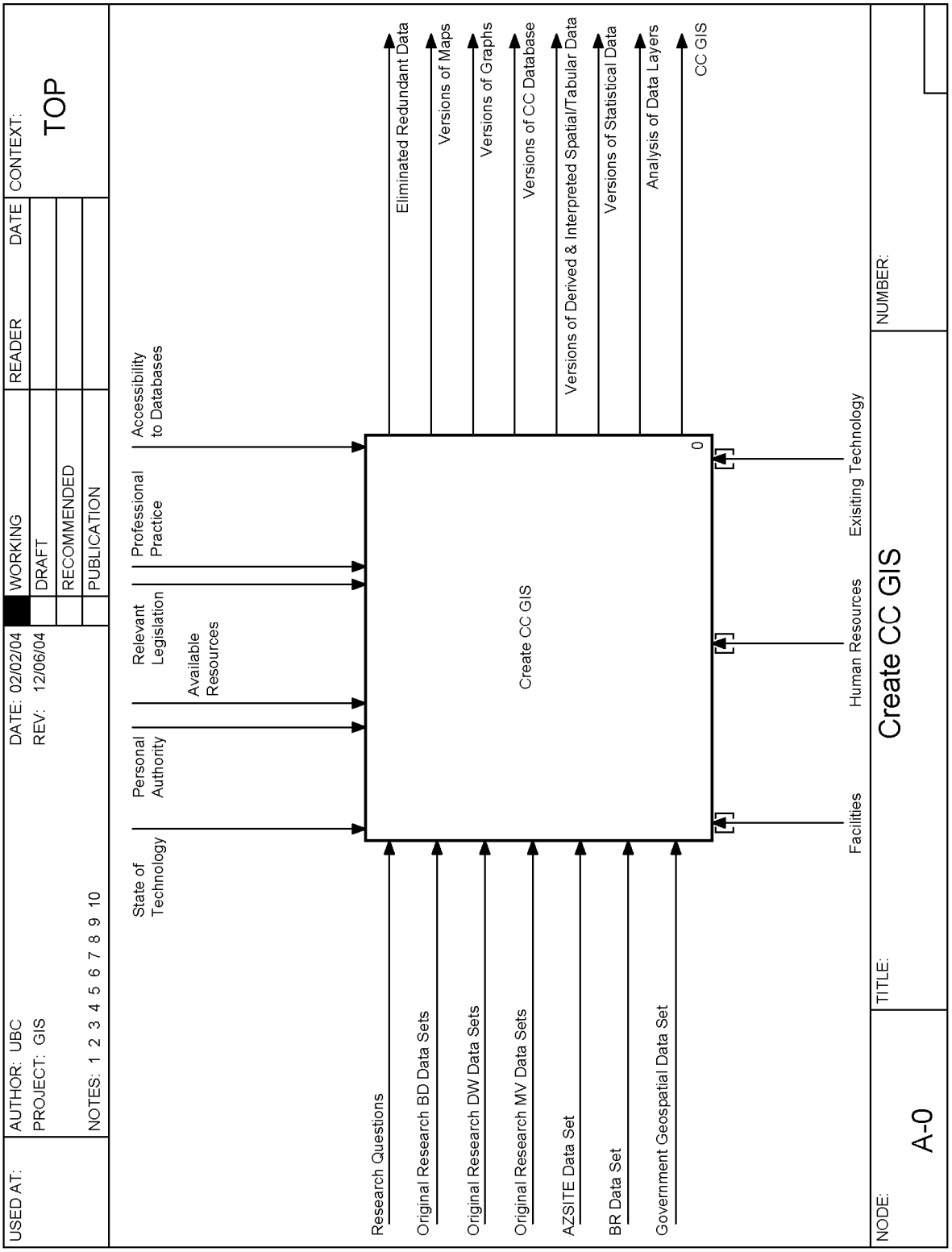
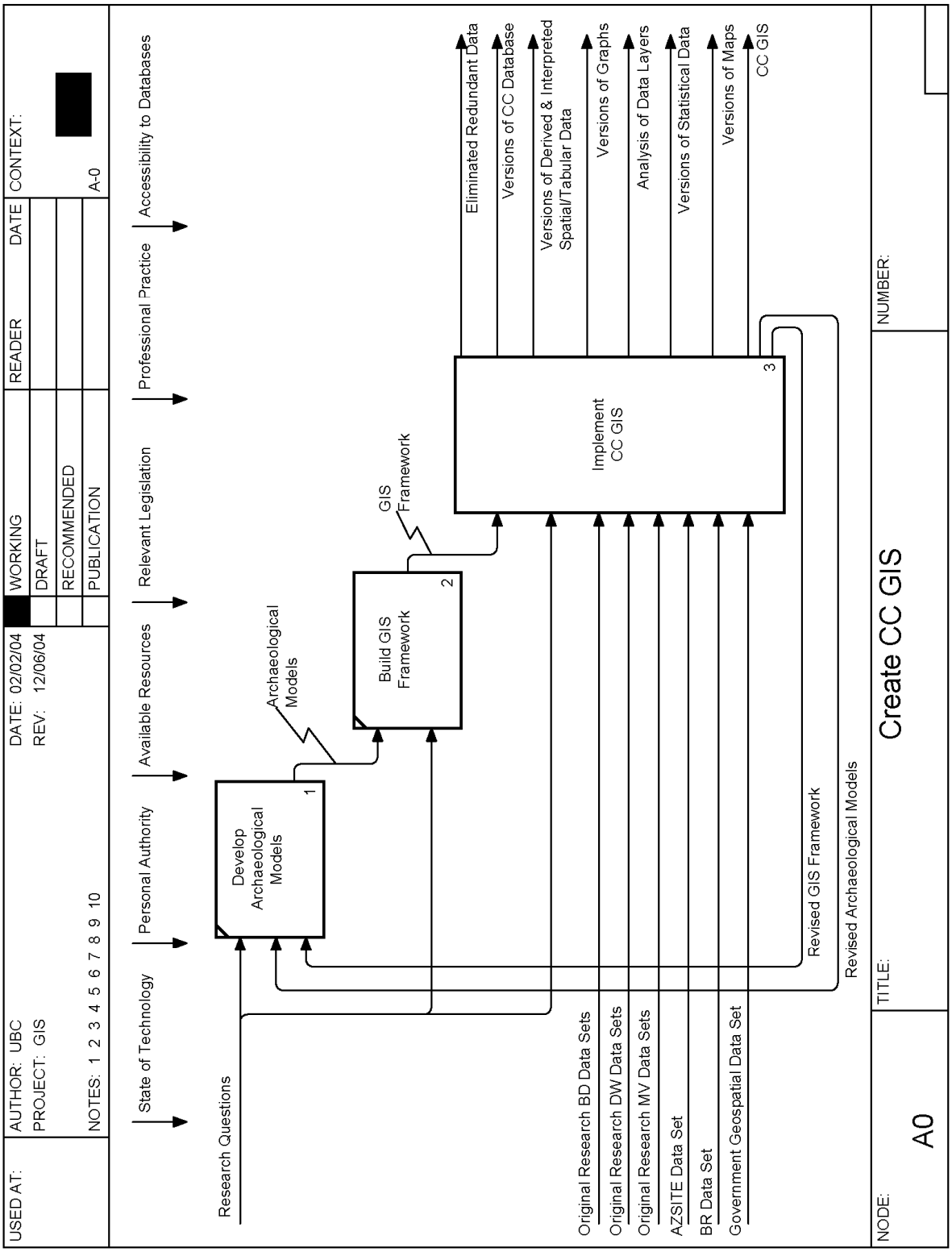
F. IDEF0 Activity Model

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Available Resources
Relevant Legislation
Professional Practice
Accessibility to Databases
Research Questions
Develop Archaeological Models
1
Archaeological Models
Build GIS Framework
2
GIS Framework
Implement CC GIS
3
Eliminated Redundant Data
Versions of CC Database
Versions of Derived & Interpreted Spatial/Tabular Data
Versions of Graphs
Analysis of Data Layers
Versions of Statistical Data
Versions of Maps
CC GIS
Original Research BD Data Sets
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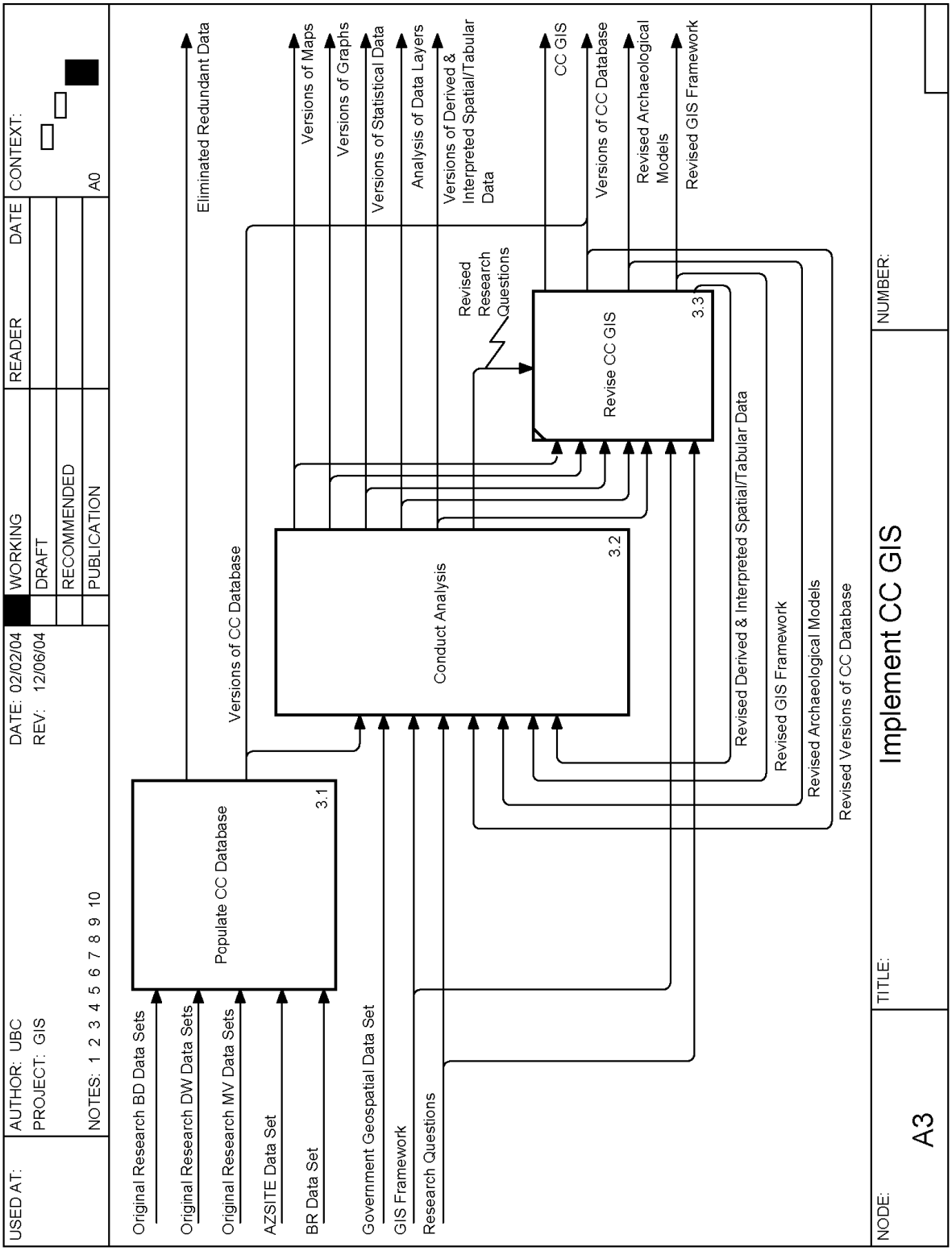
Original Research MV Data Sets
AZSITE Data Set
BR Data Set
Government Geospatial Data Set
Revised GIS Framework
Revised Archaeological Models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NUMBER:
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Original Research MV Data Sets
AZSITE Data Set
BR Data Set
Government Geospatial Data Set
GIS Framework
Research Questions
Populate CC Database
3.1
Eliminated Redundant Data
Versions of CC Database
Conduct Analysis
3.2
Versions of Maps
Versions of Graphs
Versions of Statistical Data
Analysis of Data Layers
Versions of Derived & Interpreted Spatial/Tabular Data
Revised Research Questions
Revise CC GIS
3.3
CC GIS
Versions of CC Database
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Revised GIS Framework
Revised Derived & Interpreted Spatial/Tabular Data
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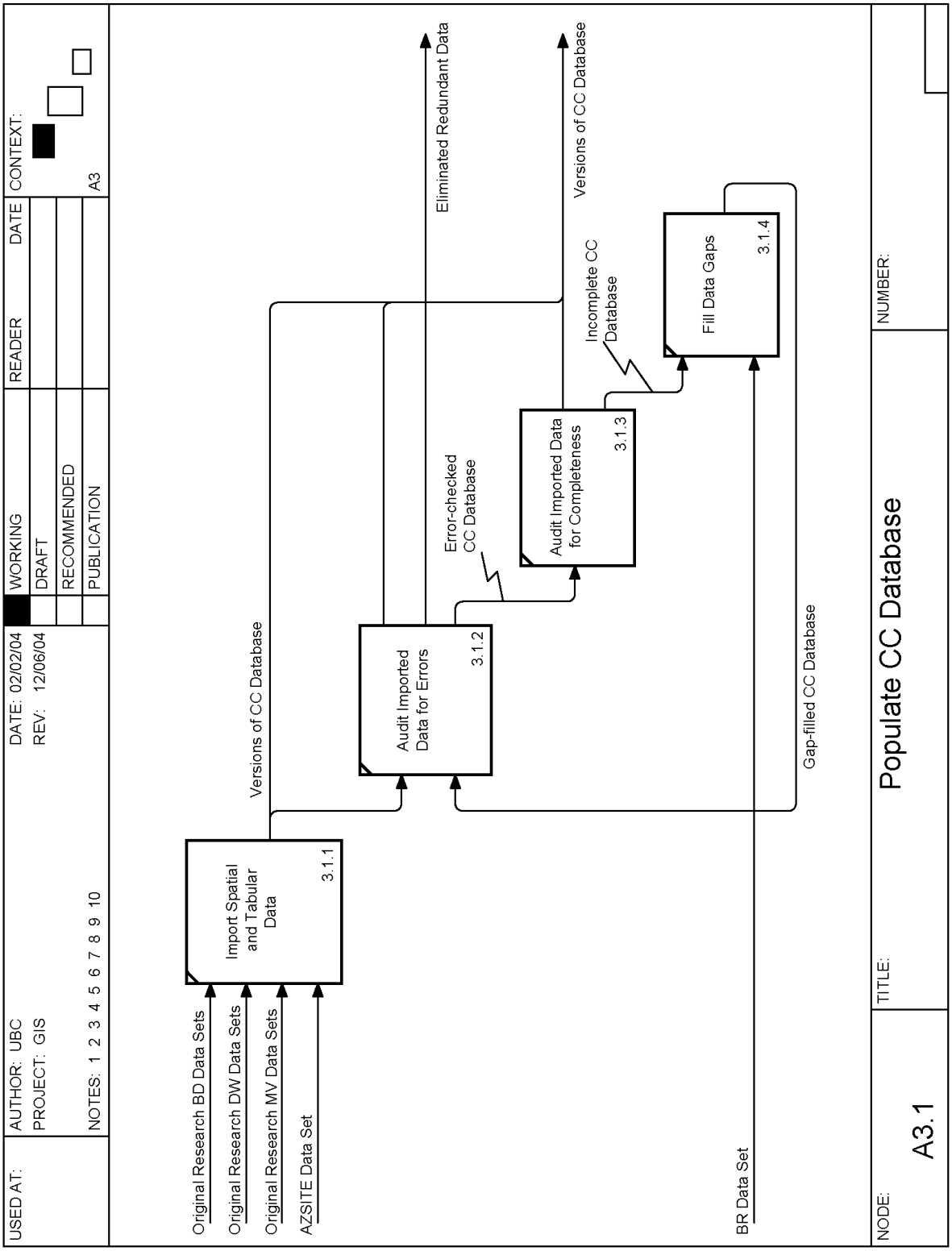
Revised Versions of CC Database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Original Research BD Data Sets
Original Research DW Data Sets
Original Research MV Data Sets
AZSITE Data Set
Import Spatial and Tabular Data
3.1.1
Versions of CC Database
Audit Imported Data for Errors
3.1.2
Eliminated Redundant Data
Error-checked CC Database
Audit Imported Data for Completeness
3.1.3
Versions of CC Database
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Fill Data Gaps
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Gap-filled CC Database
BR Data Set
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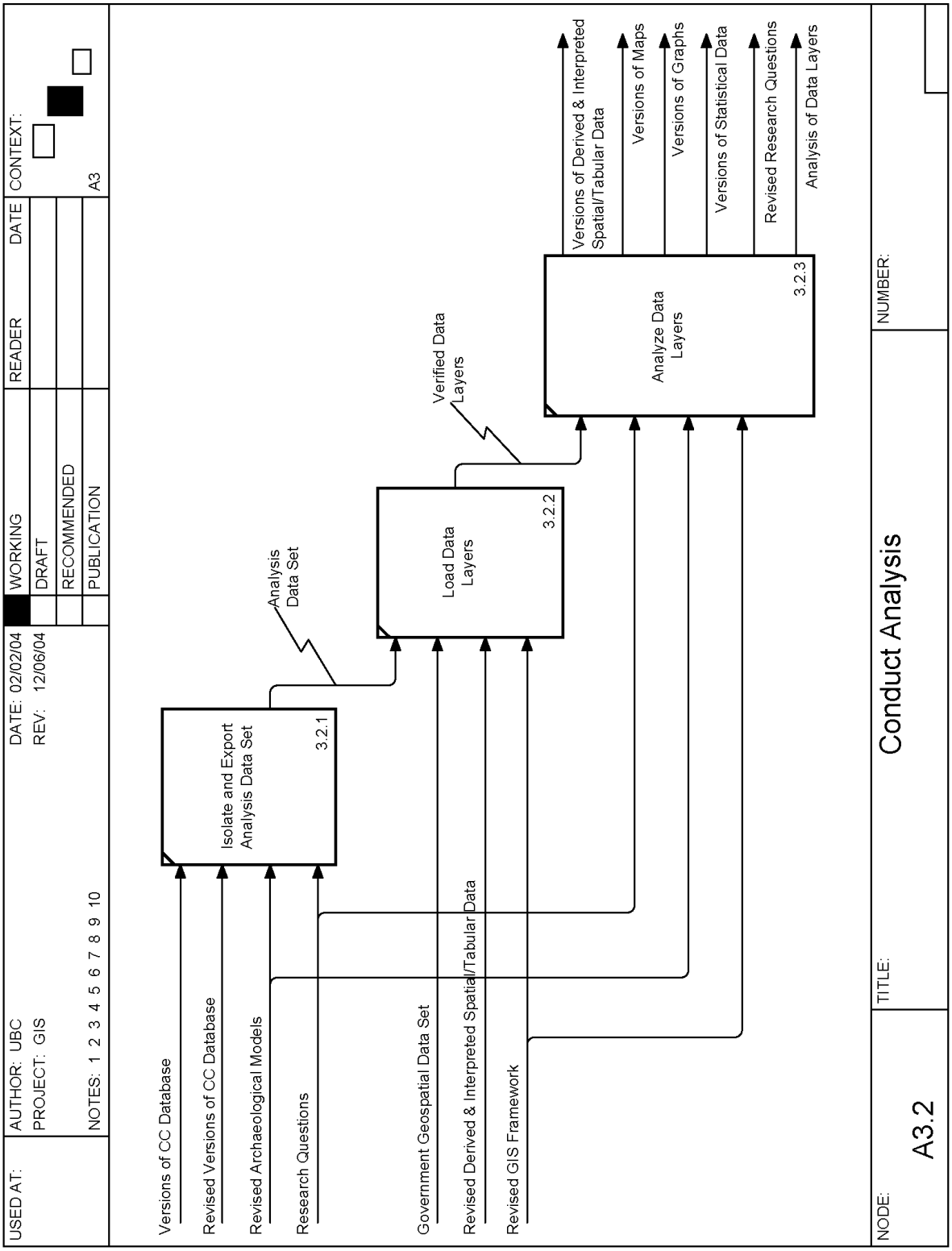
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NODE:
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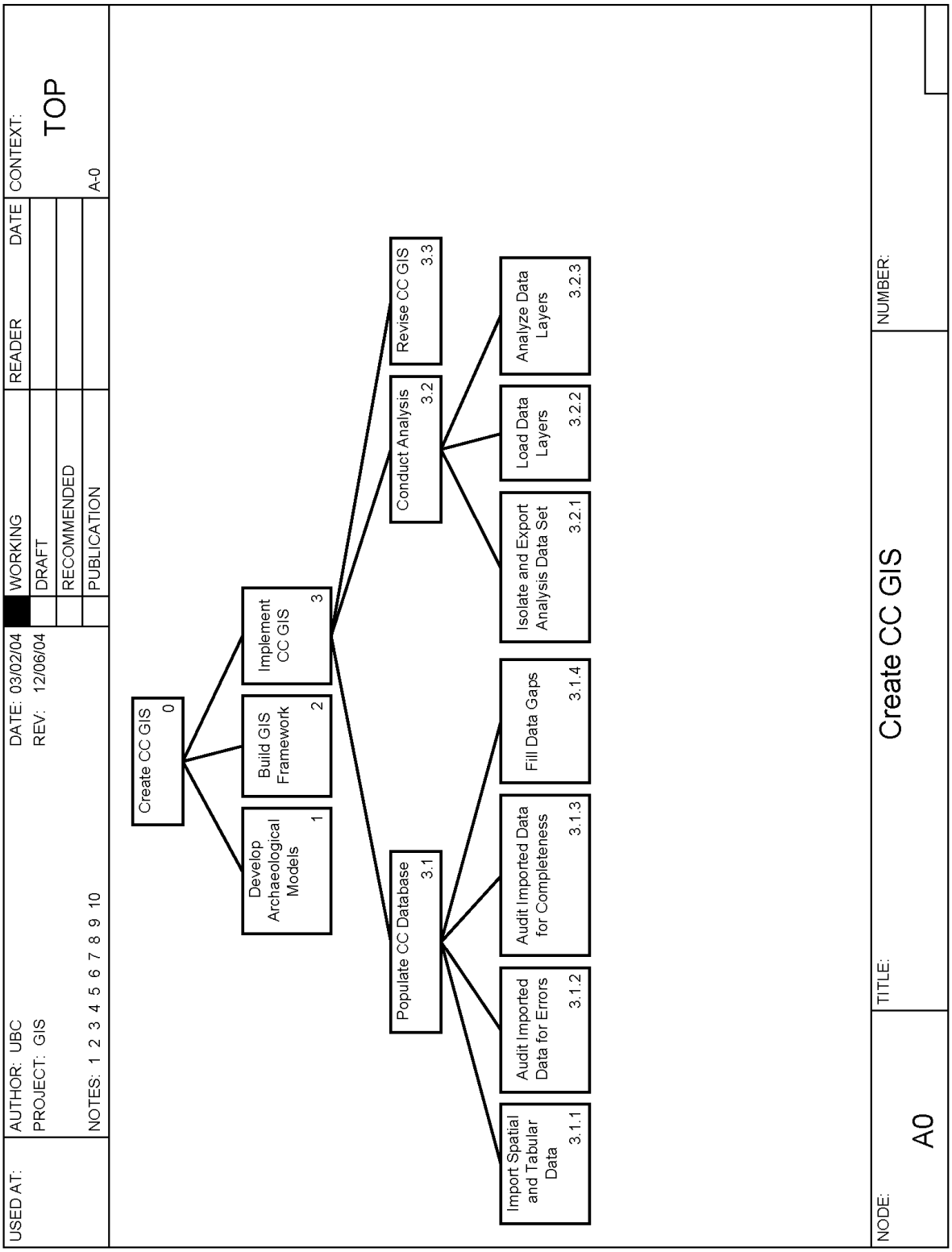
TITLE:
Conduct Analysis
NUMBER:
Versions of CC Database
Revised Versions of CC Database
Revised Archaeological Models
Research Questions
Isolate and Export Analysis Data Set
3.2.1
Analysis Data Set
Load Data Layers
3.2.2
Verified Data Layers
Government Geospatial Data Set
Revised Derived & Interpreted Spatial/Tabular Data
Revised GIS Framework
Analyze Data Layers
3.2.3
Versions of Derived & Interpreted Spatial/Tabular Data
Versions of Maps
Versions of Graphs
Versions of Statistical Data
Revised Research Questions
Analysis of Data Layers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Create CC GIS 0
Develop Archaeological Models 1
Build GIS Framework 2
Implement CC GIS 3
Populate CC Database 3.1
Import Spatial and Tabular Data 3.1.1
Audit Imported Data for Errors 3.1.2
Audit Imported Data for Completeness 3.1.3
Fill Data Gaps 3.1.4
Conduct Analysis 3.2
Isolate and Export Analysis Data Set 3.2.1
Load Data Layers 3.2.2
Analyze Data Layers 3.2.3
Revise CC GIS 3.3
NODE:
A0
TITLE:
Create CC GIS
NUMBER:

Activity Definitions – Create CC GIS (20040613)

Activity Name	Activity Number	Activity Definition	Activity Note
Create CC GIS	0		
Develop Archaeological Models	1	To develop archaeological models relating to the research questions of the Coalescent Communities Project. To brainstorm and notate representations of the nature and make-up of the GIS in relation to these models.	These models include sets of hypotheses that simplify complex observations within the archaeological record (NB, as used in the archaeological profession, archaeological record refers to cumulative archaeological knowledge, not a physical entity in an archival sense of the word record). Modelling is used for organizing and structuring the data and data collection priorities for the GIS. As such, they help increase the accuracy and precision of functional, temporal and spatial qualifiers within the GIS.
Build GIS Framework	2	To develop the framework of the GIS into a system that can be implemented.	The framework is designed by the GIS Specialist in a hypothetical, rather than physical sense because it is never formally constructed on paper or delivered to anyone in a formal product. This framework includes implementing the archaeological models that were created into a system that can be successfully implemented in relation to the research questions and goals of the organization.
Implement CC GIS	3	To populate and use the GIS.	
Populate CC Database	31	To import BD, DW, MV and AZSITE data sets into the formative CC Database and to audit those data for error, redundancy and completeness.	
Import Spatial and Tabular Data	312	To combine the BD, DW, MV and AZSITE Data Sets from various formats into one Microsoft Access Database.	It is during this stage that the GIS Specialist has to manage within the database the multiple fields that different researchers used or did not use.
Audit Imported Data for Errors	312	To rid the CC Database of redundant and erroneous data.	Involves eliminating the duplicate data within the numerous data sets that were brought together to form the CC Database. Also involves searching the database and eliminating errors relating to spatial coordinates, site description, temporal range, cultural affiliation, etc.
Audit Imported Data for Completeness	313	To identify data gaps within the CC Database.	These gaps include data relating to geographic areas/regions and sites relating to specific cultures and/or time periods. Involves looking at the CC Database and the related maps that can be produced by the existing data. This process is conducted by a volunteer (retired professor) and the project's associated researchers.
Fill Data Gaps	314	To augment the formative CC Database with data gathered by the volunteer (BR) for the purpose of filling identified data gaps in the CC Database.	Process of gathering these data involves research at various repositories (the Arizona State Museum, in the organization's fieldwork and related publications and other publications within the libraries at the University of Arizona and the Arizona State Museum). Once the data are gathered, they are entered into the CC Database (collectively, these data are called the BR Data Set).
Conduct Analysis	32	To visually and statistically analyze portions of the CC Database through ArcView and other software.	

Activity Definitions – Create CC GIS (20040613)			
Activity Name	**Activity Number**	**Activity Definition**	**Activity Note**
Isolate and Export Analysis Data Set	321	To isolate and extract certain portions of the CC Database and export them into an ArcView Project file.	Usually carried out through transforming the data into Excel files.
Load Data Layers	322	To initiate ArcView software; open a Project within ArcView and import isolated data set exported from CC Database into the Project.	Involves an iterative process of standardizing and preparing the data layers for analysis that typically involves editing, linking and verification of the data layers.
Analyze Data Layers	323	To conduct analysis (spatial and temporal) on specific data layers within ArcView with respect to the research questions.	The GIS Specialist establishes spatial relationships between data layers within ArcView through map algebra. This process may include visual analyses and/or calculations relating to population statistics, predictive modeling, archaeological site sensitivity, cost distance analysis, statistics to calculate interaction between sites, etc.
Revise CC GIS	33	To evaluate the current analyses and data (base, derived and interpreted) and make any necessary corrections, additions or completely redo certain portions of the analysis. To rid the CC Database of repetitious and inaccurate data that are identified during the analysis of the database. To monitor the changes made to the formative parts of the GIS. To identify any changes that might need to be made to the formative parts of the GIS.	This evaluation process includes looking at maps and spatial and tabular data resulting from analyses, as well as evaluating the CC Database itself. If any new research questions arise, revisions are made accordingly.

Arrow Definitions – Create GIS (20040613)		
Arrow Name	**Arrow Definition**	**Arrow Note**
Accessibility to Databases	Availability of archaeological databases with sufficient information relevant to the GIS and the proposed research questions.	CONTROL Not all data relevant to the GIS and the proposed will be accessible to the Center for Desert Archaeology, due to limited knowledge of the existence of, and/or restricted access to, researchers' archaeological data sets. As well, databases identified as relevant and available for use with the GIS may nevertheless contain insufficient archaeological data to adequately address all proposed research questions.
Analysis Data Set	A particular portion of the CC database needed for a project or to address a research question that is isolated and exported from the CC Database.	OUTPUT Excel format. Analysis data sets consist of spatial and tabular archaeological data isolated and exported from the CC Database and linked to government geospatial data for manipulation, analysis and interpretation.
Analysis of Data Layers	The process of visually and/or statistically analyzing the analysis data sets when linked to the government geospatial data and applied to the research questions.	OUTPUT May result in the creation of one of more of the following: maps, graphs, derived and/or interpreted spatial and tabular data, or statistical data. Output may be in the form of hardcopy printouts (either individually or in compiled reports) and/or digital files.
Archaeological Models	Preliminary conceptions of the GIS that encompass the ability to answer specific research questions.	OUTPUT
Available Resources	Means, whether financial or otherwise, available to the Center for Desert Archaeology.	CONTROL Resources including human, technological, financial and time resources. Being a non-profit organization, the Center for Desert Archaeology's resources are somewhat limited for the development of the GIS in question. Limited financial assistance has been provided for the development of the CC Database and resulting GIS in the form of grants, memberships, NSF grant and endowments. The Center provides an annual report to its board and the stipulations are not very tight regarding the use of financial resources from the board.
AZSITE Data Set	Comprised of a large data set of archaeological site information from numerous archaeological repositories in the state of Arizona and elsewhere.	INPUT In either Microsoft Access database .shp file. Consists of spatial and tabular data.
BR Data Set	Comprised of a large data set of archaeological site information from publications and archival repositories.	INPUT Hand transcribed from sources and then data entered into CC Database to fill in gaps identified in existing archaeological data sets. Consists of spatial and tabular data.
CC GIS	Coalescent Communities Project Geographical Information System	OUTPUT A multi-component acquisition, storage, manipulation, analysis, retrieval and visualization system for geospatial data and their attributes (i.e., tabular data). Comprised of hardware, software,

Arrow Definitions – Create GIS (20040613)		
Arrow Name	**Arrow Definition**	**Arrow Note**
		archaeological and other public geospatial and tabular data, procedures/applications and persons (operators).
Eliminated Redundant Data	Duplicate versions of data found in the multiple data sets imported into the CC database.	OUTPUT Deleted from CC Database.
Error-checked CC Database	Versions of CC Database in which data redundancies and errors have been removed and/or corrected.	OUTPUT Prior to major data redundancy and error audits, archival versions of CC Database will be created.
Existing Technology	Technology available to the Center for Desert Archaeology at any given time.	MECHANISM
Facilities	Resources available to the Center for Desert Archaeology in terms of building space and location.	MECHANISM The Center for Desert Archaeology currently is located in an historic building in the central historic corridor named University District in Tucson, Arizona. The current facilities allow for the benefits of a central location, but also create challenges relevant to an historic practice.
Gap-filled CC Database	CC Database that has been augmented with supplemental archaeological spatial and tabular data following a data completeness audit.	OUTPUT Supplemental data are imported from the BR Data Set.
GIS Framework	System design in both a technological and conceptual manner.	OUTPUT Would include description of hardware, software, data and persons (operators) that constitute the GIS.
Government Geospatial Data Set	Comprised of public geospatial data needed for the analysis of the CC Database.	INPUT Consists of Digital Elevation Models (DEMs), jurisdictions (county, state and land jurisdiction boundaries such as Bureau of Land Management (BLM) land, Arizona State Land Department (ASLD) land, private land, etc.), and locations of current towns and cities.
Human Resources	Amount of persons and person-time devoted to creating and maintaining the GIS.	MECHANISM There are two people currently working on the creation of the GIS, BH and BR. The archaeologists who have devoted their collective data sets are indirectly working on the GIS, but are not involved in the development of the database and GIS structure and are not conducting the actual analysis. The researchers can ask for certain analyses to be conducted but do not directly interact with the GIS or CC database.
Incomplete CC Database	Versions of CC Database that have been audited for data completeness and found to contain certain areas in the existing data set that need to be augmented with additional archaeological data.	OUTPUT Auditing of data completeness is conducted by the volunteer (BR).
Original Research BD Data Sets	Comprised of the research conducted by BD regarding North American Southwest archaeology.	INPUT Microsoft Excel format. From multiple sources, which include

Arrow Definitions – Create GIS (20040613)		
Arrow Name	**Arrow Definition**	**Arrow Note**
		original field work, archival research and literature searches. Data's origin is mainly from research conducted at Desert Archaeology and the Center for Desert Archaeology. Consists of spatial and tabular data.
Original Research DW Data Sets	Comprised of the research conducted by DW regarding North American Southwest archaeology.	INPUT Microsoft Excel format. From multiple sources, which include original field work, archival research and literature searches. Data's origin is mainly from research conducted at the Museum of Northern Arizona. Consists of spatial and tabular data.
Original Research MV Data Sets	Comprised of the research conducted by MV regarding North American Southwest archaeology.	INPUT Microsoft Excel format. From multiple sources, which include original field work, archival research and literature searches. Data's origin is mainly from research conducted at Crow Canyon Archaeological Research Center. Consists of spatial and tabular data.
Personal Authority	An influence exerted on an idea based on experience of an expert on a certain subject.	CONTROL Personal authority can control what is decided to be the authoritative interpretation of archaeological assemblages or data that are received from multiple sources.
Professional Practice	Opinions and notions specific to archaeology relating to professional and ethical practice.	CONTROL See Society for American Archaeology's code of ethics (www.saa.org)
Relevant Legislation	Pertinent legal requirements relating to archaeological activities.	CONTROL Includes, but not limited to Native American Graves and Repatriation Act (NAGPRA), Arizona Antiquities Acts and the Arizona Revised Statutes.
Research Questions	Questions that investigate the issue of "coalescence" during the prehistoric Southwest.	INPUT Questions include issues of migration, population, archaeological site sensitivity (in terms of present land development), predictive modeling to locate potentially undocumented sites, cost distance analysis, interaction between sites, etc.
Revised Archaeological Models	Revisions to earlier conceptions of the GIS that encompass the ability to answer specific research questions in light of new insights gained through analyses.	OUTPUT
Revised Derived & Interpreted Spatial/Tabular Data	Derived and interpreted spatial and tabular data that have undergone further modification(s) and have been monitored through changes.	OUTPUT Consists of derived and interpreted spatial and tabular data used in analyses that are subsequently modified and re-applied to the same and/or different analyses.
Revised GIS Framework	GIS Framework which has been re-evaluated in light of any changes to any of the individual components of the GIS.	OUTPUT Revisions to research questions and CC Database might incur change to the GIS Framework.

Arrow Definitions – Create GIS (20040613)		
Arrow Name	**Arrow Definition**	**Arrow Note**
Revised Research Questions	Research questions that have been changed or added due to analysis findings.	OUTPUT
Revised Versions of CC Database	Versions of CC Database that have been monitored for any changes resulting from analyses.	OUTPUT Microsoft Access format. Contains spatial and tabular data imported from original BD, DW and MV archaeological research data sets, as well as from AZSITE and BR archaeological data sets.
State of Technology	Level of technology relating to processing power, software capabilities, GIS and relational database design.	CONTROL
Verified Data Layers	Analysis data layers in which spatial and tabular data have been error-audited and properly linked.	OUTPUT
Versions of CC Database	Versions of CC Database, a relational database that consists of pre-existing archaeological data on the prehistoric Southwest between A.D. 1200-1540.	OUTPUT Microsoft Access format. Contains spatial and tabular data imported from original BD, DW and MV archaeological research data sets, as well as from AZSITE and BR archaeological data sets. Prior to major error or completeness audits, backup and/or archival versions of CC Database are created. May consist of hardcopy printouts and/or alphanumeric data saved in digital form.
Versions of Derived & Interpreted Spatial/Tabular Data	Versions of spatial and tabular data resulting from algorithm manipulation and visual analysis of base (i.e., original) spatial and tabular data exported from CC Database.	OUTPUT By-product of algorithm manipulations of base spatial and tabular data exported from CC Database and linked to government geospatial data. Typical manipulations include cost-distance analysis, site sensitivity analysis, and analysis of site density and interaction between sites. May consist of hardcopy printouts and/or alphanumeric data saved in digital form.
Versions of Graphs	Versions of diagrams depicting the quantitative relationship between two or more base, derived and/or interpreted spatial/tabular data variables.	OUTPUT Originate in ArcView. May consist of hardcopy printouts and/or images saved in digital form.
Versions of Maps	Versions of visual representations of geographic areas delineated by government geospatial data onto which selected spatial and tabular archaeological data from the CC Database are plotted or otherwise visually represented.	OUTPUT Originate in ArcView. May consist of hardcopy printouts and/or images saved in digital form.
Versions of Statistical Data	Versions of numeric data resulting from statistical analyses of spatial and tabular data.	OUTPUT By-product of statistical analyses of: 1) base spatial and tabular data exported from CC Database and linked to government geospatial data, and/or 2) derived or interpreted spatial and tabular data. Typical example of a statistical analysis is the autocorrelation of archaeological site distributions. May consist of hardcopy printouts and/or numeric data saved in digital form.

Appendix A: Summary of General Study 09 Findings in Relation to Case Study 14

To help assess the representativeness of the recordkeeping habits of the individuals interviewed during the first phase of the case study, within the context of the broader archaeological community, a survey questionnaire was developed and administered to GIS archaeologists worldwide via the internet in April 2004. To this end, the survey questions were written, in large part, to address specific records creation, management and preservation issues identified during the interviews. Personal invitations to participate in the survey questionnaire were e-mailed to approximately 900 GIS archaeologists from sixty-nine countries worldwide. Additional invitations were posted to various archaeology- and GIS-related listserves and internet discussion groups.

This survey targeted archaeologists who currently use, or who have in the past used, a GIS in their archaeological research. Consisting of forty, primarily single or multiple choice, questions, the survey was designed to be completed in approximately thirty minutes. The survey was organized into the following seven sections:

1. Introduction (1 question)
2. GIS Experience/Background (7 questions)
3. File Management/Documentation Procedures (11 questions)
4. Digital Preservation Practices (13 questions)
5. Data Input/Output Practices (2 questions)
6. Record Quality, Reliability and Authenticity Issues (5 questions)
7. General Comments (1 question)

Of the 195 log-ins recorded during the 32 days that the survey was available on-line, 157 completed (or sufficiently completed) surveys were received from archaeologists in 30 countries across 6 continents.

Summary of Results

Records Creation and Documentation Procedures

Interview Data: With just one full-time employee dedicated to creating and maintaining the CC GIS, coupled with the fact that this is a work of a small, non-governmental organization, it is not surprising that the procedural context for records creation and documentation is neither robust, systematic nor predetermined. There are no formal procedures manuals that address the creation, management or preservation of the CC GIS. Instead, the CC GIS was created and is maintained in a largely ad hoc manner under the authority of the Center's GIS Program Manager. Most creation and maintenance procedures are entirely undocumented. Even the basic file naming process that the GIS Program Manager uses to keep track of file versions, although somewhat systematic, is idiosyncratic and undocumented. Some incidental documentation does occur, however, during the course of creating certain, often transitory, records within the CC GIS. For example, the GIS Program Manager will document certain steps within various likely-to-be-repeated analyses primarily to speed the time it takes to replicate them. This example underscores the largely ad hoc nature of the documentary process and emphasizes the fact that it is conducted for other reasons than the traditional need for procedures.

Survey Data: Certain aspects of the CDA's largely ad hoc and idiosyncratic records creation and documentation procedures are closely mirrored in the survey results, others less so. For example, while the overall level of documentation is higher among survey participants, with 83% claiming that they routinely create documentation for their records, more than half of these individuals (59%) admit that their documentation procedures tend to be informal. In fact, only 29% employ formal digital or paper forms designed specifically for documentation purposes. On the other hand, most (62%) said that the documentation procedures they do use always or usually are implemented consistently, while 37% said that they only occasionally or never are. Considering the potential impact on record authenticity, accuracy and reliability, it is interesting to note that 25% of the participants said that most or all of the documentation that is created tends to occur toward the *end* of a project, or even after its completion, while another 38% said that, although documentation typically occurs throughout the duration of their projects, it often does not occur at the same time as the event being documented (Figure 1). In fact, only about one-third (37%) of the participants claim that an event and its documentation usually occur contemporaneously.

In contrast, the procedures for records creation tend to be somewhat less systematic, with just over half (52%) claiming they always or usually follow consistent procedures (Figure 2). As well, 61% indicated that they only occasionally, if ever, use a formal GIS procedures manual. Of these, 21% say they do not even have access to such a manual, while 9% do.

With respect to file version control, the overwhelming majority of participants (74%) said they use some type of file naming strategy (Figure 3), with virtually all (99%) claiming that their strategies follow some form of standardized or documented procedure (Figure 4). However, 34% also admitted that the procedures used typically vary from project-to-project, while another 16% said that standardized procedures were used only occasionally. In fact, just 18% claimed to *always* use standardized or documented file naming procedures.

Record/Data Accuracy, Reliability and Authenticity

Interview Data: The CDA attempts to use the most reliable sources of information possible, such as government spatial data and research data that are the most reliable in the field. To the extent possible, the data's reliability is based on professional authority and verification from experts in certain areas of archaeology. In general, however, it is difficult conclusively to deduce the authenticity of the data in a strict sense of the word. Instead, authenticity is assumed to a reasonable degree since data are coming from a state repository or a dataset from other trusted researchers. The CDA is assured that the data are authentic to an acceptable degree for the research that is being conducted. There is more concern over the reliability and accuracy of the data than their authenticity. These concerns are due, in part, to the sometimes inconsistent nature of archaeological data collection procedures from one researcher (or research project) to the next.

Throughout the process of creating the database, spot checks were conducted on the dataset to ensure the data were being entered accurately. Typically, the datasets were subjected to a preliminary audit in which the GIS Program Manager assessed them as a whole with regard to their general reliability and authenticity. In addition, a more thorough and systematic audit of data redundancy, error and completeness was later performed by a highly qualified volunteer (a retired archaeology professor).

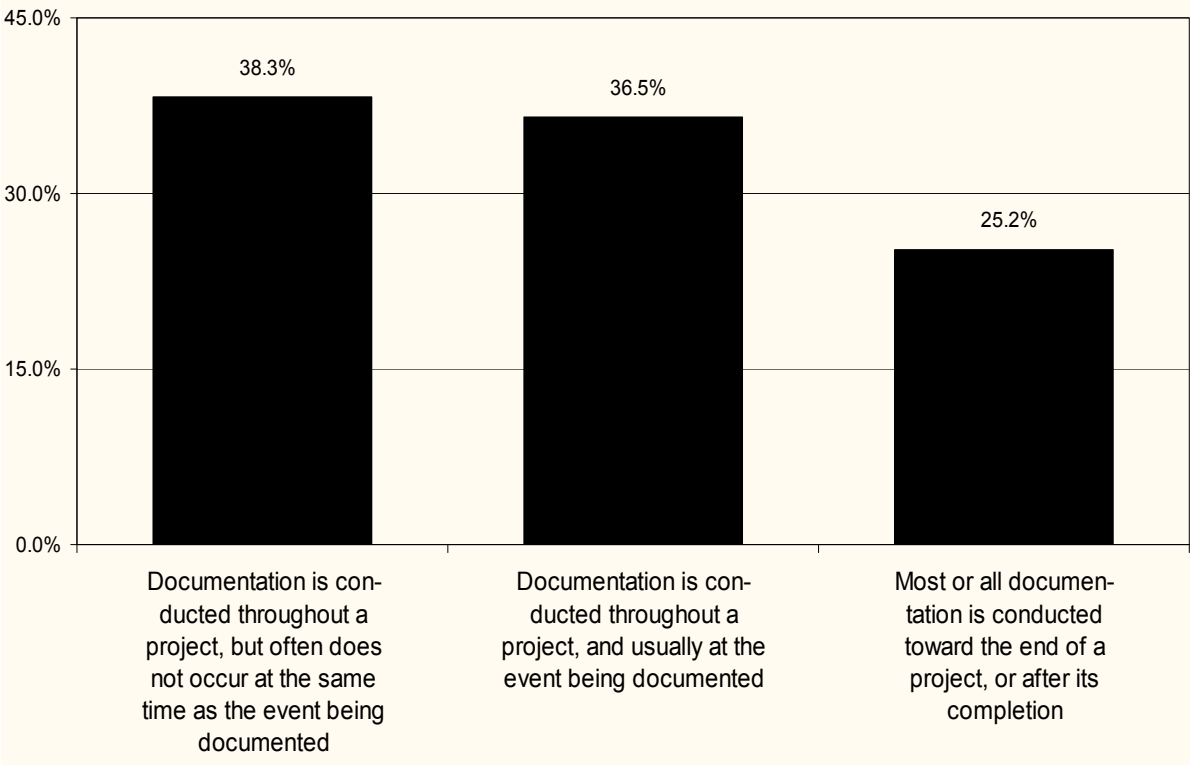

Figure 1. Concurrence of an event with its documentation.

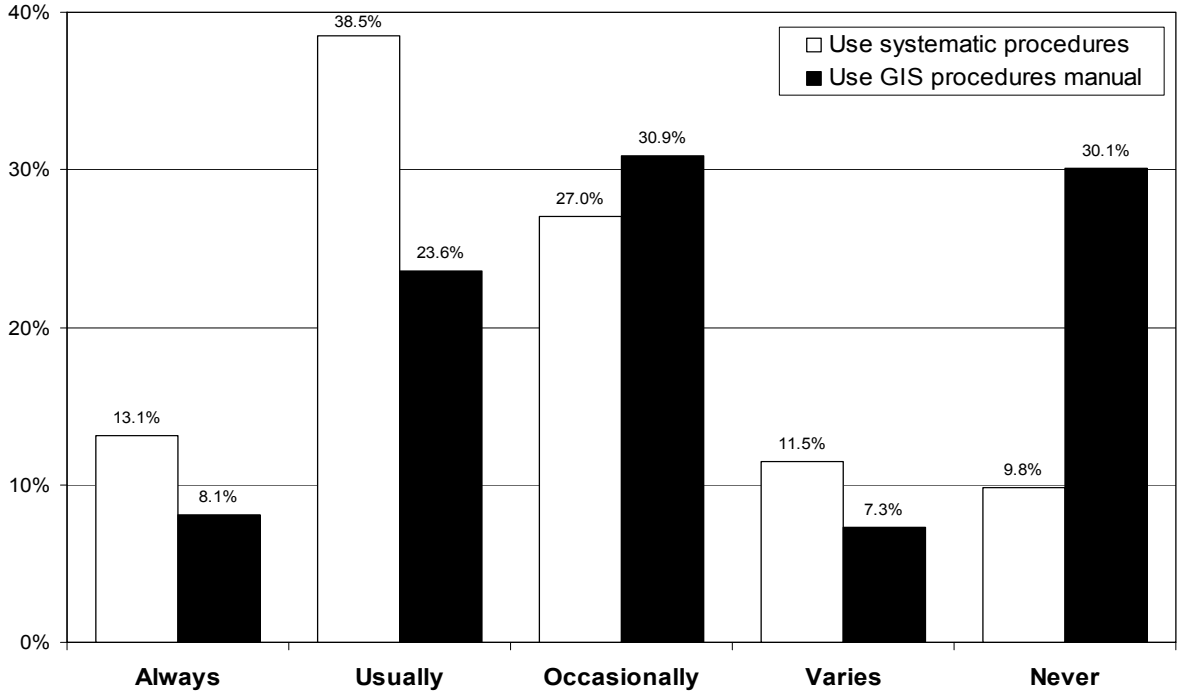

Figure 2. Frequency with which routine or systematic procedures are used to create various GIS components and outputs, and the degree to which these procedures are based on a formal procedures manual.

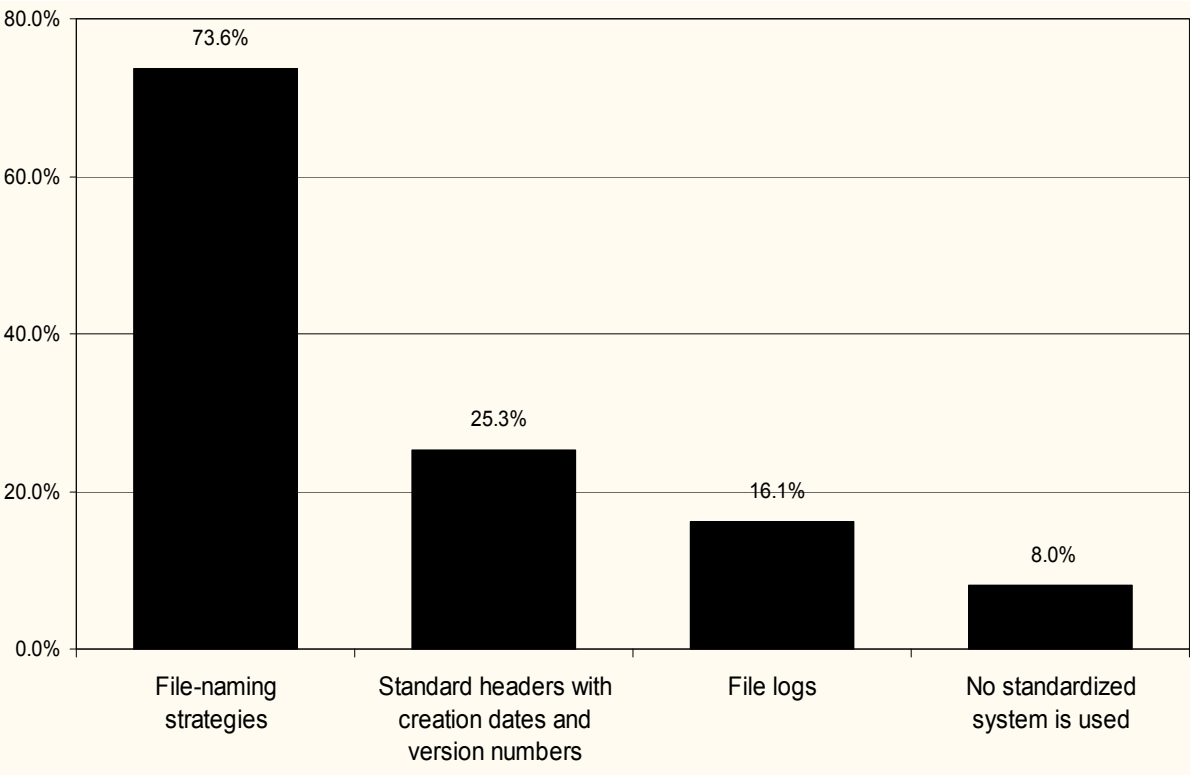

Figure 3. File version control strategies.

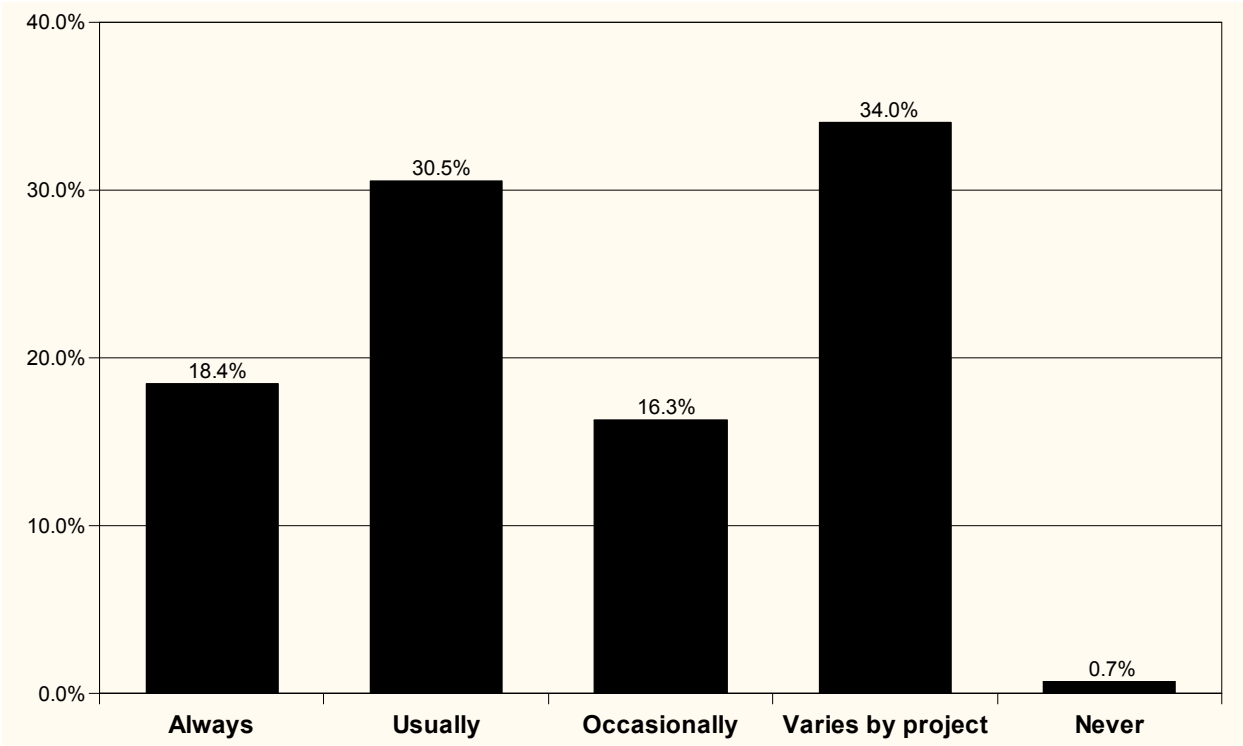

Figure 4. Frequency with which standardized or documented procedures are used for naming digital GIS project files.

With respect to procedures governing access to the database, it was found that there were no formal security or access procedures in place, such as any form of auditing to track who accesses the database or who enters or modifies what data. Instead, requests for access were decided in an ad hoc manner on a case-by-case basis for anyone wishing to view the database.

Survey Data: The relative thoroughness of the audit procedures used by the CDA to help ensure the accuracy of its GIS data stand in contrast to the results of the survey in which a substantial percentage of the participants (35%) said that they *never* formally audit the data used in their GIS research, while another 25% said that they only occasionally perform such audits (Figure 5). On the other hand 60% of the participants said that they always or usually institute some type of formal, albeit relatively unsophisticated, access or security procedure, such as the use of passwords or access control lists, to protect their GIS files from unauthorized access or modification (Figure 6). The use of more sophisticated procedures, such as user auditing or data encryption software, is much less common (23% and 8%, respectively).

Long-term Preservation

Interview Data: At present, there are no formal or systematic procedures in place for the long-term preservation of the CC GIS. However, certain short-term preservation strategies are employed, albeit on a limited and largely ad hoc basis. For example, the GIS Program Manager creates periodic 'archival' backups of the database which he variously maintains on his personal computer, on CD-ROMs and/or on the CDA's LAN server. These backups typically are created immediately prior to any significant database updates or changes and serve primarily to facilitate roll-back to an earlier version should any of the new data added to the database later be found to be inaccurate or corrupt. The GIS Program Manager also periodically migrates data and system files to newer versions of software, primarily in an effort to address immediate software obsolescence and current file useability issues, rather than long-term preservation concerns. This behaviour correlates well with the GIS Program Manager's belief that within perhaps as few as 20 years from now nobody is going to be interested in or need his data or his results, and especially not the specific analytical techniques and data manipulations he used to arrive at those results. He bases this belief in part on the assumption that GIS technology will have changed so significantly within that time that his data and results will have been rendered completely "obsolete," and in part on his observations of how little today's researchers rely on the data and results of archaeologists from 100, 50 or even 20 years ago. The underlying assumption here is that everything about the research that is worth preserving long-term will be contained in the publications of the results, so that there is little, if any, need to preserve anything else.

Survey Data: This belief that the published results are the only tangible aspects of current research that future investigators will really need or want does not appear to be as common a belief among the survey participants. In fact, as shown in Figure 7, nearly three-quarters (73%) admitted to being concerned about the transition of their GIS projects into an archival setting. Nevertheless, little concrete action appears to have thus far resulted from this high level of concern, with only 26% of participants indicating that their completed projects are in fact always or usually transferred to the long-term custody of a designated repository, such as the Archaeology Data Service in the UK, or a state, museum or university archives (Figure 8). At this point, most (59%) rely instead on "in-house" long-term preservation strategies. Perhaps the

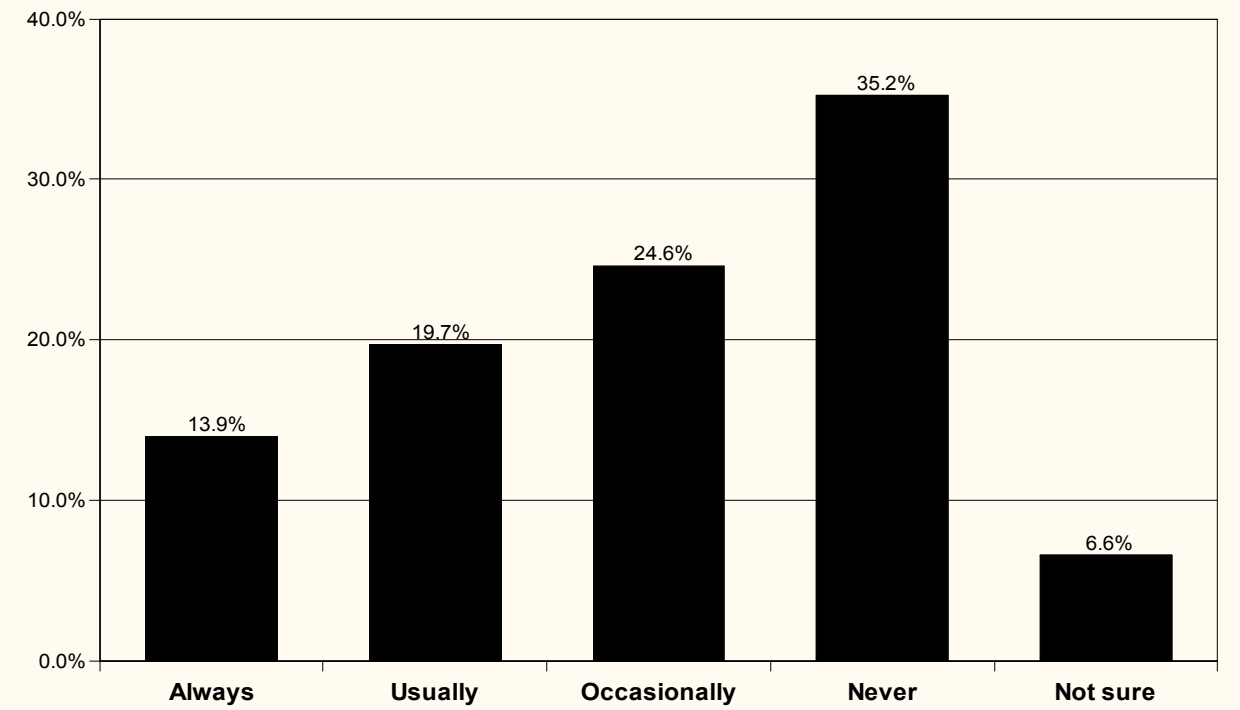

Figure 5. Frequency of formal or systematic audits of GIS data accuracy.

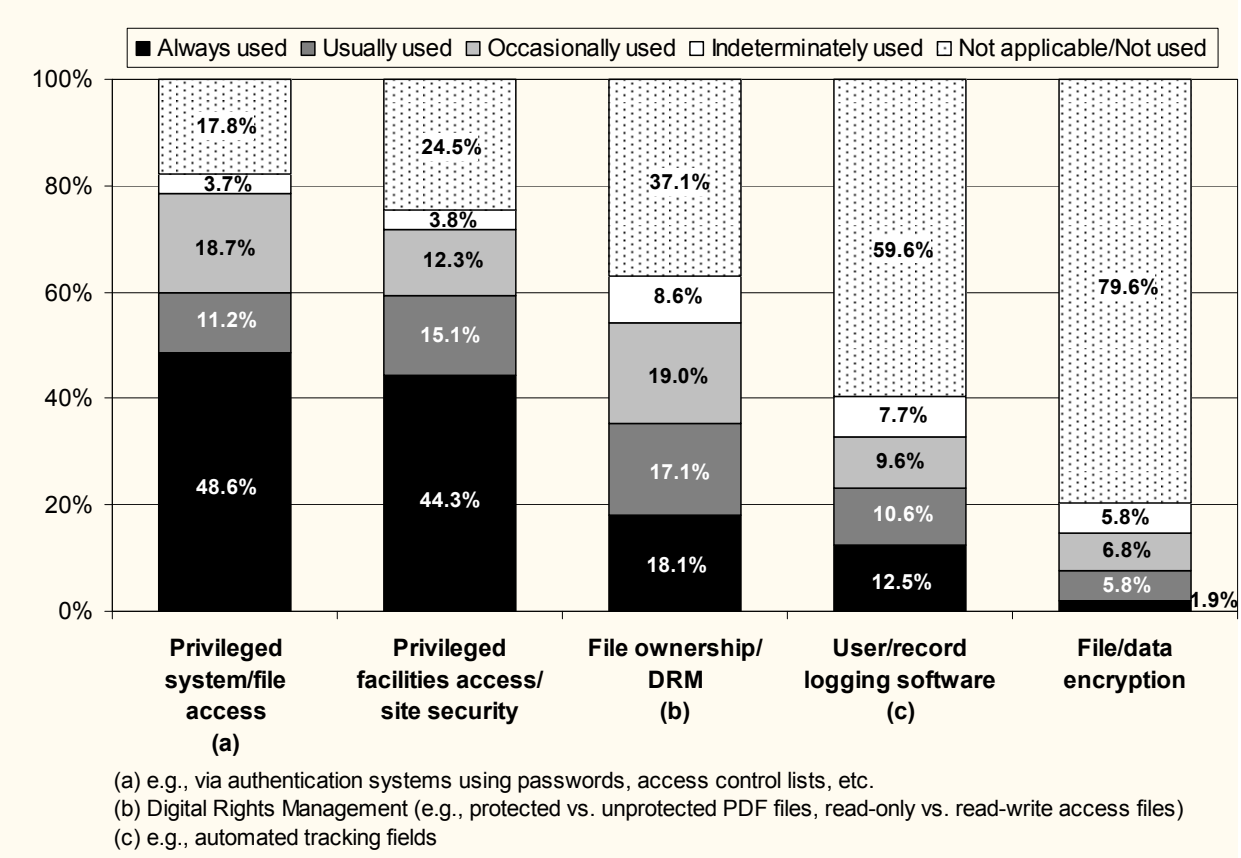

Figure 6. Frequency with which various file access or modification security strategies are used.

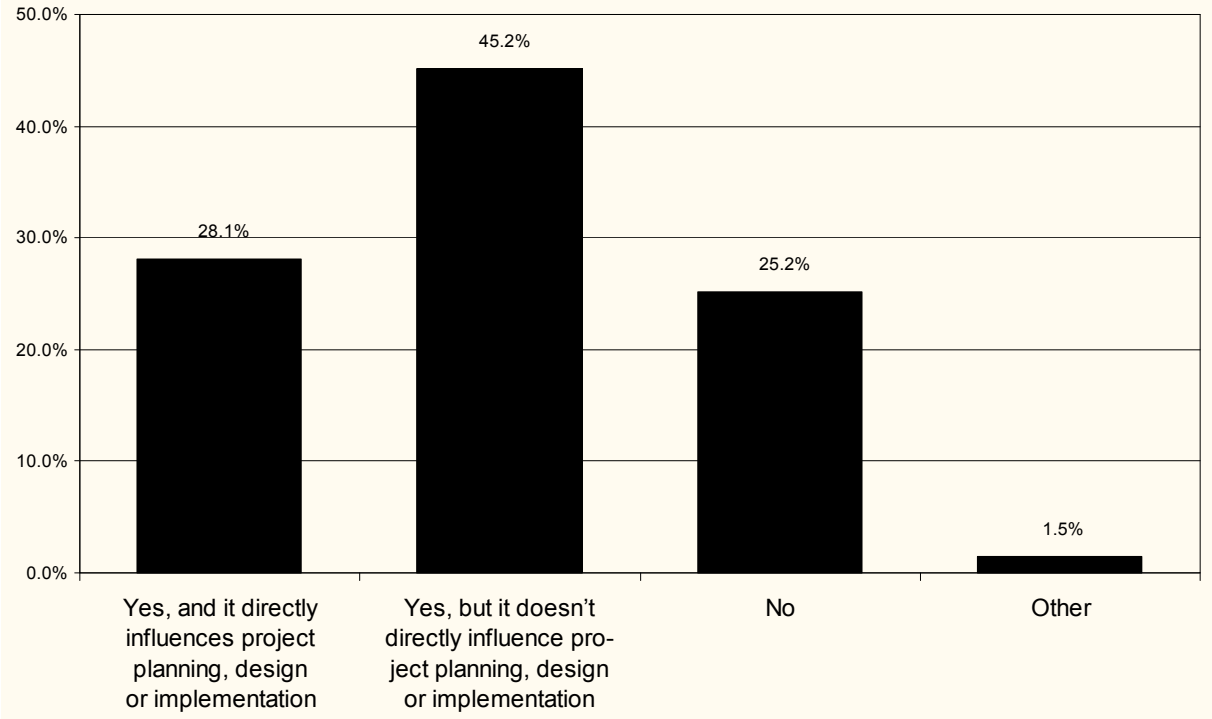

Figure 7. When planning, designing or implementing projects, are you concerned about their eventual transfer into an archival setting to help ensure they can be preserved for the long term, relocated and reused by others in the future?

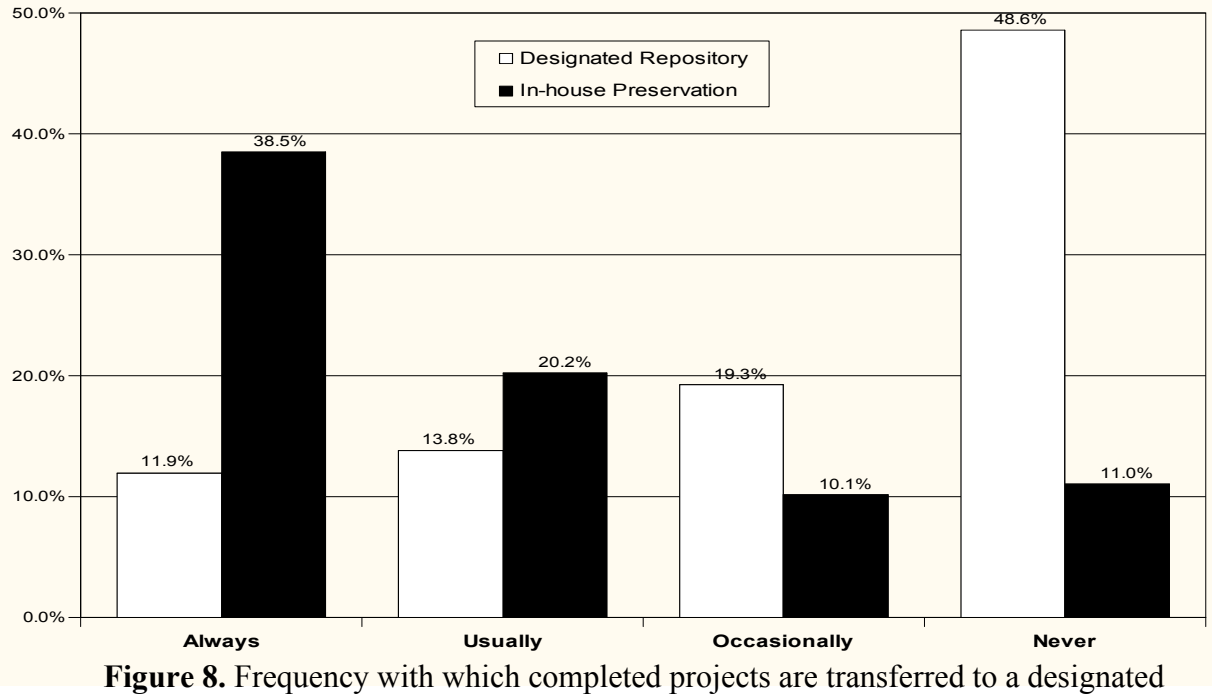

Figure 8. Frequency with which completed projects are transferred to a designated repository or preserved 'in-house'.

greatest concern with this situation, at least from an archivist's perspective, is that such strategies may prove to be largely ineffectual in the long run due to inadequate preservation procedures. Indeed, the results summarized in Figure 9, in which most participants (53%) who rely on 'in-house' preservation strategies for their GIS projects admit that the strategies are implemented irregularly and subjectively without the aid of any established standards or procedures, seem to validate these concerns.

Insufficient funding, time and personnel were the top three reasons cited when participants were asked which factors prevented them from preserving their GIS projects for the long-term (whether 'in-house' or in a designated repository) (Figure 10). However, when then asked to select what they considered to be the factor which most heavily influenced their preservation decisions, most (57%) selected "not seen as important or necessary," followed by "insufficient funding" (37%) and "lack of an available or applicable repository" (34%). These results seem to suggest that researchers feel fairly confident in their ability to distinguish between what is and is not worthy of long-term preservation.

Conclusions

Although there appears to be a considerable overall awareness among archaeologists of the issues surrounding the long-term preservation of authentic, reliable and accurate records, there has yet to emerge a concerted, profession-wide response to these issues. As was suggested in the interviews, and later confirmed by the survey data, most efforts to date have largely been ad hoc. This idiosyncratic approach appears to stem, in part, from the fact that a majority of GIS archaeologists have little or no formal GIS training. Perhaps nowhere are the consequences of this 'self-taught' approach more apparent than in the general disregard of formal and systematic procedures for records creation, maintenance, documentation and preservation.

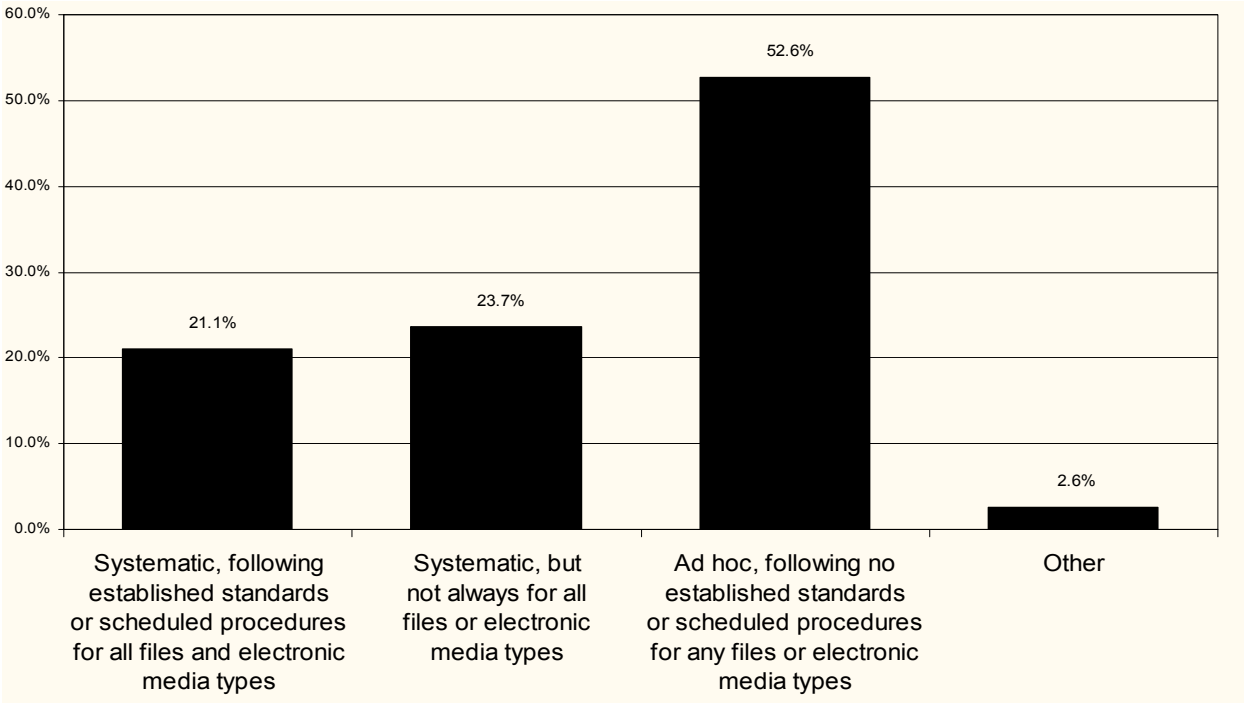

Figure 9. Which best describes how the 'in-house' preservation strategies are implemented?

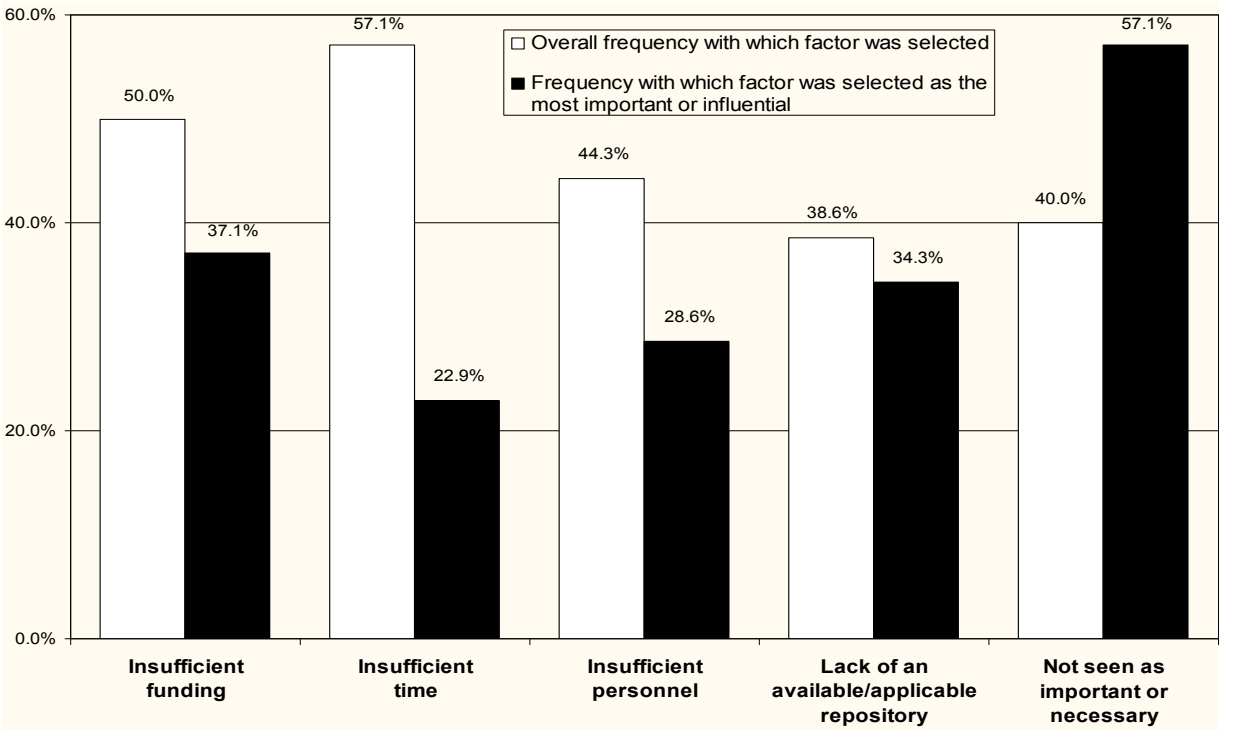

Figure 10. Factors preventing long-term preservation of some or all projects, and their relative importance.

Appendix B: Detailed Description of Juridical Context

Federal Regulations and Policies Affecting Protection of Archaeological Resources

The major federal regulations and policies affecting the protection and management of archaeological resources in the study area are embodied in the following laws, regulations and executive orders:

- *Antiquities Act* of 1906
- *Historic Sites, Buildings, Objects, and Antiquities Act* of 1935
- *National Historic Preservation Act* of 1966 (NHPA)
- *National Environmental Policy Act* of 1969 (NEPA)
- Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971
- *Archaeological and Historic Preservation Act* of 1974 (AHPA)
- *Archaeological Resources Protection Act* of 1979 (ARPA)
- *Native American Graves Protection and Repatriation Act* of 1990 (NAGPRA)
- Executive Order 13287, Preserve America, 3 March 2003

Antiquities Act of 1906

CODE CITATIONS: P.L. 59-209, 34 Stat 225, 16 USC 431.

MANAGING AGENCIES: The National Park Service, through the Secretary of the Interior, has general administrative authority, but all federal agencies have authority to enforce the act.

PURPOSE AND GOALS: This act authorizes the President to designate national monuments, historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal lands. The act also extends protection to archaeological resources on federal lands by, 1) requiring a permit for excavation and/or removal, and 2) prohibiting looting and vandalism.

COMMENTS: The newer *Archeological Resources Protection Act* of 1979, and the *Native American Graves Protection and Repatriation Act* of 1990, are the dominant laws in archeological resource preservation, and the use of the *Antiquities Act* is specialized to areas with potential for national monument designation.

Historic Sites, Buildings, Objects, and Antiquities Act of 1935

CODE CITATIONS: 45 Stat. 666, 16 U.S.C. 461 *et seq.*

MANAGING AGENCIES: The National Park Service (NPS).

PURPOSE AND GOALS: The purpose of this act is to establish "a national policy to preserve for public use historic sites, buildings and objects of national significance for the inspiration and benefit of the people of the United States."

COMMENTS: The act directs the NPS to make a survey of historic and archaeological sites (defined in this act as "the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined or vanished, where the location itself maintains historical or archeological value regardless of the value of any existing structure"), buildings and objects for the purpose of determining which possess exceptional historic value. The act further establishes criteria for assessing national significance, and authorizes the creation of the National Historic Landmarks Program (NHLP). In particular, the NHLP authorizes the NPS to identify, designate, recognize, list, and monitor National Historic Landmarks.

Properties designated as National Historic Landmarks are listed in the National Register of Historic Places upon designation as National Historic Landmarks. It is important to note, however, that listing of private property on the National Register does not prohibit under Federal law or regulations any actions which may otherwise be taken by the property owner with respect to the property.

The National Register was designed to be and is administered as a planning tool. Federal agencies undertaking a project having an effect on a listed or eligible property must provide the Advisory Council on Historic Preservation a reasonable opportunity to comment pursuant to section 106 of the *National Historic Preservation Act* of 1966, as amended.

National Historic Preservation Act of 1966 (NHPA)

CODE CITATIONS: P.L. 89-665, 80 Stat 915, 16 USC 470, 1966 U.S. Code Cong. and Ad. News 3855; amended: P.L.s 91-243, 93-54, 94-422, 94-458, 96-244 and 96- 515.

PURPOSE AND GOALS: This law declares the national policy that the United States' historical heritage "should be preserved as a living part of [its] community life and development in order to give a sense of orientation to the American people."

MANAGING AGENCIES: Each agency is responsible for administering this law, but state review authorities have significant responsibility for federal compliance with its provisions. The Department of the Interior, through the National Park Service and the Advisory Council on Historic Preservation, has responsibility for national oversight.

JURISDICTION: This law applies only to federal agency actions and not to private actions.

COMMENTS: This act provides for a National Register of Historic Places, and has broad authority over national, State, and local historic preservation programs. Despite the fact that this law applies only to federal agency actions and not to private actions, several aspects of the act are of particular relevance to the GIS project. First, the act established the State Historic Preservation Offices (SHPOs), a group that conducts state- or territory-wide inventories of historic properties, nominates properties to the NRHP, maintains preservation plans, and

participates in Section 106 of the NHPA reviews. A 1992 amendment to the act provides for Tribes to establish Tribal Historic Preservation Offices (THPOs) that can assume all the duties of SHPOs on Tribal land and in some cases, adjoining lands.

Secondly, Section 106 of the act embodies the rules that govern the manner in which cultural resources are treated during any undertaking involving a federal lead agency, federal funding, or federal lands (this portion was added in 1979, and most recently amended in 1999). In general, Section 106 outlines a series of steps which facilitate archaeological resource identification, evaluation and mitigation. It is noted that the Center for Desert Archaeology was a recent recipient of federal funding in the form of a National Endowment for the Humanities (NEH) grant for $100,000.

Finally, Section 110 of the act directs the heads of Federal agencies (e.g., Bureau of Land Management, National Park Service, Forestry Service) to assume responsibility for the preservation of National Register listed or eligible historic properties owned or controlled by their agency. Agencies are directed to locate, inventory, and nominate properties to the National Register, and to exercise caution to protect such properties. The latter mandate includes implementing measures to closely regulate archaeological research activities.

National Environmental Policy Act of 1969 (NEPA)

CODE CITATIONS: P.L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by P.L. 94-52, July 3, 1975, P.L. 94-83, August 9, 1975, and P.L. 97-258, § 4(b), Sept. 13, 1982.

PURPOSE AND GOALS: NEPA establishes a national goal of maintaining or enhancing environmental quality. It requires all federal agencies to conduct thorough evaluations of the potential impacts of their programs and activities in the planning stage and to weigh environmental costs against program or project benefits. Projects deemed likely to have major effects on the environment require the sponsoring agency to develop an Environmental Impact Statement (EIS) that considers the environmental consequences of alternative project designs. Projects deemed likely to have minor effects require the sponsoring agency to develop an Environmental Assessment (EA).

COMMENTS: "Environment" is defined broadly in this act to include cultural resources, social values, and various aspects of the natural environment. It is important also to note that compliance with Section 106 of the NHPA is interlinked with NEPA compliance with respect to historic properties (including archaeological sites).

Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971

PURPOSE AND GOALS: This executive order directs federal agencies to: 1) inventory cultural properties under their jurisdiction, 2) nominate to the National Register of Historic Places all federally owned properties that meet the criteria, 3) use due caution until the inventory and nomination processes are completed, and 4) assure that federal plans and programs contribute to

preserving and enhancing nonfederally owned properties. Some of this executive order's provisions were incorporated into Section 110 of the NHPA by amendment.

Archaeological and Historic Preservation Act of 1974 (AHPA)

CODE CITATIONS: P.L. 86-523, 16 U.S.C. 468–469c-2

PURPOSE AND GOALS: This act was adopted to further improve the intent of the *Historic Sites Act* of 1935. The intent of AHPA is to preserve historic American sites, buildings, objects, and antiquities of national significance. The AHPA specifically provides for the protection of historical and archaeological data (including sites, relics and specimens), which might be irreparably destroyed or lost as a result of alterations to the land caused by a Federal agency or a Federally assisted, licensed or permitted construction project.

MANAGING AGENCIES: The Department of the Interior.

JURISDICTION: This law applies to federal agency actions, or the actions of private agencies involved in a federal undertaking.

COMMENTS: This act was originally known as the *Reservoir Salvage Act* when the initial legislation was enacted in 1960. With broadening amendments, the act became known as the *Moss-Bennett Act* (after an early amendment) or the *Archeological Recovery Act*, and finally the *Archaeological and Historic Preservation Act* or the *Archaeological Data Preservation Act* following amendments in 1971 and 1974.

Archaeological Resources Protection Act of 1979 (ARPA)

CODE CITATIONS: P.L. 96-95, 93 Stat. 721, USC 470aa *et seq.* 43 CFR part 7, 36 CFR part 79.

PURPOSE AND GOALS: This act's stated purpose is to protect irreplaceable archaeological resources on federal and Indian lands from individual and commercial interests and to foster the professional gathering of information for future benefit. To this end, the act establishes definitions, permit requirements, and criminal and civil penalties to correct legal deficiencies in the *American Antiquities Act* of 1906. Finally, this act requires proper curation of archeological records and materials, identification of archeological resources, and active public awareness efforts.

COMMENTS: The focus of this act is on the preservation of archaeological resources for their scientific value with a major emphasis on increasing the exchange of information and general communication among governmental entities, professional archaeologists, and the public. Indeed, one of the conditions for issuance of a permit under this act is that the applicant demonstrate that the proposed activities will provide increased knowledge of archaeological resources. Another permit condition requires that applicants proposing projects on Indian lands first obtain consent of the Indian allottee or Indian Tribe owning or having jurisdiction over such lands.

Another important provision of the act deals with the disclosure of sensitive archaeological resource location information. Under the act, information concerning the nature and location of any archaeological resource on federal or Indian lands may not be made available to the public unless it is determined that such disclosure would further the purposes of the act and not create a risk of harm to the resources or to the site at which such resources are located.

Native American Graves Protection and Repatriation Act of 1990 (NAGPRA)

CODE CITATIONS: P.L. 101-601, 104 Stat. 3048, 25 USC 3001-3013.

PURPOSE AND GOALS: This act formally recognizes Indian tribes and native Hawaiian organizations as owners of human remains, funerary and sacred objects, and objects of cultural patrimony. Specifically, the act imposes various requirements when such objects are excavated, and specifies the procedures museums and federal agencies are to follow when inventorying such objects already in their collections. The act also requires that the inventory results be made available to tribes and native Hawaiian organizations who may then request the repatriation of cultural items to which they can show reasonable cultural or biological affiliation. Finally, the act provides for civil penalties for the trafficking in human remains and cultural items and establishes a review committee to advise on carrying out the law and resolving ownership disputes.

JURISDICTION: This act only applies to federal and Indian lands and to repatriation of objects in federal or federally funded institutions. The act does not apply to private collections, private lands or state lands (unless they involve a federal undertaking)

COMMENTS: This act is primarily concerned with remedying the inequality in treatment between Non-Native and Native archaeological remains, and truly is Native American cultural property rights legislation. The ARPA is repugnant to many Native Americans because it treats sensitive objects and human remains as scientific resources and economic commodities requiring the assignment of a dollar value during the course of any criminal prosecution under the act.

Executive Order 13287, Preserve America, 3 March 2003

PURPOSE AND GOALS: This executive order restates and emphasizes the policy originally established in the NHPA that calls for Federal agencies to take a leadership role in preserving the heritage of the United States. Many of the specific directives of the order are aimed at improving the stewardship of historic properties within federal ownership. Several other provisions of the order call for Federal agencies to establish partnerships to promote preservation and heritage tourism where consistent with the agency mission

Arizona State Regulations and Policies Affecting Protection of Archaeological Resources

Arizona Antiquities Act of 1973 (AAA)

CODE CITATIONS: Title 41, Chapter 4.1 History, Archaeology and State Emblems, Article 4 Archaeological Discoveries, A.R.S. Sec. 41–841 *et seq.*

PURPOSE AND GOALS: The intent of this act is to protect the information contained in historic and prehistoric archaeological ruins, and palaeontological deposits by controlling access to sites on state lands through a permit program administered by the Arizona State Museum.

COMMENTS: The act has been amended six times to keep pace with federal and state historic preservation policy and is considered one of the strongest cultural resources protection laws in the United States. In particular, the act prohibits unauthorized excavation, disturbance or collection of any archaeological or palaeontological resource (excluding arrowheads, coins or bottles) on any state owned or controlled land. Permits to conduct such activities are administered by the Arizona State Museum and are limited to qualified institutions, organizations or corporations organized for scientific, research or land planning purposes only. Significantly, the act requires all permit holders to undertake measures "to propagate the knowledge to be gained and to *preserve permanently* all objects, photographs and records in public repositories under their own supervision or control, or the supervision or control of other similar institutions, organizations or corporations." (Section 41-842, Paragraph C, emphasis added)

In Arizona, all archaeologists must first qualify, obtain and have in possession an up-to-date AAA Permit (either Blanket or Project-Specific) to do any archaeological survey or excavation on state, county, city or other municipal properties. Conversely, Blanket and Project-Specific permits are not required for a survey or excavation project on private land unless the project involves a state agency providing state funding.

Minimum qualifications for permitees include:

1. A graduate degree in anthropology or archaeology, or equivalent training or experience. Equivalent training or experience means the applicant must have a minimum of two years of full-time professional anthropological or archaeological experience. In addition, the applicant must provide the permits office with one juried journal article, or other publication, he or she authored alone.

2. A demonstrated ability to plan and conduct research based on contemporary archaeological method and theory. Demonstrated ability means that the applicant must provide the permits office with a bibliography of authored archaeological manuscripts and publication(s).

3. At least four months of supervised field experience in survey, four months in excavation, and at least four months additional experience in artifact identification and the analysis and synthesis of archaeological data.

4. At least one year of full-time professional experience at a supervisory level in the study of archaeological remains. Experience gained as a university student research assistant or teaching assistant cannot be listed as professional supervisory experience.

Arizona Historic Preservation Act of 1982 (AHPA)

CODE CITATIONS: Title 41, Chapter 4.2 Historic Preservation, Article 1 General Provisions, A.R.S. Sec. 41-861 through 864.

PURPOSE AND GOALS: This act and its associated policies are administered in part by the Arizona SHPO and guide land-managing agencies and institutions through their responsibilities to protect and preserve archaeological and other cultural resources on lands they own or control.

Arizona Burial Protection Act of 1990 (ABPA)

CODE CITATIONS: Title 41, Chapter 4.2 Historic Preservation, Article 1 General Provisions, A.R.S. Sec. 41-865.

PURPOSE AND GOALS: This act makes it unlawful to disturb an unmarked human grave on private land in the state of Arizona without authorization.

Arizona Revised Statutes

CODE CITATIONS: Title 39, Chapter 1 Public Records, Article 2 Searches and Copies, A.R.S. Sec. 39-1255.

PURPOSE AND GOALS: Exempts information relating to the location of archaeological resources on state land and sites or objects that qualify for, or are included on, the Arizona Register of Historic Places from public disclosure requirements if the release of that information creates a risk of vandalism, theft or other damage to the sites or objects.

Appendix C: Detailed Description of Administrative Context

Professional Associations

The major American professional archaeological associations include:

- Society for American Archaeology (SAA)
- Archaeological Institute of America (AIA)
- American Anthropological Association Archeology Division (AAAAD)
- Society for Historical Archaeology (SHA)
- Register of Professional Archaeologists (ROPA)

Society for American Archaeology (SAA)

Founded in 1934, the SAA is an international organization with more than 6,100 members dedicated to the research, interpretation, and protection of the archaeological heritage of the Americas. The society represents professional, student, and avocational archaeologists working in government agencies, colleges and universities, museums, and the private sector.

SAA Principles of Archaeological Ethics[1]

In 1996, the SAA Executive Board, after extensive consultation with its members, adopted the *Principles of Archaeological Ethics*. This is a series of 8 hortatory and non-enforceable principles that nevertheless serve as ethical ideals towards which all archaeologists (whether SAA members or not) are encouraged to strive during the course of negotiating the complex responsibilities they have to archaeological resources.

Of the 8 ethical principles addressed, the following 3 are directly pertinent to the issue of the archaeologist's responsibilities with respect to the long-term preservation of archaeological records:

Principle No. 1: Stewardship

The archaeological record, that is, *in situ* archaeological material and sites, archaeological collections, records and reports, is irreplaceable. It is the responsibility of all archaeologists to work for the long-term conservation and protection of the archaeological record by practicing and promoting stewardship of the archaeological record. Stewards are both caretakers of and advocates for the archaeological record for the benefit of all people; as they investigate and interpret the record, they should use the specialized knowledge they gain to promote public understanding and support for its long-term preservation.

[1] Available at http://www.saa.org/aboutSAA/ethics.html.

Principle No. 6: Public Reporting and Publication

Within a reasonable time, the knowledge of archaeologists gain from investigation of the archaeological record must be presented in accessible form (through publication or other means) to as wide a range of interested publics as possible. The documents and materials on which publication and other forms of public reporting are based should be deposited in a suitable place for permanent safekeeping. An interest in preserving and protecting *in situ* archaeological sites must be taken in to account when publishing and distributing information about their nature and location.

Principle No. 7: Records and Preservation

Archaeologists should work actively for the preservation of, and long term access to, archaeological collections, records, and reports. To this end, they should encourage colleagues, students, and others to make responsible use of collections, records, and reports in their research as one means of preserving the *in situ* archaeological record, and of increasing the care and attention given to that portion of the archaeological record which has been removed and incorporated into archaeological collections, records, and reports.

Register of Professional Archaeologists (ROPA)

Formerly known as the Society of Professional Archaeologists (SOPA), ROPA is a listing of archaeologists who have agreed to abide by an explicit code of conduct and standards of research performance, who hold a graduate degree in archaeology, anthropology, art history, classics, history, or another germane discipline and who have substantial, documented practical experience. Although registration is entirely voluntary, it is nevertheless seen as a formal recognition of an individual's personal responsibility to be held accountable for their professional conduct.

Established in 1998, ROPA provides the mechanism for the easy identification of Registered Professional Archaeologists (RPAs). RPAs are listed in a directory, published annually, and updated quarterly on the Register's Web site at <www.rpanet.org/directory.htm>. RPAs may also identify themselves by displaying a registration certificate or by including the abbreviation 'RPA' after their names. At present, at least one staff member at the Center for Desert Archaeology is an RPA.

Unlike most other archaeological organizations, the Register of Professional Archaeologists is not a membership society. It is focused solely on the promotion and maintenance of professional standards in archaeology and the registration of qualified archaeologists. ROPA also certifies archaeological fields schools as meeting the basic requirements for training future RPAs.

Recognizing the crucial importance of these needs, ROPA was created by a joint task force of SOPA, SAA, SHA and AIA. Through a vote of its board and membership, SOPA voted to transfer its responsibility, authority, and assets to the Register and to enter into a dormant state. In turn, the SAA, SHA and AIA all voted to become sponsors of the Register. Sponsorship

means that these scholarly organizations endorse the mission of the Register, encourage their qualified members to register, and provide annual financial support.

It is interesting to note that, in contrast to many of the other codes of ethics and professional conduct, ROPA supports a formal grievance procedure that allows for the investigation of complaints about the professional conduct of an RPA. If an allegation of a violation of the code or standards is supported during an investigation, sanctions, including termination of registration, can be given.

Code of Conduct[2]

The ROPA Code of Conduct establishes specific guidelines for what RPA's shall and shall not do with respect to their interactions with the various groups who have a stake in the study, enjoyment and preservation of archaeological resources, including: the general public, colleagues, employees, employers, clients and students. Of particular relevance to this case study are the following sections:

II. The Archaeologist's Responsibility to Colleagues, Employees, and Students
  2.1 An archaeologist shall
    b. Stay informed and knowledgeable about developments in her/his field or fields of specialization;
    c. Accurately, and without undue delay, prepare and properly disseminate a description of research done and its results;
    d. Communicate and cooperate with colleagues having common professional interests;
    e. Give due respect to colleagues' interests in, and rights to, information about sites, areas, collections, or data where there is a mutual active or potentially active research concern;
    f. Know and comply with all federal, state, and local laws, ordinances, and regulations applicable to her/his archaeological research and activities;
  2.2 An Archaeologist shall not
    d. Refuse a reasonable request from a qualified colleague for research data;

Standards of Research Performance[3]

The ROPA Standards of Research Performance provide a set of minimum standards intended to address the belief that research archaeologists have a responsibility to design and conduct projects so that they: 1) add to the collective understanding of past cultures, and/or 2) add to the development of better theories, methods, or techniques for interpreting the archaeological record, while 3) minimizing the attrition of the non-renewable archaeological resource base. Of particular relevance to this case study are the following sections:

I. The archaeologist has a responsibility to prepare adequately for any research project, whether or not in the field. The archaeologist must:

[2] Available at http://www.rpanet.org/conduct.htm.
[3] Available at http://www.rpanet.org/conduct.htm.

1.1 Assess the adequacy of her/his qualifications for the demands of the project, and minimize inadequacies by acquiring additional expertise, by bringing in associates with the needed qualifications, or by modifying the scope of the project;
1.4 Ensure the availability of adequate and competent staff and support facilities to carry the project to completion, and of adequate curatorial facilities for specimens and records;
1.5 Comply with all legal requirements, including, without limitation, obtaining all necessary governmental permits and necessary permission from landowners or other persons;

III. Procedures for field survey or excavation must meet the following minimal standards:
3.4 All records should be intelligible to other archaeologists. If terms lacking commonly held referents are used, they should be clearly defined.

IV. Specimens and research records resulting from a project must be deposited at an institution with permanent curatorial facilities, unless otherwise required by law.

V. The archaeologist has responsibility for appropriate dissemination of the results of her/his research to the appropriate constituencies with reasonable dispatch.
6.2 Requests from qualified colleagues for information on research results directly should be honored, if consistent with the researcher's prior rights to publication and with her/his other professional responsibilities.
6.5 Archaeologists have an obligation to accede to reasonable requests for information from the news media.

American Anthropological Association - Archeology Division

The AAA, the primary professional society of anthropologists in the United States since its founding in 1902, is the world's largest professional organization of individuals interested in anthropology. The Archeology Division of the AAA was founded in 1983 to: 1) advance the study of archaeology as an aspect of anthropology, 2) provide a forum for members to discuss issues central to the development of archaeology, and 3) foster the publication and communication of the results of archaeological research and interpretations to anthropologists, to other scholars, and to the general public.

Code of Ethics of the American Anthropological Association[4]

Approved by the Commission to Review the AAA Statements on Ethics in 1998, the Code of Ethics of the AAA provides a set of principles and guidelines for anthropologists to utilize in developing and maintaining an ethical framework for all anthropological work. Of particular relevance to this case study is the following section:

B. Responsibility to scholarship and science

[4] Available at http://www.aaanet.org/committees/ethics/ethicscode.pdf.

5. Anthropological researchers should seriously consider all reasonable requests for access to their data and other research materials for purposes of research. They should also make every effort to insure preservation of their fieldwork data for use by posterity.

Society for Historical Archaeology (SHA)

Formed in 1967, the SHA is the largest scholarly group concerned with the archaeology of the modern world (A.D. 1400-present). The SHA promotes scholarly research and the dissemination of knowledge concerning historical archaeology. Geographically the society emphasizes the New World, but also includes European exploration and settlement in Africa, Asia, and Oceania. The ethical positions of the SHA are set forth in its newly adopted *SHA Ethical Principles*.

Society for Historical Archaeology Ethical Principles

Adopted in 2003, these principles are intended to help guide the professional archaeological practices of members of the SHA and others who actively participate in SHA-sponsored activities, as well as researchers in allied fields. This is a series of 7 hortatory and non-enforceable principles that nevertheless serve as ethical ideals. Of particular relevance to this case study are the following principles:

Principle 2

Members of the Society for Historical Archaeology have a duty to encourage and support the long-term preservation and effective management of archaeological sites and collections, from both terrestrial and underwater contexts, for the benefit of humanity.

Principle 4

Members of the Society for Historical Archaeology have a duty to collect data accurately during investigations so that reliable datasets and site documentation are produced, and to see that these materials are appropriately curated for future generations.

Principle 7

Members of the Society for Historical Archaeology encourage education about archaeology, strive to engage citizens in the research process and publicly disseminate the major findings of their research, to the extent compatible with resource protection and legal obligations.

Archaeological Institute of America (AIA)

Founded in 1879 and chartered by the United States Congress in 1906, this non-profit Institute is North America's oldest and largest archaeological organization, with more than 11,000 members belonging to 101 local societies in the United States, Canada, and overseas. The underlying tenet of the AIA is "that greater understanding of the past enhances our shared sense of humanity and enriches our existence." Indeed, the Institute exists "to promote archaeological inquiry and

public understanding of the material record of the human past worldwide…by educat[ing] people of all ages about the significance of archaeological discovery."

AIA Code of Professional Standards[5]

The AIA Code of Professional Standards sets forth three broad areas of responsibility—to the archaeological record, to the public and to colleagues—and provides examples of the kinds of considerations called for by each. Acknowledging the conflicts embedded in many of the ethical issues encountered by archaeologists, the goal of the AIA Code is not "to legislate all aspects of professional behavior." Rather, its stated purpose is "to encourage all professional archaeologists to keep ethical considerations in mind as they plan and conduct their research." Further, it emphasizes that, "as primary stewards of the archaeological record, [archaeologists] should work actively to preserve that record in all its dimensions and for the long term." Of particular relevance to this case study are the following standards:

Area 1. Responsibilities to the Archaeological Record

Professional archaeologists incur responsibilities to the archaeological record—the physical remains and all the associated information about those remains, including those located under water.

4. Archaeologists should anticipate and provide for adequate and accessible long-term storage and curatorial facilities for all archaeological materials, records, and archives, including machine-readable data, which require specialized archival care and maintenance.

6. All research projects should contain specific plans for conservation, preservation, and publication from the very outset, and funds should be secured for such purposes.

Area 3. Responsibilities to Colleagues

5. Archaeologists should honor reasonable requests from colleagues for access to materials and records, preserving existing rights to publication, but sharing information useful for the research of others. Scholars seeking access to unpublished information should not expect to receive interpretive information if that is also unpublished and in progress.

6. Before studying and/or publishing any unpublished material archaeologists should secure proper permission, normally in writing, from the appropriate project director or the appointed representative of the sponsoring institution and/or the antiquities authorities in the country of origin.

[5] Available at http://www.archaeological.org/pdfs/AIA_Code_of_Professional_StandardsA5S.pdf