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Geomorphological and Geoarchaeological Investigations in Support of Archeological Investigations

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Introduction

Geomorphological and geoarchaeological investigations on archeological sites should be designed to (1) establish the physical context of archeological deposits and (2) assist in assessing the effects of post-depositional (post-abandonment) environment on the condition or integrity of the archeological deposits. The physical context is three dimensional and has four major components: (1) morphology, (2) soils, (3) stratigraphy, and (4) biota. Because geomorphology is the study of earth surface processes, numbers 1 through 3 are directly in its realm. Number 4, biota, covers the role of flora and fauna, including humans, in shaping the landscape and therefore lies on the interfaces between geomorphology, biology, ecology, and archeology (social sciences). The role of people in the formation of archeological deposits is, obviously, the purpose of archeological investigations. Not as obvious is the important role of people and other biota in post-depositional changes that structure the archeological record.

The post-depositional environment consists of all the physical and biological forces that impinge on the archeological deposits after the archeological site is abandoned. Post-depositional conditions determine what archeological features and artifacts will be preserved. The major forces involved are (1) erosion, (2) deposition, (3) soil formation including biological activity, and (4) anthropogenic activity. Here the focus is on the archeological deposits themselves as a source of information on past human activity and the need to make decisions about site integrity and eligibility for the National Register.

Resources for preservation or excavation of archeological sites are limited; therefore, it is important to understand the condition of the deposits when designing research and making preservation decisions. For instance, specific sets of data are necessary to address specific research questions. The condition of the deposits in part determines whether the appropriate data can be recovered. In Wisconsin, a major factor in altering and destroying archeological deposits is Euro-American land use, especially farming, lumbering, and urbanization.

The guidelines focus on geomorphological and geoarchaeological aspects of locating and interpreting (developing a physical context that directly or indirectly aids in interpretation) archeological deposits. Archeological deposits are the result of the interaction of the four components outlined above with the material remains of human activity. The interaction begins when a landscape facet is occupied and continues until the soil/sediment is removed. The continuous interaction creates the archeological deposit and turns a landscape facet into an archeological site.

Physical context is, in some ways, analogous to historic context as outlined in the WAS Guidelines. As with a historic context, a physical context can be viewed as an "organizational framework" for the geomorphological and geoarchaeological variables. Continuing with the analogy, a geomorphic equivalent of a property type, the Landform-Soil-Sediment Package (LSSP) is suggested. The physical context of each archeological deposit is not unique; patterns exist and can be discovered. An LSSP characterizes the morphology of the land surface, the soils/sediments, and the stratigraphy, in three dimensions. Also, site formation processes can be addressed through the relationships between soils, vegetation, and biomechanical mixing regimes. LSSPs can be constructed from archival data and refined in the field. In combination with the soil-region approach to site location outlined in the WAS Guidelines, LSSPs will form project- and site-specific data for assessing site integrity and data potential (Criteria D for determination of eligibility), in the context of preservation planning.

The portion of the guidelines that follow are based on those recently adopted in Iowa (Association of Iowa Archaeologists 1993). Additional sections not covered in the Iowa guidelines pertain to geoarchaeological investigations of site formation processes and determinations of site "integrity," especially in regard to the direct and indirect effects of modern land use on archeological deposits.

All archeological projects need some level of geomorphological assessment. The level of assessment and the degree of expertise needed depends on the complexity of the landscape in the project area. Archeological deposits cannot always be located by examining the modern landscape surface (pedestrian survey and shovel testing). To determine the type of geomorphological investigation needed, the phase of the archeological investigation, the complexity of the landscape, and the archeological or geoarchaeological research questions should be considered.

Phase 1 Reconnaissance Survey

The goal of Phase I archeological survey is to identify and record all archeological properties in a project area. Perhaps it is useful here to view the geographic location of the project not as an area but as a volume, especially when considering the project's potential for destroying archeological resources. The role of geomorphological investigations at the Phase I level are twofold: (1) to locate and investigate areas of the landscape where the potential for buried archeological deposits exists, and (2) to aid in assessing the integrity of the archeological deposits. Archeological deposits are considered buried if they occur below the penetration depth of the archeological survey technique utilized. Generally shovel probing and pedestrian surface survey sample the upper 30–40 cm of the landscape. In areas where buried archeological deposits are suspected, soil-stratigraphic investigations should be designed to evaluate the potential of the buried environment for archeological deposits and suggest techniques for sampling that environment for archeological materials. The effects of modern land use on the archeological deposits is the major initial concern in assessing deposits' integrity.

Geomorphological investigations of large project areas or study corridors in which the final project design will impact only a portion of the area surveyed sometimes must be divided into standard survey and deep survey subphases. The reason for the two subphases is cost. If large parts of the project area have potential for buried soils and/or archeological deposits, the cost of subsurface geomorphic exploration to identify areas with archeological potential and then sample those buried environments to locate archeological material would be prohibitive. A solution is the two subphase approach carried out either during the Phase I archeological survey (geo-subphase 1 and 2) or during the Phase II archeological evaluation (geo-subphase 2). In the first subphase the parts of the project area with *potential* for buried deposits are identified, and standard archeological survey techniques are employed over the rest of the project area. In the second subphase the areas with potential for buried sites are investigated from both an archeological and a geomorphological perspective. If the area to be impacted by the project construction activities can be narrowed down, then the geo-subphase 2 should be conducted in the potential impact areas.

Pre-Field Investigation Preparation

Literature search. A search of the geological, soil science, and geoarchaeological literature should be conducted to locate information relevant to the project area and/or the project goals. The search should include technical reports, published material, and maps (especially the county soil surveys, published by the USDA, and the county surficial and Pleistocene geology series published by the Wisconsin Geological and Natural History Survey). Maps, especially 1:24,000 topographic maps, and the other sources, if extant, should provide information for the initial assessment of the potential for buried sites and provide, at least, a general physical context for the project area.

The project geomorphologist should coordinate scheduling and research goals, including (1) providing information to the archeologists for use in planning the archeological investigations and (2) determining project goals that need geomorphological data to be adequately addressed. To provide useful information a preliminary geomorphological field reconnaissance, with the archeologist, may be necessary, especially if landscape in the project area is complex.

Environmental assessment: land use history. Modern land use (post–Euro-American settlement) impacts archeological deposits both directly and indirectly. Understanding these impacts is important to determining the integrity of the archeological deposits and assessing their information. Because the impacts are relatively recent, the effects of the impacts and evidence for interpreting the impacts is easily obtained.

Previous to field investigations, if possible, a brief land use history should be compiled from old air photos, deeds, old maps, and old plats, to name a few. Much of the information for a land use history may already have been collected during records searches for the archeological and historical literature search. From the perspective of the environmental assessment, land use that results in ground-disturbing activities, including cultivation, excavations, or filling, should be documented. The effect of the land use identified during the record search must be confirmed during the field investigation. In addition, data collected during the records search is useful in determining what type of disturbance to look for and where to look for it during the field investigations.

Field Investigations

Environmental assessment during field investigation. Assessing the effects of modern land use on the landscape should be an integral part of all archeological surveys. Direct impacts fall into two very broad categories: (1) construction activities, especially in urban and suburban areas, and (2) agricultural activities, especially plowing and timber harvesting.

The types of construction activities associated with urban and suburban sprawl are numerous and their effects on archeological deposits need to be assessed on a case by case basis until research linking types of construction with degree of soil disturbance is undertaken. Just because an archeological project is in a suburban or urban area does not mean that in situ archeological deposits, both historic and prehistoric, do not exist. Archeological phenomena exist at a variety of scales, and therefore important archeological resources may be preserved in patches in urban and suburban areas.

The intensity and nature of construction activities varies from place to place and through time. For example, the pre–Euro-American soil surface in a backyard, park, or courtyard may be relatively undisturbed even in the midst of buildings and roads. Before the extensive use of modern excavating equipment and the “moonscape” approach to civil engineering, construction methods were very different and often less destructive to archeological deposits. Fill, depending on how and when it was emplaced, may actually preserve archeological deposits.

No project area should be summarily written off because it is in part covered by building and roads. The degree of disturbance to archeological deposits should be determined in the course of field investigations and/or by examining old construction or road-building plans or the building themselves to determine if the pre–Euro-American soil surface has been removed.

Landowner interviews conducted either when obtaining permission to enter private land or as a separate procedure are very useful for obtaining information on present and past land use. An effective approach is to use a map or air photo with the project area clearly marked and direct questions about land use to the specific project area.

Plowing has an obvious direct impact on archeological deposits. Less obvious is its indirect impact. Plowing exposes the soil surface to erosion, which proceeds at a rate many times greater than on a vegetated surface. The erosion results in the removal of soil by sheet flow, rill flow, and gullying. On many plowed fields erosion also results in the movement of artifacts downslope or the creation of artifact lags. Eroded soil and artifacts are transported to lower areas on or off the agricultural fields. In these areas the original A horizon or plow zone may be buried and isolated below the depth of cultivation. The direct and indirect impacts of cultivation on the archeological deposits should be an explicit component of the process of determination of eligibility.

Identification of areas with potential for buried archeological deposits. Geomorphic processes are all ultimately powered by gravity, by gravitational forces on water, and by wind. Gravity and water move material from high landscape positions to low landscape positions. Wind can move material either up or downslope. In general, especially with regard to gravity and water-laid deposits, low landscape positions are depositional and high landscape positions are stable or erosional. Low landscape positions or depositional landscape facets have potential for buried archeological deposits. Conversely, higher landscape positions or erosional facets (slopes) have low potential for buried archeological deposits. A couple of exceptions exist: (1) burial of archeological deposits by eolian sediments, which can occur anywhere, including uplands; and (2) burial and movement of artifacts by biomechanical processes within the soil, sometimes to depths below standard penetration of plows or shovel tests.

It is not yet possible to predict where on the landscape or within a geographical region archeological deposits may be buried by biomechanical processes in the soil. Suffice it to say archeological deposits can be buried by these processes and that further research will determine where biomechanically buried deposits occur and what the effect is on the archeological record. Using minimal training in soils and geology, archeologists can determine which parts of a project area have potential for buried archeological deposits.

In the field, landscape position and degree of soil formation can be used to locate areas where archeological deposits may be buried. Subsurface investigations should be conducted on floodplains, terraces (former floodplains), alluvial fans, and footslopes. Subsurface investigations should begin with the simplest and least expensive techniques, such as soil pits and hand probing, and move to more expensive and sophisticated techniques as needed. Degree of soil development can be used to get a gross relative age on the surface deposits: historic (A–C horizon sequence with depositional structures in the subsoil), prehistoric? (A–Bw or E–C horizon sequence), and prehistoric (A–E–Bt or Bs horizon sequences). Soils can be used to relatively date geomorphic surfaces but a detailed study is necessary. The tripartite scheme (historic, prehistoric?, and prehistoric) is designed to be used as one line of evidence in assessing the potential for buried archeological deposits. Field identification then involves interpreting multiple lines of evidence, landform, landscape position, and degree of soil development, to delineate areas with potential for buried archeological deposits.

Investigation of areas with potential for buried archeological deposits. Investigation of areas with potential for buried archeological deposits should be both archeological and geomorphological in nature. Strata/horizons identified in the subsurface should be de-

scribed using standard terminology and checked for artifacts, preferably by screening a sample of the matrix. Techniques for sampling a volume of soil/sediment for archeological materials at depth are fraught with logistical and statistical problems. However, it is necessary to apply state-of-the-art approaches to locating buried archeological deposits and begin developing efficient, cost-effective means of
doing so. Some suggested techniques are as follows:

1. ***Existing exposures**:* Stream bank cuts, gravel pits, road cuts, and any other existing exposure should be described. Exposures are extensive in some areas of the state and provide quick, inexpensive access to the subsurface.

2. ***Hand-excavated soil test units**:* These units are effective in sandy soils where exploratory holes can be dug quickly, allow for good vertical control as each unit is excavated, and expose soil/stratigraphic profiles to depths of 1–2 meters.

3. ***Backhoe trenches**:* Backhoe trenches are fast and economical, especially over large areas. They can expose large areas of buried soils for archeological sampling and expose soil/stratigraphic profiles to depths of 2–4 meters. If no stratigraphic or pedogenic indicators of buried archeological deposits exist, artifacts may be missed. Selected strata exposed in the profile wall should then be screened.

   Hand and power auguring (flight augers and bucket augers): A flight auger is essentially a large screw that delivers a continuous stream of sediment to the top of the hole; the depth of penetration depends on the sediment and the diameter of the auger (for example, a 12-inch-diameter auger can reach a depth of 8–10 feet in a silt loam or sandy loam soil; smaller-diameter augers can penetrate deeper). All material coming out of the hole should be screened for artifacts. There are problems with vertical control because only the upper profile and the cuttings are directly observable. Mixing of strata /horizons may occur. This technique can be used as a method of systematic deep sampling analogous to shovel testing, but it is best utilized in conjunction with techniques that expose a deep profile (excavations).

   Bucket augers recover an arbitrary interval of soil/sediment depending on the length and width of the auger bucket. The advantages of bucket augers are the depth control on the sample and the lack of mixing. The disadvantages are the lack of an exposed profile and the relatively long time required to sample deep into the subsurface. Bucket augers can be effectively used in conjunction with flight augers for sampling easily recognizable horizons or strata.

5. ***Hand and power coring**:* Various lengths and volumes of intact soil and sediment can be recovered and small-diameter cores taken by hand, but larger-diameter cores need a motorized drill rig. Intact cores are advantageous for soil and stratigraphic analysis but do not recover an adequate volume of soil for reliable archeological sampling. If cores are to be used for locating archeological deposits, the core should be of as large a diameter as possible and samples should be fine-screened by flotation. The hope is to recover small artifacts (microdebitage) or ecofacts that may indicate the presence of archeological deposits. Coring is best used in conjunction with some sort of open excavation.

6. ***Remote sensing*****:** Remote sensing uses various magnetic, electrical, and acoustic techniques for examining the subsurface. Techniques are too varied and setting specific to be outlined here; for a concise explanation of the applications in archeology (see Heimmer 1992). These techniques are useful for extending point data (trenches or cores) laterally over a larger area, increasing the strength of stratigraphic correlations. They should be used in conjunction with techniques other than remote sensing. Remote sensing techniques can also be used to identify some archeological features.

Evaluating the potential of buried environments for archeological deposits. Evaluating the potential of a subsurface environment for archeological deposits is basically landscape analysis with very few data points. The subsurface environment is defined by sedimentary environments and buried soils. Sedimentary environments provide information on the type of buried deposit or landform, and soil attributes provide data on the condition of the buried landscape before burial.

Buried soils mark former landscape surfaces, and soil attributes provide information on the environment during soil formation, particularly whether the soil was formed under well or poorly drained conditions. Nationally accepted guidelines have been established for identifying hydric soils (Wetlands Training Institute 1995) in conjunction with delineating wetlands. Hydric soils have organic surface horizons (peat or muck) or are mineral soils that are gleyed and/or mottled. Landscape position and/or environment of formation can be inferred from hydric features. All the soil morphological attributes of hydric soils can be identified in the field readily, with minimal training. Training received by a certified soil tester is all that is needed to describe a soils morphology. A manual published by the State of Wisconsin for soil testers is a inexpensive source that could also be used by archeologists *(Soil and Site Evaluation Handbook)*.

As in archaeology, in geomorphology there are always exceptions and corollaries that depend on context. Soil morphological features that result from soil formation under wet conditions are reversible if the conditions change and the soil becomes better drained. Climate change, for instance, could result in a soil becoming better drained, due to lower water tables. With the new soil-forming environment, soil morphology would begin to reflect the new conditions, imprinting over or destroying soil features formed under the wet conditions. Soils formed in deposits of early and middle Holocene age may be better drained during some part of their developmental history.

Determining sedimentary environments is complicated if a person lacks training in geology and sedimentology; a good description of the sediments, fossils, and sedimentary structures is necessary. The best approach is to familiarize oneself with some basic terminology by consulting some of the texts listed in the References Cited section.

Archeological deposits are rarely encountered during the reconnaissance coring. Therefore, recommendations are based on the *potential* for a buried soil to contain archeological deposits, given the stratigraphic and pedologic context. If the potential is high, the buried surface should be sampled for archeological material either by (1) exposing the surface for shovel probing or test excavations, or (2) using large-diameter core tubes or augers at close intervals to obtain large samples without exposing the buried surface. With the latter it is recommended that the archeological deposits be screened through very fine mesh to recover microartifacts or ecofacts indicative of human habitation.

Phase II Evaluation

The purpose of the soil and geomorphological investigations during Phase II archeological investigations is to (1) develop and interpret the geomorphic, pedologic, and stratigraphic history of the archeological deposits at the site and (2) determine the effects of the geomorphic and pedologic processes on the formation of the archeological deposits. If a geomorphic context for the Phase II investigations was not developed during the Phase I investigations, it should be incorporated as part of the Phase II investigations.

The geomorphological evaluation methods are flexible and consist of a two-stage approach. The first stage is collection of field data and samples. Field data are collected from archeological excavation units, backhoe trenches and cores. Backhoe trenches and cores are used in nearby off-site areas, and on-site in areas not being hand excavated, to obtain critical information for interpreting site stratigraphy and site formation processes. Field data consist of detailed descriptions of strata and soil horizons, photographs, and drawings. Descriptions follow standard terminology for soils (Soil Survey Staff 1975, 1993) and sediments (Tucker 1982; Collinson and Thompson 1982; Folk 1974). The types and number of soil/sediment samples taken depend on the types of laboratory data necessary to address pertinent research questions. The following forms of analysis are available for various types of geomorphological and geoarcheological investigations.

1. ***Basic characterization:*** This level of analysis provides descriptive data for general interpretation of pedogenesis, sedimentation, and site formation processes. A basic characterization is generally necessary for any extensive soil-geomorphic investigations.

2. ***Sedimentological analysis:*** This type of analysis furnishes data for interpretation of depositional units from the perspective of physical processes of sedimentation by both natural and cultural agents.

3. ***Chemical analysis:*** This form of analysis provides data for interpretation of cultural content of the deposits that is not preserved in macro form such as bone, ash, wood tissue, etc. It may also provide ancillary information on the formation of the deposits by distinguishing cultural from noncultural strata.

Report Preparation

A separate technical report on the geomorphological investigations should be prepared and included as an appendix to the archeological report unless the geomorphologist is one of the authors, not just a contributor. If the geomorphologist is not an author, the soil-geomorphic data should be integrated into the text by the archeologists with a citation to the appendix. The geomorphologist's report should include the following as a minimum.

1. Introduction

The introduction should contain

- the location of the project area relative to the landform and/or geologic regions
- the scope and purpose of the geomorphological investigations, especially relative to the archeological research questions and goals

2. Background Research

This section should include the locations of and a summary of literature and maps that provide information on the physical and environmental context of the project area. Included should be any information on landforms, soils, land use, geology, and environmental and geomorphic history as they relate to the location and interpretation of the archeological deposits.

3. Methods

The Methods section should provide descriptions of

- methods and techniques used and how they fit in with the goals of the project
- equipment and personnel used in the field and laboratory investigations.

4. Results of the Geomorphological Investigations

The Results section should

- provide a geomorphic/geologic map (a 7.5' USGS Quadrangle or portions thereof) of the project area that include the location of data points such as bore holes, soil pits, trenches, or exposures
- describe and interpret landforms, soils, deposits, and stratigraphy with the goal of constructing a physical contextual framework for interpreting the archeological and environmental data (including presentation of relevant field and laboratory data)
- integrate the geomorphology with the archeological investigations, including direct reference to research questions, potential for buried archeological deposits, effects of geomorphic and pedogenic processes on the archeological deposits, and possible paleoenvironmental reconstructions

5. Conclusions and Recommendations

The final section should present

- conclusions with regard to archeological and geomorphological research questions and project goals
- recommendations for further work if project goals have not been achieved, and/or recommendations for geomorphological and geoarcheological investigations for the next phase in the evaluation process.

6. References

7. Appendix

The appendix should contain the raw data from which inferences and conclusions were drawn, including (1) detailed soil and strata descriptions from profiles, exposures, and cores and (2) tables of all laboratory data, including radiocarbon dates and associated information. It should also serve as a data repository for use by other researchers.

Qualifications

Persons conducting geomorphological and geoarcheological investigations should have the ability to describe and evaluate the sedimentology, stratigraphy, and pedology of the deposits in and around the project area using standard terminology and techniques. The persons need not be geomorphologists but should know enough to bring in professional geomorphologists when needed. Much of the geomorphological-type investigation can and should be done by archeologists with earth science training. The minimum training should be a working knowledge of standard descriptive systems available for describing landscapes, soils, and sediments (see attached references). Standard descriptions not only provide an objective data base for geoarcheological and archeological research, they also facilitate communication with professional geomorphologists and soil scientists.

Geoarcheologist (Para-geomorphologist)

A geoarcheologist is an archeologist who, through experience, publication, or earth science training has

- acquired adequate skills to evaluate project areas, especially on Phase I reconnaissance surveys
- demonstrated familiarity with and ability to apply standard descriptive terminology in field situations
- experience in the Upper Great Lakes and/or Upper Mississippi valley

Project Geomorphologist

A geomorphologist qualified to be a project geomorphologist has

- completed or nearly completed a postgraduate degree in geology, physical geography, soil science (pedology), or Quaternary studies
- experience in the Upper Great Lakes and/or Upper Mississippi valley

Systematic Procedures for Landscape Evaluation

Geomorphological analysis is implicitly, to at least some degree, an integral part of all archeological investigations. The context of all archeological deposits is soil or sediments that occur on or within landforms. Archeologists are aware of the physical contexts of sites but often do not study the physical context of a site explicitly.

The following procedures are an attempt to design a scheme to assist archeologists in implementing geoarcheological and geomorphological investigations in conjunction with archeological investigations. The procedure is based on the concept of landscapes as a three-dimensional phenomenon, with the vertical dimension extending below the modern landscape surface. It is the vertical subsurface dimension that is important to interpreting formation processes and landscape history.

Landscape Hierarchy

Consider the landscape in the project area as a hierarchy of forms. The landscape consists of landforms that in turn consist of slopes. Initially, landforms and groups of landforms can be delineated on topographic maps and air photos. Detail must be added through a thorough field reconnaissance. Without the field reconnaissance, the landform map is not detailed enough to use at the scale of archeological survey. The landscape should be divided based on the surface morphology as follows:

1. First subgroup:

a. Interfluves and valleys in dissected landscapes, such as in the Driftless Area and in areas covered by glacial deposits older than Late Wisconsin.
b. Upland and lowland landforms in areas glaciated during the Late Wisconsinan.

2. Second subgroup:

a. The first subgroup is divided into landforms based on surface morphology.
b. For example: terraces and floodplains, or end moraine and abandoned lake basin.

3. Third subgroup:

The landforms are divided into slopes based on length and gradient. Archeological deposits exist on slopes or groups of slopes. Landscapes and landforms are generally larger than archeological deposits (sites). Often pedogenic and geomorphic processes at the scale of slopes are the most critical to interpreting the archeological deposits.

Evaluation of the Subgroups

The landscape morphology is only a part of the data necessary to interpret the landscape. The three subgroups are a hierarchy of forms, that is they are delineated on the basis of surface dimensions. In the geomorphic evaluation phase, the subsurface dimension is investigated. Shallow subsurface investigations and examination of existing exposures is a quick and inexpensive way to obtain information on soils and stratigraphy, especially in conjunction with Phase I archeological investigations.

Shallow subsurface investigations involve using hand probes or augers and small soil pits to gather geologic and pedologic information on landforms and slopes in the project area.

Deep subsurface investigations are necessary on depositional landscape segments that are Holocene in age and in which sedimentary sequences greater than 1 meter thick have accumulated. Machine coring and trenching are the most effective ways to directly investigate the deep subsurface. Remote sensing techniques (geophysics) can also be used but should be augmented with data from cores or trenches.

At the Phase I level, implementation of the landscape hierarchy would entail mapping landforms, with field checking and limited shallow and deep subsurface investigations as needed. The product would be a map that could be used to predict areas where there is potential for (1) archeological deposits buried by sedimentation or biomechanical processes, (2) eroded archeological deposits, and (3) the absence of archeological deposits.

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