3.0 DEEP TEST METHODS, RESEARCH DESIGN, AND TEST LOCALE DESCRIPTIONS

3.1 DEEP TEST METHODS

3.1.1 Introduction

A variety of different methods and techniques are employed to identify buried archaeological resources. These mainly include two types: mechanical procedures that require direct disturbance, most commonly backhoe trenching or borehole drilling, and various less intrusive geophysical techniques, such as resistivity, geomagnetics, and GPR. Each of these methods has advantages and disadvantages, and each can be effective in different environmental settings. For example, Monaghan and Lovis (2005) suggest that in Michigan backhoe testing is often the most predictable and cost efficient way of locating buried archaeological resources within relatively shallow floodplain or alluvial settings. In areas where impacts will be deeper than about 3 m to 5 m (10 ft to 16 ft), on the other hand, coring may be more expedient and cost effective. For locales with known sites, where minimizing disturbance is an issue, low impact geophysical and small-diameter borings may be the best way to proceed. At issue is that cost-benefit analysis must also consider the potential for disturbing the same archaeological site(s) one is trying to find. Regardless of cost or potential for disturbance, however, if a particular method is not reliable for discovery of buried archaeological deposits, it should not be part of the deep testing process to identify sites.

Three categories of methods were selected to test and compare for this project. These include 1) several remote sensing devices; 2) a two-step coring and augering process; and 3) a procedure that includes a combination of backhoe trenching and archaeological test unit excavation. None of these methods involved hand tools as their primary means of investigations but rather relied on the use of power equipment or sophisticated electronic instruments. Such tools were chosen to take advantage of modern labor-saving methods that free scientists in the field to focus on their primary job, assessing an area for buried archaeological sites. Generalized details of these techniques, their advantages and disadvantages, and the reasons they were selected, are discussed below. First, however, the types of methods that have been commonly used in Minnesota prior to this study are reviewed and discussed.

3.1.2 Deep Test Methods Used in Minnesota

A review of compliance reports from the past few decades in Minnesota indicates that deep test investigations, while often successful, have been largely idiosyncratic as to goals, procedures and methods. Interestingly, this review also shows that the most commonly employed techniques used to discover buried archaeological deposits in the state are actually similar to the deep test methods compared during this project. This is not surprising as the methods selected for our study were chosen, in part, because they are among the most commonly used for deep testing.

The most frequently mentioned methods used in Minnesota are various types of hand- and power-augering/coring. However, coring and augering procedures that are similar to those used in this research (see below) and, rarely, even backhoe trenching have also been applied. In some instances, these methods have been supplemented by the use of various geophysical methods, as well as methods aimed at recovering small-scale lithic material and microdebitage (Michlovic 2005; Skarr 1993). The goal of such supplemental studies, presumably, is to enhance the probability of identifying buried archaeological sites. The use of supplemental lab analyses, however, has often resulted in observations and interpretations consistent with the field observations (Mulholland et al. 2000a, 2000b)

Geophysical methods have been employed in the site discovery process, but they are used more frequently during either a later stage of deep testing or during the site evaluation (i.e., evaluation of National Register eligibility) process (e.g., Forsberg and Dobbs 1997). Their use for site discovery, however, has been advocated (Dalan 2001; Dalan and Bevan 2002). While backhoe testing also has been used in the deep test process, it usually has been employed only after an archaeological site was identified (Butler 2004; Nienow and Baltus 2003; Olson and Tate 1994; Summit Envirosolutions 2003), often to evaluate the National Register eligibility of the site. This results in a curious juxtaposition of deep site testing methods in which the most destructive procedure, backhoe trenching, is used to evaluate a site, while less invasive methods, such as coring and augering, are reserved for discovery. Presumably, backhoe trenching is used to investigate the archaeological significance of the site because it fully exposes the stratigraphy, sedimentology, and archaeological context and provides a level of detail that is not afforded by coring. The choice of coring for discovery and applying trenching only after archaeological deposits are suspected, as has been common in Minnesota, appears to be based on the untested assumption that coring is more cost-effective than trenching, despite the clear recognition that trenching may be more effective. The heart of the Mn/DOT DTP project is to address this very assumption by actually evaluating the relative costs and outcomes of different deep test procedures.

Regardless of goals or methods, deep test projects in Minnesota, particularly before the mid-1990s frequently were undertaken with the goal of simple site discovery, rather than discovery and evaluation, in mind. The basic philosophy of deep testing focused on discovery, while geomorphological context and evaluation of National Register of significance were secondary concerns that would be considered by further investigations. Although this approach fulfills the immediate requirements of the Section 106 compliance process, buried sites almost always require additional investigations to determine their National Register eligibility. Thus, in both the short and long run, focusing solely on site discovery in the best of cases postpones the inevitable, and in the worst of cases causes delays and/or increases costs. This latter point has been made by others with experience in deep testing in Minnesota (e.g., Foth and Van Dyke 1995; Hajic 1993).

The two most common methods that have been employed in Minnesota are augering, particularly using a bucket auger (Florin 2004) and, more recently, a mechanical coring and augering procedure that identifies and tests subsurface horizons that are believed to be of high archaeological potential (Kolb 1999a). The former was often performed by archaeologists while the latter by geologists. Regardless, the use of these methods was seldom placed within the multidisciplinary framework that integrates earth and archaeological sciences advocated here. Archaeologists untrained in earth sciences who undertake deep testing risk overlooking or misunderstanding subtle and important details concerning the archaeological potential of buried surfaces and/or misinterpreting the basic structure and age of the subsurface sediments. Conversely, when earth scientists untrained in archaeology undertake deep testing, they focus less on archaeology and buried site potential and more on addressing questions of interest to geologists. We believe that each of these perspectives is necessary and important to a good faith effort to identify deeply buried archaeological sites. Simply identifying the most successful site identification or least expensive method(s) is only a small part to formulating a scientifically sound, cost-effective deep test protocol.

A few of the coring investigations employed to test for buried sites in Minnesota have, in fact, successfully identified paleosols (Kluth 2002; Mulholland et al. 2000a, 2000b). Some that have utilized augering to identify deeply buried archaeological sites also have been relatively successful (Butler 1993; Justin and Peterson 1990). However, these investigations generally lacked any clear assessment of the dynamic, three-dimensional geomorphological context of the discovered buried archaeological deposits. As a consequence, projects have sometimes been delayed or required a great deal of additional work. In a few instances, the lack of sufficient upfront geoarchaeological data has also resulted in deeply flawed Phase II and Phase III excavation strategies (Hajic 1993; see Foth and Van Dyke 1995).

For example, at site 21PL0077, where coring resulted in the identification of a paleosol associated with a bison kill, backhoe trenching subsequently was employed to establish whether archaeological deposits were in fact associated with the paleosol(s) (Summit Envirosolutions 2003). Due to time constraints of the project, which were compounded by the fact that the Phase I deep test investigations did not confirm or contextualize the initial findings, the confirmatory backhoe trenching, accompanied by limited archaeological investigation, was conducted during the winter under clearly less than ideal field conditions. Had backhoe trenching been conducted in the identification process, then these situations may not have occurred. Additionally, small cores do not provide nearly the quality of contextual information that is afforded by long-profile trenches, which affects the evaluation process. In one instance, for example, a piece of root was submitted for ^{14}C age estimate from a core and resulted in a confusing chronology and stratigraphy (Kluth 2002).

While a staged methodology to discover and evaluate buried sites is excellent in theory, such an approach to applying various methods and procedures is neither efficient nor effective, particularly if not undertaken within a multidisplinary, geoarchaeological framework. For example, another project (Nienow and Baltus 2003) also used coring for initial site discovery. In this case, a series of paleosols at depths up to 185 cm (73 in) was identified and then shovel tests were excavated to recover archaeological materials and confirm the presence of a site (Nienow and Baltus 2003). The discovery of cultural material in the subsurface prompted further examination of the buried deposits using an arsenal of techniques including augering, backhoe trenching, additional coring, and excavation of hand excavated test units. These ultimately resulted in a recommendation that a Phase II investigation be initiated to more formally evaluate the National Register eligibility of the site.

Given the plethora of deep testing methods approaches taken in Minnesota in the past, the different deep test methods selected for this project are discussed in detail below from least intrusive to most intrusive.

3.1.3 Remote Sensing Methods for Deep Testing

Because geophysical methods of subsurface investigation seldom involve direct subsurface disturbance, they are generally the least intrusive site exploration procedure (Somers and Hargrave 2001). Additionally, except for the relatively high equipment cost, geophysical surveys can be rapid and inexpensive. A variety of efficient geophysical techniques can be used to identify archaeological features or understand the distribution of buried soil horizons and other natural and cultural disturbances within relatively large area. However, the choice of methods depends on several methodological, natural, and cultural considerations, and the relative importance of these at any given location. The most important of these are survey objectives, archaeological research questions, underlying geology, local geomorphology and topography, prior geophysical or other survey results, and the time, money, and personnel available for the project (Clark 1990:124-31; Kvamme 2001:379). For a variety of reasons discussed below, at least for the depositional settings and archaeological site types common in the upper Midwest, geophysical methods are seldom effective at finding sites with the degree of confidence desired within the Section 106 review process.

In general, the success of nearly all geophysical techniques rely on the presence of cultural material or features that contrast in some fashion with natural sediments and soils (i.e., composition, size, shape, etc.). Examples of such contrasting phenomena include concentrations of fire-cracked rock in an otherwise fine-grained matrix; large metal objects in sandy soil; or compacted earth associated with prehistoric palisades (e.g., Martin et al. 1991; Nobes 1996; Peterson 2003a). As a consequence, such approaches are generally most effective for large historic sites or within urban landscapes where relatively extensive cultural features, such as building foundations and large metal artifacts, occur in abundance, and in cemeteries (Clark 1990; Shaffer et al. 2004; Shapiro 1984; Weymouth 1986). Research undertaken through the Glenn Black Laboratory for Archaeology, Indiana University, has applied resistivity, magnetic, and GPR survey techniques to successfully map subsurface features and disturbances over large areas of the Middle Mississippian Angel Mounds site (Peterson 2005), as well as grave shafts in historic cemeteries (Ball 2001; Peterson 2003b, 2003c; Shaffer et al. 2004).

Geophysical techniques are often less successful for locating temporary camp sites often found in the glaciated Great Lakes and upper Midwest regions. This kind of site may contain only small numbers of rather ephemeral features and, on such sites, natural anomalies can often have a stronger signature than those associated with cultural activities. Distinguishing such natural features from those related to cultural activities, particularly in buried contexts, is a significant challenge for remote sensing technology. These limitations are particularly true for resistivity and geomagnetic techniques. For example, in areas that commonly contain cobbles in their matrix (e.g., till, fluvial gravel), fire-cracked rock concentrations may not stand out from the surrounding matrix (Nobes 1994). Because they generally rely on the presence of some type of soil or sediment anomaly, the origin of which is usually unknown, geophysical explorations typically show positive results for subsurface features. These can be buried archaeological features or natural soil and sedimentary anomalies (e.g., well-indurated argillic B-subsurface soil horizon, channel fill, peat deposit, etc.).

Outcomes for geophysical exploration undertaken within areas of unknown archaeological potential can be equivocal and usually require a relatively high level of interpretation to argue for the presence of archaeological resources (Nobes 1994). The horizontal and vertical resolution, and consequently the ability to accurately interpret features in the subsurface, is scalar dependent. On prehistoric sites with relatively small and limited numbers of cultural features, for example, magnetic survey should be performed with transect spacing of <1 m (<3.3 ft). However, this also means that natural features are also more apparent, which can lead to confusion or mask cultural features due to this "noisier" data. Consequently, these methods are more typically applied during later phases of work related to exploration of known or newly-discovered buried sites. They are most useful for tracing known strata to determine the site boundaries or the remnants of larger-scale features like fragmentary and partially destroyed earth works (Peterson 2003b, 2003c).

Recognizing all of these limitations, we have, nevertheless, included remote sensing methods in this research and selected three different geophysical survey techniques. These include magnetometry, electrical resistivity, and GPR. These were chosen both because they are among the most commonly applied survey techniques used in archaeological research, but also because they measure different properties of the subsurface, are able to "sense" the subsurface at different depths, and are effective in different environmental and depositional settings. For example, magnetic survey data is mainly restricted to two-dimensional measures of the relative intensity of magnetic fields present near the ground surface (i.e., < 1 m [3.3 ft] depths). Resistivity, when used as multi-probe arrays, and GPR can provide deeper, three-dimensional information, not only about the depths and configurations of anthropogenic features, but also about soils, subsurface moisture conditions, depths to bedrock, and presence of underground voids. In addition, these methods, particularly GPR, can provide detailed images of subsurface sedimentary structures and features.

Magnetic Survey Methods

Magnetometry has a long history of use in archaeological survey. The first controlled survey was performed by Aitken and Hall in England (Aitken 1958), and the first in North America was performed at the Angel Mounds site in Indiana (Black and Johnston 1962). These early surveys were hampered by low instrument sensitivity, inability to control for diurnal shifts in the total magnetic field, and computational limitations. Surveys were uncommon over the next few decades (e.g., Garrison et al. 1985; Weymouth and Huggins 1985), with European practitioners devoting more attention to developing methods and applications (e.g., Graham and Scollar 1976; Scollar et al. 1986; Tite 1972). As both sensors and computers evolved, the number and quality of surveys increased substantially. Magnetometry for archaeological survey is now widely used in cultural resource management in the United Kingdom (Schmidt 2003) and the United States (Kvamme 2001). Hundreds of archaeological magnetic surveys have been published in North America. These range from a series of surveys of prehistoric and historic period Native American villages in North Dakota (Weymouth 1986) to discovery of an Archaic site in Texas (Martin et al. 1991). The National Park Service now supports a comprehensive database of archaeological magnetic surveys (North American Database of Archaeological Geophysics [NADAG] 2005). Large-scale surveys of Midwestern prehistoric town sites include Peterson (2003a) and Butler et al. (2004). Recent trends are toward increases in spatial extent and sensor sensitivity and increasing the depths, dimensions, and precision at which features are can be resolved.

Archaeological magnetic prospecting is one of the best established survey methods because of the relative speed of coverage and sensitivity to archaeological features (Clark 1990:130). Using equipment similar to that employed in this study, magnetic surveys are generally effective in measuring anomalies in the top meter of deposits on archaeological sites where the target features are of relatively low magnetic contrasts (Clark 1990:78-9). Magnetic surveys attempt to map deviations in the local magnetic field gradient, which is zero at all locations if the magnetic field within the survey is uniform. If deviations occur, they can be caused by many natural and cultural factors, including the presence of archaeological features. The anomalies in the local magnetic field gradient reflect changes in iron present within sediments, rocks, soil horizons, artifacts, and anthropogenic features and ultimately relate to soil chemical reactions and bacterial activity, as well as cultural practices such as heating of iron particles and minerals (ceramics, fire-cracked rock, etc). Buried cultural features are primarily detected by sensing contrast in the magnetism of objects or fill found in the features and surrounding matrix (Weymouth 1986:344). The more magnetically pronounced the archaeological record, the greater the field distortion and the greater the feature contrast in the survey map, which at archaeological sites relates both to cultural processes that formed the anomaly and the amount of time that natural processes act to disturb and mix the cultural features.

Magnetic surveys are typically conducted using a grid system, with magnetic measurements taken point by point at set intervals within the grid. The point data are then assembled to create a contour map showing the changes in magnetic contrast within the gridded area. Ultimately, the analyst's goal is to distinguish between magnetic anomalies resulting from cultural phenomena and those derived from non-cultural, natural processes. Although some guidelines have been developed concerning the magnitude, size, and types of magnetic contrasts, researcher experience still remains the most important factor in distinguishing between natural and cultural features (Kvamme 2001:356). At archaeological sites, cultural features can be detected because soil disruptions (pits or trenches) and buried artifacts interrupt the more uniform magnetic field of the undisturbed sediment and soil matrix, and the resultant magnetic contrast between the features and surrounding matrix can be mapped during the survey.

Resistivity Survey Methods

Resistivity, like magnetometry, has a relatively long history in archaeological research and is extensively used throughout Great Britain. Like magnetics, resistivity is widely used in archaeological prospection because it is sensitive to many of the targets that are commonly encountered on archaeological sites. The main advantage of resistivity over magnetic and GPR surveys at prehistoric archaeological sites is that it is less susceptible to the noise created by modern metal objects in the ground. It also performs well in rough or densely wooded settings. Compared to magnetics, however, resistivity can perform well near modern structures or debris containing iron. The instrumentation is also relatively inexpensive to own and operate (Kvamme 2001:360). Resistivity survey is one of the best established remote sensing methods because of the relative speed of spatial coverage and sensitivity to archaeological features. However, as configured for this study, the resistivity survey took three to four times longer than magnetometry or GPR and required double the personnel to complete. This reflects the complexity of the type of three-dimensional, multiplexed survey performed during this project.

Resistivity surveys are well suited to detect variation in soil strata; buried anthropogenic features such as foundations, graves, and hearths; and near surface hydrological (groundwater) conditions (Carr 1982). Resistivity data is usually collected from point locations on a grid. The point data are then used to construct a map showing continuous variation in the calculated resistivity across the survey area. A DC electrical current is induced into the soil via metal probes, and the ability of the soil near these probes to conduct the current is measured. Conductivity variation is controlled by soil moisture and other soil properties (Clark 1990), but ultimately depends on soil porosity, the degree of saturation, and the concentration of dissolved salts (Carr 1982:54-60). For example, wetter soils conduct electricity better than dry soils and, therefore, have lower resistivity. Fine-grained and clay-rich soils are relatively better conductors than coarse-grained soils, such as sand and gravel. Soil salinity decreases resistivity because salts are relatively good conductors of electricity. Of interest to this study, prehistoric cultural features, such as pits or hearths, typically show low resistivity values because their fill has decreased pore space and higher organic content compared to the surrounding matrix (Clark 1990:124-125), though this relationship is also dependent on water saturation. Even subtle differences in soil properties between features and surrounding soils allow moisture differences that result in a resistivity contrast. Resistivity survey results can also vary simply by season or because of specific environmental conditions at the time of survey. For example, droughty conditions at an archaeological site can decrease resistivity contrast between features and surrounding soils to such an extent that features become invisible.

In a uniform subsurface, resistivity surveys are sensitive to depths between 0.5 and 1.0 times the probe separation distance (Scollar et al. 1990:321-324). Thus, instruments with 50 cm (20 in) probe separation, sense about 25 cm to 50 cm (10 in to 20 in) into the ground, while those with 1.0 m (3.3 ft) separation sense 0.5 m to 1 m (1.7 ft to 3.3 ft) deep. Probe spacing can be increased to suit conditions, though the deeper the survey, the lower the resolution of individual targets. The potential difference measurements are directly proportional to the changes in the deeper subsurface. Apparent resistivity values calculated from measured potential differences can be interpreted in terms of overburden thickness, water table depth, and the depths and thicknesses of subsurface strata. In practice, the depth of penetration for any individual probe pair is variable across space, as currents induced by the instrument refract at layer boundaries causing distortion. With the right instrument configuration resistivity can allow three-dimensional mapping of the subsurface. In this study, a series of progressively deeper electrical potential difference maps were acquired using five successively greater electrode spacings that induced current through successively deeper layers to create a three-dimensional, multiplexed resistivity subsurface model. Because the relationship between electrode separation and depth sensitivity is complex, the vertical scale quoted for the pseudo-sections displayed are approximate. Because the precision of resistivity profiles diminishes as the inverse square of the electrode spacing (United States Department of Energy [DOE] 2000:25), only relatively large anomalies can be resolved within deeper profiles. However, small features can be resolved from near-surface contexts using three-dimensional, multiplexed resistivity instrumentation.

Ground Penetrating Radar Survey Methods

Ground penetrating (or probing) radar is a high-resolution method for discerning structures or features that are shallowly buried in soil or sediment. It generally images subsurface anomalies using electromagnetic (EM) waves in the 10 MHz to 1000 MHz frequency range. The EM waves of such short wavelength can be generated and radiated into the ground to detect anomalous variation in the dielectric properties of soil and sediment. In this fashion, GPR methods work for similar reasons as resistivity and magnetic techniques and attempt to reveal areas that contain contrasting soil properties. GPR uses differences in the amount and type of EM wave reflection that occur within the subsurface to map the distribution of contrasting underground structures. GPR can actually determine the three-dimensional position of such buried features. When a radar (EM) pulse is emitted into the ground, part of the wave is reflected back to the unit when it encounters any electrical discontinuity in the subsurface. By measuring the time between transmission and reception of reflected pulses, depths to subsurface features can be determined. Ultimately, the depth of penetration and ability to resolve small objects depends on the pulse wavelengths, on the character of the subsurface geology, and on electrical properties of the objects causing reflections. By making parallel traces or grid patterns, GPR can achieve good definition of buried objects. Wavelengths of GPR systems vary from 50 MHz to 1000 MHz, with the longer (lower MHz) waves providing greater depth penetration but less angular resolution. Archaeological work sometimes uses short wavelengths of the 1000 MHz instruments for resolving small objects but can detect only those near the surface (<1 m [<3.3 ft] deep). Geological and archaeological survey applications for characterizing relatively large and shallow features use a 250 MHz instrument.

GPR was developed in the mid-1950s but improved significantly after 1970. It has been regularly employed in archaeology for only about 20 years, which is relatively young compared to magnetic and resistivity techniques. The method is quite useful in a wide-range of environmental settings where assessing the structure of the shallow subsurface is important, including detecting underground pipes, tunnels, utilities, faults, lithologic changes, groundwater depths, and large-scale sedimentary features (e.g., Sutinen 1992; Dagallier et al. 2000; Nobes 1996; Shaffer and Powell 2001; Wenning and Shaffer 2001a, 2001b). It has also been used to study soil and other unconsolidated sediments (e.g., Bristow and Jol 2003) as well as in engineering projects (e.g., Goodman 1994; Zeng and McMechan 1997). GPR is rapidly becoming accepted as a valuable component of many archaeological projects (Ball 2001; Conyers and Goodman 1997; Kutrubes et al. 1997; Llapis and Sharp 1997; Parasnis 1997) because it is easy to use, nondestructive, and noninvasive (Wynn 1986, 1990). GPR has been used to detect unmarked burials within historic cemeteries in Indiana (Shaffer et al. 2004) and elsewhere (Bevan 1991; Davenport et al. 1992; Unterberger 1992), as well as for other more general forensic work (Mellett 1992).

Regardless of the recognized suitability of GPR techniques to discern shallow features or buried horizons at archaeological sites, limitations, some of which are severe, do apply. Fundamentally, GPR is most effective when used in areas where soils and sediments have generally low electrical conductivity, which is characteristic of unsaturated sand and other coarse-grained deposits. Conversely, GPR is usually much less effective, and sometimes completely ineffective, when working with high-attenuation media, such as saturated clays or silty sediments. Taken as a whole, these basic factors suggest that GPR surveys to assess buried components of archaeological sites are probably most valuable when applied to settings in sandy uplands, such as dune fields, and are least useful when applied to lowland settings in low-lying, saturated, fine-grained alluvial contexts, such as backswamp environments. This is not to say that all alluvial settings are necessarily poor candidates for GPR survey. For example, well-drained coarse-grained sediments typically make up levee or alluvial fan landforms. These are not only attractive for human settlement, but also are depositional environments with a high potential for preserving buried soil surfaces (Bettis and Benn 1984; Bettis et al. 1991; Bettis and Hajic 1995; Bettis and Mandel 2002; Monaghan and Hayes 1997, 2001; Monaghan and Lovis 2005). In fact, alluvial fans are usually assigned the highest potential for the preservation of buried archaeological sites by Mn/Model's Landscape Suitability Models (Hudak and Hajic 2001), and such locations could yield excellent GPR survey results.

3.1.4 Coring and Augering Methods for Deep Testing

Drilling, using continuous core recovery equipment, is a common and effective tool for buried site exploration, but, like geophysical survey methods, also includes its own set of positive and negative features. Coring procedures are frequently used in both historic and prehistoric archaeological site investigations as well as in buried site exploration (Canti and Meddens 1998; Stein 1986, 1991). While hand coring using gouge probes (e.g., Oakfield samplers) or bucket augers is commonly employed for shallow investigations of archaeological sites (Schuldenrein 1991; Stein 1986, 1991), power coring devices have become more common during the past decade, especially for studies of deeper (>1 m to 2 m (3.3 ft to 6.6 ft]) sites. Importantly, augering cannot recover undisturbed samples of the subsurface and is not nearly as valuable as coring for understanding depositional, pedological, and/or archaeological processes. Regardless of high equipment costs, power coring remains more cost-effective than hand augering, with which it is impractical to investigate the subsurface of relatively large land parcels at depths greater than one or two meters. The most common powered coring tools include vibracore devices and split-spoon sampling using a hollow stem auger, as well as hydraulic equipment such as Gidding's Drilling Rigs or GeoProbes. These latter two types of equipment can also drill deep auger holes using flight augers. The primary advantage to coring procedures is the ability to transport modern drilling rigs into remote areas and provide a rapid, *visual* assessment of stratigraphy and/or buried surface or soil horizons with only moderate disturbance of the subsurface.

Vibracore devices work best in saturated and semi-saturated deposits, but are somewhat less effective for core recovery in dry or dense upland sediment. The equipment necessary is relatively small, inexpensive, and usually easily transportable by an individual. Vibracoring generally requires a small gasoline engine and works by vibrating a rigid tube through sediment. The vibration of the sample tube partly desegregates the sediment and allows recovery of a continuous, up to 8-cm to 10-cm (3-in to 4-in) diameter, solid core. The lengths of these cores are determined by the practical length of the sample tube, but are usually 2 m to 3 m (6.6 ft to 9.8 ft) long. Vibracore sample recovery from more than one sample tube length is seldom possible because of equipment constraints.

Split-spoon sampling requires a much larger drilling rig and is typically performed using a 60-cm (2-ft) long, 5-cm (2-in) diameter core tool that is inserted into a hollow-stemmed auger. Larger core devices are sometimes employed and require even larger drilling rigs. The split-spoon coring device is driven into the ground the length of the spoon (i.e., usually 60 cm [2 ft]) using a hammer-blow tool mounted on the drilling rig. Once hammered the length of the spoon, it is withdrawn, opened, and the sample is extracted. The hollow-stemmed auger is subsequently drilled down the length of the split-spoon core, and the operation is repeated. In this fashion, a series of core samples can be taken to form a more or less continuous core of any length.

Hydraulic coring devices, such as Gidding's and GeoProbes devices, are similar to split-spoon devices but are usually smaller and less expensive, but are still usually either truck or trailer mounted. To recover sediment cores, a 2.5-cm to 5-cm (1-in to 2-in) diameter hollow tube (usually a 2 ft to 6 ft [0.6 m to 1.8 m] long and made of plastic or aluminum) is mounted into a rigid core barrel, which is then hydraulically pushed (using rapid short hammer strokes) into the ground the length of the core tube. Once the appropriate depth is reached, the tube is pulled out of the ground and the core sample is either pushed from the sample tube or the tube is cut in half and the core extracted. Like split-spoon sampling, a continuous solid-earth core can be collected by inserting another core sample tube into the previous core hole and again pushed the length of the sample tube. Under the best of conditions hydraulic coring devices can recover cores up to 15 m to 20 m (49 ft to 66 ft) long, but more typically are limited to <10 m to 12 m (< 33 ft to 39 ft).

Although they are often lumped together, coring and augering are actually two very different processes and we believe that coring usually produces superior results. Coring (which includes Hydraulic, Split-spoon, and Vibracore techniques) can collect a series of vertically-continuous, solid earth cores that when assembled provide an intact, undisturbed profile showing exact depths, stratigraphic relationships and contexts of the buried soil, sedimentary or archaeological horizons. The most important aspect of this is that the context and subtle sedimentary or soil features are not disturbed by the coring processes. Augering, on the other hand, uses powered posthole-like screws or hand-turned bucket-type augers to bring pieces of disturbed sediment to the surface for sampling. Importantly, unlike solid earth coring methods, augering does not provide undisturbed samples. For example, in order to bring sediment to the surface, power augers depend on drilling into the bottom of the auger hole and then "screwing" sediment upwards using a set of flight-auger screws. As a result, the original context of samples is destroyed by mixing and often pieces of sediment, which may contain artifacts, bone, or charcoal, can become incorporated into the sample from anyplace on the auger-hole side-wall. This is also true for bucket auger sampling. Additionally, both of these methods disturb soil and sedimentary structures as part of the sampling process making all but the most basic environmental, sedimentological, or pedological reconstructions impossible.

The use of large-diameter bucket augers has been proposed as a quick and inexpensive method to obtain cores of the subsurface (Schuldenrein 1991). However, we do not believe that such a procedure is reliable enough for buried site discovery. The use of bucket or power augering for buried site discovery cannot yield anything close to the range and quality of continuous, undisturbed core data and, as discussed in Chapter 12, is also probably at least as expensive as the preferred methods for all but the most shallow investigations. The disturbed nature of the samples derived from augering as well as their lack of detailed sedimentological or pedological context means that any artifacts that might be found within the samples cannot be reliably related to a specific depositional or stratigraphic context. While neither power nor hand augers can yield the same high quality geological and sedimentological information as other solid-earth coring methods (Stein 1991), power augering actually may have a place in the deep testing process. For example, because small diameter cores (2 cm to 4 cm [0.8 in to 1.6 in]) are too small to recover artifacts at any but the more artifact rich sites, larger diameter augers could be used to obtain a sample of a horizon that was identified through coring as having a high potential to contain archaeological materials. In fact, such a two-step coring and augering process previously has been used for deep testing in Minnesota and surrounding states (Hudak and Hajic 2001; Kolb 1999a, b, 2001, 2002, 2003a, b) and is one of the procedures selected for testing in this study.

While the focus of this study is to evaluate methods for buried site discovery, determining the usefulness of techniques for collecting subsurface information that can be used during the National Register eligibility evaluation process is also important. From this perspective, because it only marginally impacts archaeological deposits, core data are often effectively employed to trace known, well-defined archaeological deposits within the subsurface (Schuldenrein 1991; Stein 1986). Coring can be used to demarcate site boundaries or trace site remnants and can also be used to determine where excavation block locations should be placed to maximize archaeological information. Such a procedure was used at the Converse Site (20KT2) for the US 131 S-Curve bridge replacement project in Grand Rapids, Michigan (Hambacher et al. 2003) to establish the limits of a relatively undisturbed deeply buried occupation midden and to guide the placement of excavation blocks for data recovery efforts at the site (Monaghan and Hayes 2002).

One of the critical factors for coring on archaeological sites, buried or not, is that all the tools employed in the process are relatively non-intrusive. Depending on the equipment used, only a 1-in to 6-in (2.5-cm to 15.2-cm) diameter core will actually impact the archaeological deposits. An important advantage of continuous coring is that, unlike geophysical methods, sediments and soils can be directly observed. Limitations, however, do exist. The typical small-diameter sediment cores recovered using most coring rigs allow only a limited view of the sedimentary (i.e., bedding types and extent) and soil characteristics. Additionally, as mentioned above the probability of actually recovering archaeological material from the types of prehistoric sites characteristically found in the upper Midwest in small diameter cores is small. Sediment cores are not likely to include direct evidence for an archaeological site (i.e., artifacts and cultural features) unless sampling intervals are increased to replicate that of shovel testing.

Despite its limitations, coring was selected as one of the three procedures investigated for this project. The deep test coring procedure we employed is a two-step process. We collected standard 1.75-in (4.5-cm) diameter cores to document the stratigraphy and reconstruct a three-dimensional model of the subsurface. The size of the core was chosen to maximize successful penetration in all types of sediments. Based on their stratigraphic, pedological, and sedimentological characteristics, surfaces and horizons that might contain buried archaeological deposits were identified and mapped. These archaeological target horizons were then sampled for cultural materials using 4-in and 5-in (10-in and 13-cm) diameter flight augers. More details of the coring/augering deep test procedure are provided in Chapter 4.0.

3.1.5 Backhoe Trenching Methods for Deep Testing

Of all the techniques commonly employed for deep testing, backhoe trenching is the only one that exposes a relatively long, continuous soil and geological (sedimentary) profile. These profiles provide a complete view of the subsurface and allow direct examination of sedimentary units. Sedimentary features (i.e., bedding types and extent) and soil characteristics thus can be accurately determined, while buried soils and associated archaeological features and/or artifacts are commonly uncovered during backhoe trenching. If artifacts are not observed in the profile, relatively large volumes of soil can be screened to establish their presence and facilitate the assessment of the integrity and significance of the deposits.

While backhoe trenching may be one of the most effective methods for discovering buried archaeological resources (Monaghan and Lovis 2005), it has several significant drawbacks. It is clearly the most intrusive and potentially destructive of the methods typically used for buried site exploration. Moreover, the maximum depth that can be realistically explored is limited by equipment constraints. In most cases, only the upper 3 m to 5 m (9.8 ft to 16.4 ft) of sediment can be effectively tested without seriously expanding the backhoe trench. Although alluvial deposits in smaller drainages in the upper Midwest are commonly not much deeper than this, larger systems, such as the Mississippi and Red River, usually include sediments that may contain archaeological deposits at considerably greater depths. In practice, the practical depth of backhoe testing is more limited. For example, the strength of trenching, the ability to observe long continuous profiles, is only valuable if one can physically inspect the trench wall. Once the trench extends deeper than 1.5 m to 2 m (4.9 ft to 6.6 ft), the trench becomes dangerous to enter without stepping the wall back or installing trench boxes. While both of these safety measures meet OSHA work place standards, they also severely limit visual inspection of the trench wall or compromise the intact nature of the trench profile. Although many states have established guidelines as to the number of trenches and their placement, from a practical standpoint the number of and distances between trenches often depends on the testing objectives, topography, and stratigraphy at the test locale. The maximum depth of trenches is also controlled both by the stratigraphy observed during excavation and by physical constraints such as the maximum extension of the backhoe boom, groundwater levels, and wall stability (Monaghan and Lovis 2005).

Backhoe trenching is the final method selected for evaluation in this project. Experience elsewhere in the upper Midwest has demonstrated that backhoe trenching can be an efficient and cost-effective method to discover buried archaeological sites (Monaghan and Lovis 2005). This is because only one visit to a test locale is typically required to determine, with some confidence, the presence of subsurface archaeological material. Although the process of deep testing with backhoe trenches may seem deceptively simple, when properly done it involves, as advocated throughout this study, interaction between geologists and archaeologist to place each trench into an overarching chronological, depositional, and geoarchaeological framework. More details concerning the methodological procedures employed during backhoe trenching are provided in Chapter 4.0.

3.2 RESEARCH DESIGN AND TEST LOCALE SELECTION

The research design of the Mn/DOT DTP project is quite simple. The geomorphological and geophysical methods described above, which are commonly used for deep testing in the upper Midwest, are directly evaluated to determine how effective each is in discovering buried archaeological sites. The methods' relative costs and outcomes are compared based on a cost/benefit analysis. Basically, we address the question: What did we learn about buried archaeological sites during deep testing and how much did it cost to learn it? We ultimately chose remote sensing using three different geophysical survey methods, a two-step coring and augering process, and backhoe trenching, because of their different levels of impact to potential archaeological deposits. To compare their value for finding buried sites, each of the methods was applied to a set of the same one-acre test locales by separate, independent field teams. The test locales were surveyed in the order of increasing impact to each test locale (e.g., remote sensing, coring/augering, and backhoe trenching) and the results of each technique were reported without any knowledge of the results of any other method. We then ranked methods qualitatively and quantitatively by considering both cost and outcome.

To undertake this methodological comparison, six areas from throughout Minnesota were selected as test locales (Figure 3.2-1). These were chosen in consultation with the Mn/DOT DTP project Steering Committee based on a set of major testing goals for the project. The goals focused mainly on controlling for some of the more significant physiographic, chronological, ecological, and geomorphological variation in geological setting across Minnesota. To guarantee that the methods would receive a valid test in the presence of cultural materials, the committee recommended that two of the areas selected have previously known buried archeological sites. Importantly, the test locales studied were not selected randomly, but rather were chosen using LfSAs mapped as part of the Mn/Model project (Hudak and Hajic 2001). The areas that were ultimately selected included LfSAs that had Landform Suitability Rankings (LSRs) suggesting a high or moderate potential for preserving buried cultural resources if present. Consequently, only areas with sediments too young to contain archaeological resources or in environments too active to have preserved such resources were avoided. Areas of Minnesota that have not yet been mapped were also avoided because the landform characteristics of these areas are unknown. While LfSAs and LSRs have only been mapped for a relatively small portion of Minnesota, much of Red River (of the North), the Mississippi River above the Twin Cites, and the Minnesota River valleys have been classified and presented ample areas from which to select various types of test locales.

One of the important goals of this project was to select areas that represent different types of landforms associated with the potential to preserved buried cultural materials. This allowed us to choose test locales with a variety of specific *a priori* testing conditions and criteria, providing a better understanding of the effectiveness of the deep test methods across a range of different landforms, depositional environments, and archaeological contexts. Consequently, we selected only test locales whose sedimentological and chronological characteristics were well-constrained and understood and whose LSR indicated at least a moderate potential for preserving buried cultural resources.

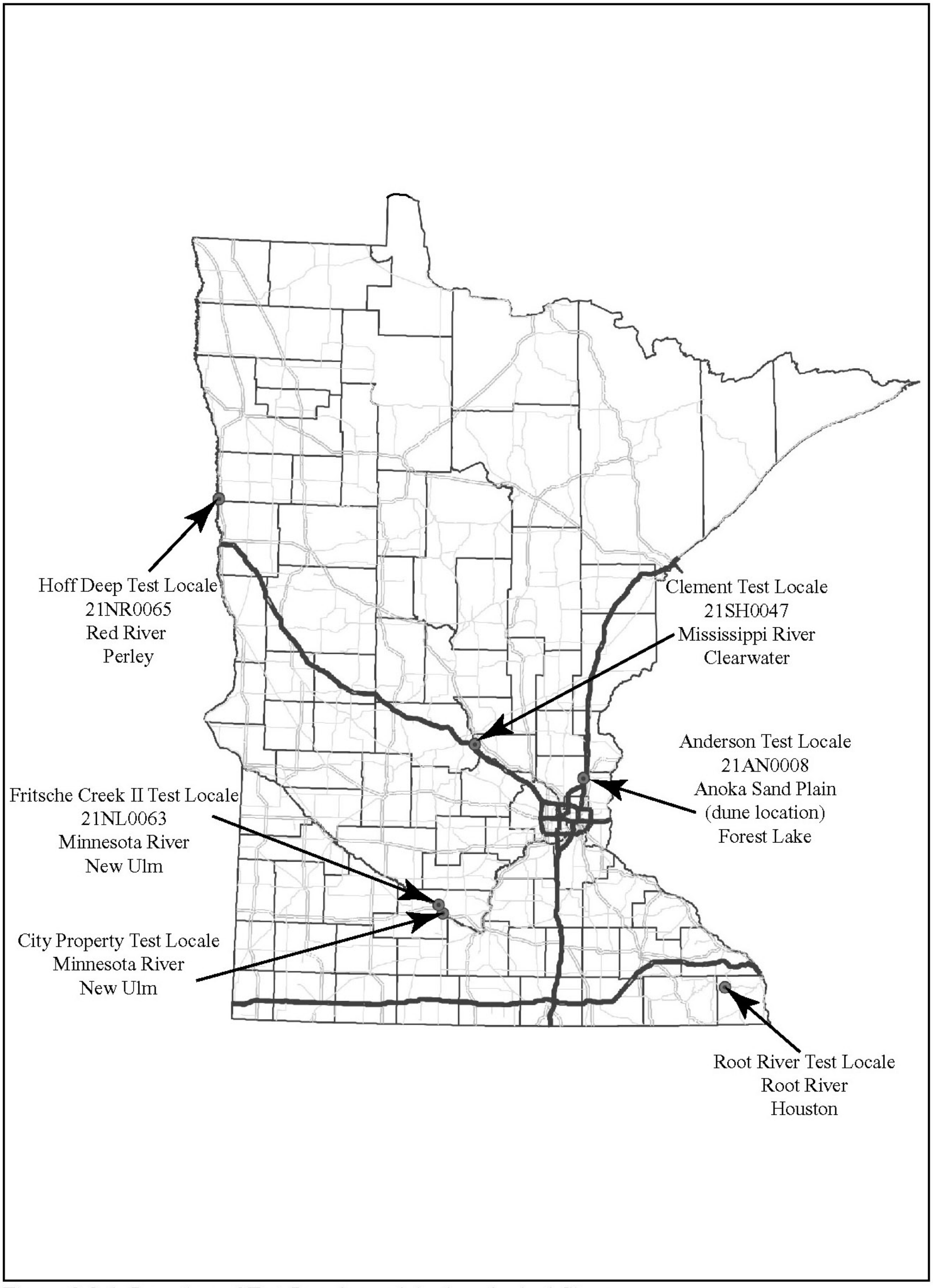

Figure 3.2-1 Location of Test Locales and Archaeological Sites

Test locales were also chosen with consideration of whether the results might prove useful for future work Mn/DOT may undertake. The goal was to select sites that were geographically and geomorphologically diverse, but still representative of the types of landforms setting that are undergoing development and infrastructure expansion. In addition, test locales were selected with the relative strengths and weakness of each of the methods in mind. That is to say, consideration was given to allow the geophysical methods to be employed in ideal circumstances and in circumstances that would test their limitations. The Anderson test locale (Figure 3.2-1), which contains a known archaeological site that was partly buried within a sand dune, was selected in part because the sediment and landform types at the site are ideally suited to geophysical analysis. Such sandy locales can also be problematic for both coring (loss of core with sand) and backhoe trenching (collapse of unstable walls in deeper trenches). Very fine-grained sequences, such as those at the Hoff Deep test locale (Figure 3.2-1), on the other hand, are difficult for geophysics, but much more suitable for coring and trenching. The sedimentary sequence at Hoff Deep was suspected to include a sequence of stacked, ephemeral paleosols that would provide the ideal test of the ability of trenching and coring methods to detect such deposits.

The dimensions of the six testing locales varied depending on local conditions, but were generally 1.0 ac (0.4 ha) in size. This is large enough to address scalar issues associated with geophysics and provide a fair comparison of costs and small enough for the work to be accomplished within the limits of the project budget. Additional logistical considerations included such issues as the ability to get both a backhoe and a coring rig onto the sites, the amount of vegetation that would require removal to allow survey grids to be laid out, and topography. Consequently, heavily wooded, excessively wet, or land-locked parcels could not be used. Moreover, wooded areas or parcels with excessive relief would not be a fair test for geophysical methods because these factors adversely affect their results. The selected test locales, therefore, were generally flat or gently rolling open areas with road access. Surprisingly, despite the large size and environmental diversity of Minnesota, these factors, combined with the vagaries of land-owner permission, limited the pool of candidate test locales. Enough were available, however, to meet the goals of the project.

The selected test locales necessarily focused on landforms near rivers, where the potential for site burial is highest (see discussion of site formation processes in Section 2.1.2). They were chosen, however, from both large and small fluvial systems to include a range of depositional environments. Two of these locations included known buried archaeological sites within landscapes with deeper high potential deposits. Two groupings emerged based on commonalities in their depositional and geographical frameworks. The first grouping includes test locales found in valley margin and valley-tributary junction landform settings. These (Hoff Deep, Fritsche Creek, and City Property; Figure 3.2-1) are located in the Minnesota River and Red River of the North valleys. The other grouping includes test locales found in floodplain and dune landform settings. The test locales (Clement, Root River, and Anderson; Figure 3.2-1) are located in the Mississippi River Valley, its tributaries, or related outwash deposits outside of the valley (i.e., Anoka Sand Plain). Each test locale is described below.

3.3 TEST LOCALE DESCRIPTIONS

3.3.1 Valley Margin and Valley-Tributary Junction Landform Settings: Sites in the Minnesota River and Red River of the North Valleys

Two locations were investigated in the Minnesota River valley, a tributary of the Mississippi, and one in the Red River (of the North) valley. Both locales in the Minnesota Valley were near New Ulm (Fritsche Creek and City Property test locales; Figure 3.2-1) while the Red River test locale lies about 25 mi (40 km) north of Fargo, North Dakota (Hoff Deep; Figure 3.2-1). These test locales are in depositional settings within valley margin and valley tributary junctions. One of the New Ulm area test locales (Fritsche Creek) also includes a known, buried archaeological site, Fritsche Creek II (21NL0063). Each of these locales is on a landform classified by the LSRs as having a high suitability for the preservation of buried archaeological materials, if present.

Fritsche Creek Test Locale: Valley Margin Setting with Thick Alluvial/Colluvial Fan Deposits

<u>Location and Geomorphological Background</u>

The Fritsche Creek test locale lies along the north bank of the Minnesota in Nicollet County, about 1.25 mi (2 km) upstream (west) of New Ulm, Minnesota (Figure 3.2-1). The property is privately owned by Kenneth and Shirleen Barenek, who granted us permission to work on their land. The test locale (Section 8, T110N/R30W) lies at the valley margin where Fritsche Creek, a small drainage, emerges from the glaciated uplands above the Minnesota Valley (Figure 3.3.1-1). Previous investigations at the site indicate that it is shallowly buried within the uppermost part of an alluvial fan that was apparently formed by an early Holocene stage of Fritsche Creek (Roetzel and Strachan 1992). The Fritsche Creek II site is believed to be an early to middle Holocene (Early to Middle Archaic) bison kill site. The LfSAs designate the alluvial fan landform in which the site is found as an area of high suitability for preservation of buried archaeological material at all depths.

The Fritsche Creek test locale was selected for several reasons. First, the Minnesota River valley is a large first-order tributary of the Mississippi and is one of the most important waterways in south-central Minnesota. Second, the region is undergoing rapid development. Also, the Fritsche Creek test locale includes parts of a known, previously studied, buried archaeological site, Fritsche Creek II (21ML0063). Previous research and geomorphic mapping show that the Fritsche Creek II site occupies the upper part of an alluvial fan. The fact that a known, buried site occurred within the alluvial fan was an important factor for selecting the Fritsche Creek locale for testing because alluvial fans, particularly in the Minnesota River valley, are typically ranked as having a high suitability for the preservation of buried archaeological deposits throughout Minnesota. In fact, except for some floodplain deposits in the Red River Valley, alluvial fans are the only other alluvial landform to exhibit high suitability for preservation of buried archaeological deposits at significant depth (i.e., 3 m-5 m [9.8 ft-16.4 ft]). Additionally, the presence of buried archaeological material within at the Fritsche Creek alluvial fan offered the opportunity to analyze how effective the deep test methods are in detecting actual buried cultural material and assess how well they could also determine the cultural and depositonal processes within alluvial fan landforms.

The testing grid for the Fritsche Creek test locale was 100 m by 40 m (328 ft by 131 ft) and was laid out to encompass the major components of the alluvial landform, particularly with respect to the Fritsche Creek II site itself. The eastern end of the grid was placed mainly in relatively flat- and low-lying deposits that were probably formed as floodplain and/or over-bank deposits from Fritsche Creek. The western end of the grid lay about 7 m (23 ft) higher and was situated on the main part of the alluvial fan. Previous investigations showed that this area also probably included the core of the Fritsche Creek II archaeological site. The portion of the grid between the eastern and western ends occupies transitional landforms.

Archaeological Background

The Fritsche Creek II site (21NL0063) was first identified in 1990 during a Phase I archaeological survey for a proposed road widening and bridge replacement project (Peterson 1991). These investigations identified bison vertebrae in a road cut, a small number of surface artifacts, and a few flakes and burned bone between 90 cm and 125 cm (35 in and 49 in) below surface. Another archaeological site (Fritsche Creek I [21NL0062]) was also discovered on the south side of Fritsche Creek during this survey. Phase II work at the two Fritsche Creek sites included augering to greater depths than previous investigations, more shovel testing, and excavation of two 1 m × 1 m (3.3 ft × 3.3 ft) test units (Roetzel and Strachan 1992). Tool fragments, flake tools, flakes and burned bone as well as a smooth/cordwrapped paddle-treated sherd, which indicates that the site includes at least a Late Woodland occupation, were found on the site surface during this work (Roetzel and Strachan 1992:26). More importantly, however, bison bone fragments, chert scrapers, and flakes were recovered from a bone bed within a road cut adjacent to the site. This bone bed apparently extended into the site where it occupied a zone 85 cm to 100 cm (34 cm to 39 in) below surface. In addition, bone apparently was found no deeper than 115 cm (45 in) and was sparse above 75 cm (30 in) (Roetzel and Strachan 1992:17-18).

Over 300 animal bones and five lithic artifacts (including scrapers and a core) were found in the bone bed, but only seven of these bones, all bison, were identifiable (Roetzel and Strachan 1992). This suggests that the bone consisted mostly of small, poorly preserved fragments. Only a secondary flake and four bone fragments were found between 70 cm (28 in) below the surface and the base of the plow zone.

Phase III data recovery investigations at the Fritsche Creek II site identified a habitation area with abundant, fragmented bison remains and a low density of cultural material (<20 lithic artifacts; Roetzel et al. 1994). Although, cultural material extended throughout the entire stratigraphic profile, the general pattern noted during the Phase II investigations was replicated by the Phase III investigations (Roetzel et al. 1994: Figure 4). These excavations yielded further artifacts and provided a more detailed picture of the vertical distribution of cultural material. The investigations also showed that only limited cultural materials were found above about 70 cm (28 in), where its distribution was vertically discontinuous. Several small ceramic sherds found just below plow zone in one of these discontinuous horizons indicate that an undisturbed

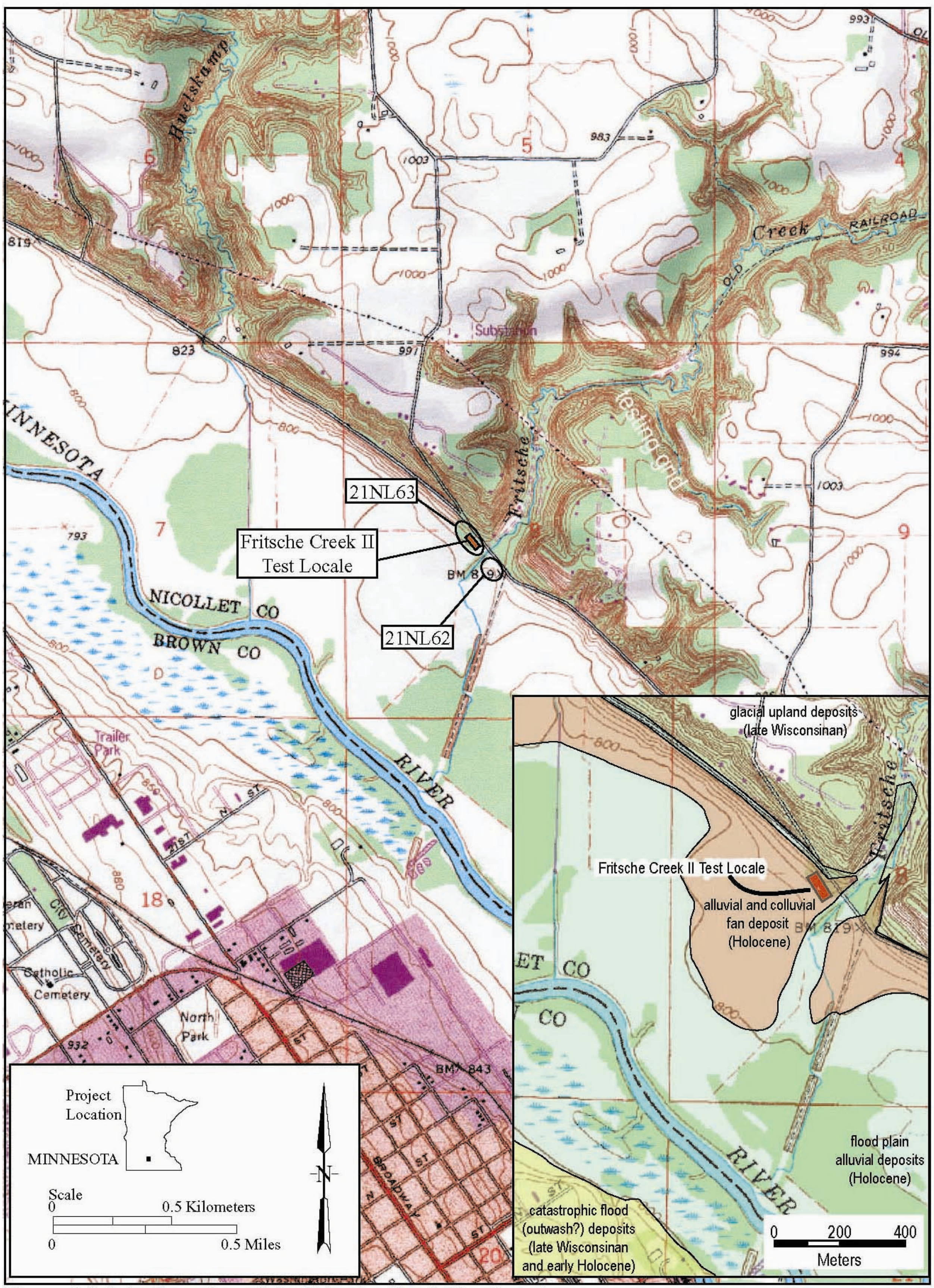

Figure 3.3.1-1. Location of the Fritsche Creek Test Locale

Late Woodland occupation may exist at the site. Moreover, a low density of artifacts extended in a few areas to 240 cm (95 in) below the surface and may include more than one bone bed or occupation horizon. For example, relatively high artifact counts are found 110 cm to 120 cm (43 in to 47 in) and 150 cm to 160 cm (59 in to 63 in) below the surface (Roetzel et. al. 1994).

Roetzel et al. (1994) concluded that the site was an Early Archaic or late Paleoindian bison kill site. This functional interpretation was based on the extensive bone bed and the species identified in it. The site age was inferred based on the depth of the bed and its stratigraphic position immediately over pre-Holocene deposits. These suggest that the site may be similar in age and use to other late Paleoindian bison kill sites such as Casper, Hudson-Meng, and Olsen-Chubbock (Roetzel and Strachan 1992:24-27). Chronologically, Roetzel et al. (1994:35) date the formation of the "bone bed" and initial human occupation to 10,000 BP-8000 BP, based partly on a possible parallel-sided Plano-style projectile point associated with the bone bed. While such an early age may be correct, a previously unreported ^{14}C age of 6080±100 BP (Beta-74130; bone collagen) on bone from the bone bed indicates that occupation probably extended into at least the Middle Archaic.

City Property Test Locale: Valley Margin Setting in a Floodplain at a Tributary-Valley Junction

Location and Geomorphological Background

The City Property lies on a relatively broad, sandy stretch of the Minnesota River floodplain at the southern outskirts of the City of New Ulm in Brown County (Figure 3.2-1). The area chosen for survey is owned by the City of New Ulm and is being returned to native prairie grass by the city. The testing area is located where the Cottonwood River, a large tributary stream of the Minnesota River, flows into the Minnesota Valley (Figure 3.3.1-2). Consequently, at least some of the floodplain deposits are probably associated with deposition from the Cottonwood River. The City Property test locale had not been previously tested for buried archaeological resources, although a few known surface sites have been recorded nearby

The conjoining of the Cottonwood and Minnesota rivers at the City Property was an important factor for choosing this test locale. Here the relative utility of buried site discovery methods could be tested in a situation of rapidly accreting and complicated depositional systems that epitomize valley-tributary junction contexts. Like alluvial fan deposits, rapid deposition of variable textural sediments is typical. Consequently, such settings are likely to include rapid vertical and horizontal changes in facies relationship. High-energy channel cut and fill structures from the tributary valley system, for example, could easily cut and erode floodplain accretionary, back-swamp, or levee systems associated with the larger Minnesota River. Moreover, geometry of such cross-cutting and superimposed depositional systems could also vary from perpendicular to sub-parallel with each other and create a highly variable and confusing vertical and horizontal jumble of depositional units that may or may not be conformable. For example, although trenching methods can allow complex and superimposed depositional system to be sorted out in vertical profiles, their relatively wide spacing may not allow rapid horizontal changes in facies to either be observed or understood. Although the small size of cores may only poorly resolve rapid and complicated vertical facies variation, their relatively close spacing may allow better

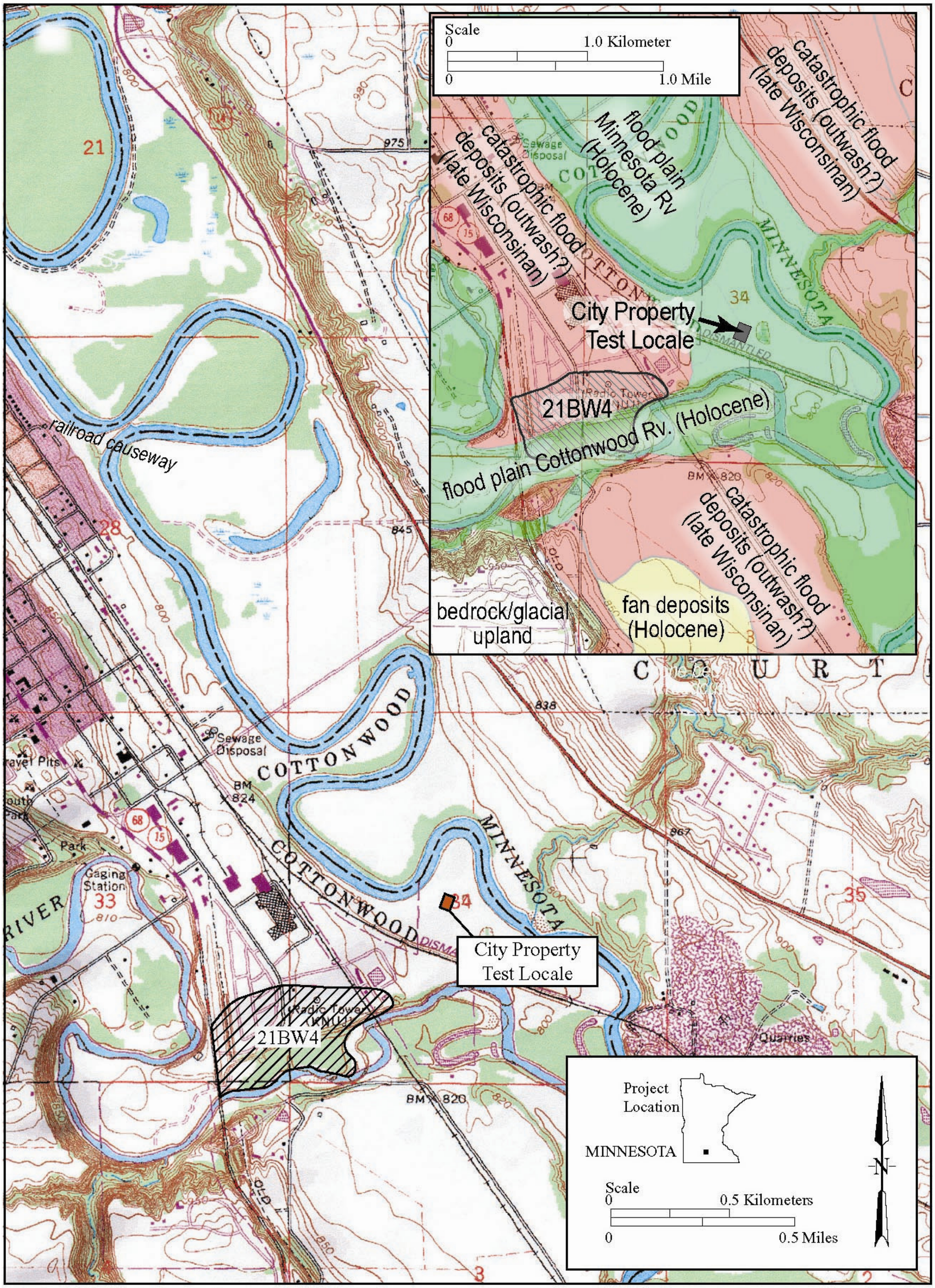

Figure 3.3.1-2. Location of the City Property Test Locale

horizontal resolution than trenching. Geophysical methods are the most comprehensive spatially, but may only provide vague details for the actual sedimentary environments.

The testing area surveyed was 60 m by 80 m (197 ft by 263 ft), level, and generally topographically and texturally poorly differentiated. Thus, the uniformity of the floodplain presented few obvious depositional markers from which to define and sample various land form assemblages. The grid was placed, however, so that its southern half lay on a slightly higher sandy portion, while its northern half was lower and surface soils appeared slightly more fine-grained. A faintly defined ca. 1-m (3.3-ft) high shallow bench that trended west-southwest-to-east-northeast across the testing grid separated these areas.

Archaeological Background

Prior to this research, no surface or subsurface survey had been undertaken on the floodplain within or adjacent the City Property test locale. However, south of the City Property test locale and adjacent to Cottonwood River a few sites are known, most of which are located above the floodplain of both the Minnesota River and Cottonwood River and have only limited potential for site burial. For example, the Brian site (21BW0004), which is a Middle Woodland site that included both domestic refuse and an earthwork/mound, was identified through shovel testing and lies partly on the Cottonwood River floodplain (Figure 3.3.1-2). In addition, buried sites are located within a few miles of the City Property test locale. These include the Fritsche Creek I and II sites, the latter of which was also part of this testing project. The processes responsible for burial of these sites, however, relate to completely different ecological and depositional settings and probably do not have significance for the City Property test locale. Given that the LfSA classified the area as moderate suitability for preservation of buried archaeological deposits less than 2 m (6.6 ft) deep, archaeological site burial could occur at or near the City Property test locale, but probably at relatively shallow depth.

Hoff Deep Test Locale: Valley Margin Setting with Thin, Fine-Grained Alluvium

Location and Geomorphological Background

The Hoff Deep test locale is located on the eastern bank of the Red River of the North near the town of Perley in Norman County, in Section 25, T43N/R49W (Figure 3.2-1). The property is privately owned by Mark Hoff, who allowed access for this research. The area surrounding the site includes two distinctive landforms. A variably wide area along the river has been designated by the LfSAs as floodplain (specifically floodplain on which point bars and other channel migration features are not evident). Sediments that make up this landform are generally fine-grained (i.e., silt- and clay-rich), as is typical within the Red River Valley. In general, this landform type is considered to have high suitability for preserving buried archaeological materials at shallow depths (<2 m [<6.6 ft]) and relatively low suitability for site preservation at greater depths. A second major landscape, mapped by the LfSAs as glacial lake plain, occurs away from the river at slightly higher elevations adjacent to the Hoff Deep test locale. This landform is underlain by thick sequences of laminated (varved?) silt and clay deposited within glacial Lake Agassiz during the end of late Wisconsinan. Presumably these glaciolacustrine sediments also underlie the floodplain deposits along the river (Figure 3.3.1-3).

The test locale was chosen for inclusion in the Mn/DOT DTP project for several reasons. First and foremost, it is situated along the Red River, a major waterway in western Minnesota, and is characteristic of the alluvial and fluvial regimes of the region. Throughout most of its valley, the Red River flows through very fine-grained silt- and clay-rich sediment deposited within glacial Lake Agassiz. As a result, alluvial sediments deposited within floodplain sequences are typically also very fine grained. One important goal of this project was to assess the efficacy of the site discovery techniques in typical, but diverse settings and landforms. The Hoff Deep test locale offered the opportunity to compare the results of the deep test methods within a fine-grained setting. The test grid was placed to investigate the edge of the Red River meander belt, along its northwestern part, and also see what information could be gathered within glaciolacustrine sequences that are marginal to the Red River floodplain. Research questions included: Do shallow, Holocene alluvial sediments overlie the laminated Lake Agassiz sequence? Can the methods applied to this study clearly distinguish varved lake sediments from floodplain accretionary deposits in near-surface (<1 m [<3.3 ft]) depths? Thus, the Hoff Deep test locale actually combines two types of testing locales that were originally proposed for this study: 1) a location near either a large river system that has not been directly tested, whose buried archaeological resources are unknown, but includes high suitability for preservation of buried cultural resources at depths >1 m (>3.3 ft) depths; and 2) a location that LfSAs indicated has low suitability for preservation of buried cultural resources but has at least some potential alluvial deposition. The former area is represented at Hoff Deep by the alluvial sequence within the Red River floodplain, while the latter corresponds to the area underlain by glacial lake plain (Figure 3.3.1-3). The low potential for buried archaeology defined for Lake Agassiz deposits at Hoff Deep reflects the assumption that their age precluded human occupation and that only limited Holocene-age flood alluvium could overlie glaciolacustrine sediments near the boundary of the Red River floodplain.

Some important research questions related to archaeological site formation and preservation during the Holocene within the Red River Valley may also be addressed at the Hoff Deep test locale. The Red River is unique in Minnesota, as well as in most of the rest of the glaciated Midwest, because it flows north, generally in the direction of the regional isostatic uplift, for its entire valley. As a consequence, the river channel has undergone greater uplift within its northern reaches relative to the southern portions of the valley, which must have resulted in a continuous change in relative stream gradient along the river throughout the Holocene. Given that the rate and magnitude of uplift was considerably greater in the early Holocene than in the late Holocene, the channel and fluvial characteristics of the valley must have also varied more greatly pre-5 kyBP than post-5 kyBP. For example, because the tendency of streams to meander actually increases as the stream gradient becomes more shallow, the meander belt of the Red River (the portion of the floodplain through which the stream meanders; Figure 3.3.1-3) probably also expanded through time, but also varied geographically and temporally during the Holocene. Meandering was probably most intense in the southern portions of the valley, near Fargo, during the early Holocene, and expanded northward and accelerated as a function of relatively greater uplift in the northern portions of the valley within the floodplain during the middle Holocene. Such a pattern may have resulted in generally earlier stabilization, and possibly entrenchment, of the Red River channel in more southern compared to the northern parts of the valley. This may have affected both the timing and regularity of site burial differently within the valley. For

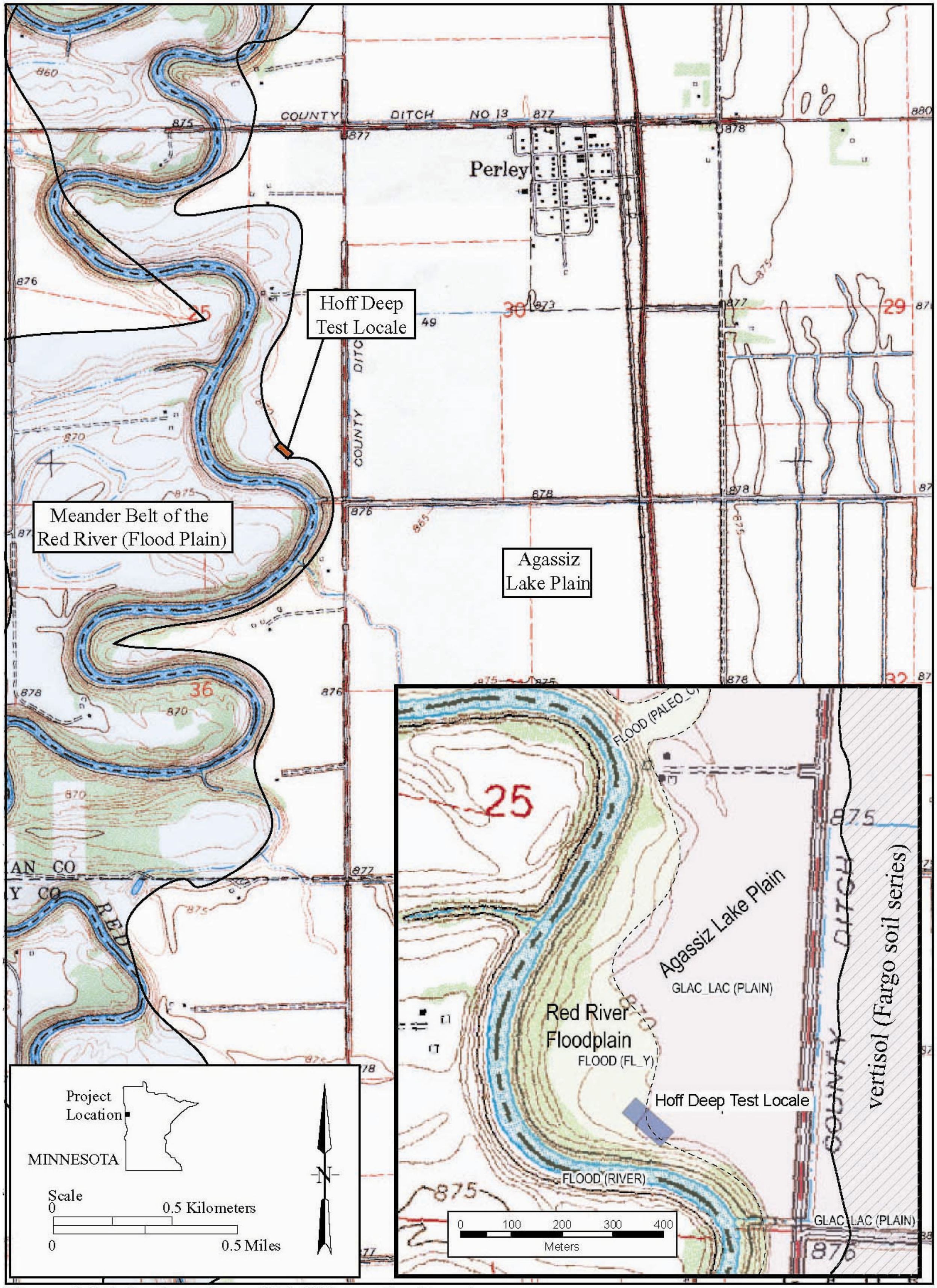

Figure 3.3.1-3. Location of Hoff Deep Test Locale

example, entrenchment of the river early in the south may have resulted in a more stable floodplain in the south during the Holocene and more frequent and regular meandering of the floodplain in the south during the Holocene and more frequent and regular meandering of the channel. This would have resulted in erosion of the floodplain sediments and reworking, poor preservation, or the outright destruction of any included archaeological site(s). Moreover, this process would have been greatest during the middle Holocene (Middle and Late Archaic).

Archaeological Background

Prior to this research, no surface or subsurface testing had occurred near the Hoff Deep test locale. Although no site occurs near the test locale, two of the best-known stratified sites in Minnesota, Canning (21NR0009; Michlovic 1986) and Mooney (21NR0029; Michlovic 1987), are located along the Red River several miles north of the test locale. More detail of these sites and their importance to the geoarchaeological understanding of the Red River Valley has been presented in Chapter 2.0. One of the reasons that the Hoff Deep test locale was selected for testing was because several different LfSAs that had different LSRs were designated within a small area. Thus, the situation afforded an opportunity to evaluate the sensitivity of the deep test methods for discerning and reconstructing complex depositional settings. Additionally, at least part of the Hoff Deep test locale was designated as underlain by late Wisconsinan glacial Lake Agassiz deposits and assigned a lower suitability for including buried archaeological deposits. The fact that buried deposits were found within all of the LfSAs at the Hoff Deep locale regardless of their LSR is important. The existence of other buried sites (i.e., Canning and Mooney) associated with different LfSAs than those occurring at the Hoff Deep test locale may indicate that a high potential for site burial may be characteristic of many more LfSA in alluvial settings of the Red River Valley than has previously been determined. This is particularly indicated because major areas of the Hoff Deep locale, which actually contained significant buried archaeological deposits, included LfSAs whose LSR indicated a low potential for containing buried archaeological resources.

3.3.2 Floodplain and Dune Settings: Sites in the Mississippi River Valley

Three locations were studied within this grouping of sites. Two of the locations investigated are floodplain alluvial contexts in the Mississippi River Valley (Clement and Root River test locales; Figure 3.2-1). These test locales lie in depositional settings within broad, well-defined floodplains near the channel margins. They typically are found within ridge and swale-type (levee-back-swamp/flood chute) landforms. The alluvial test locales studied are within geographically and depositionally variable settings. One of these, Clement, is adjacent to the Mississippi River just downstream from the city of St. Cloud, while the other is along the Root River, a tributary of the Mississippi River in the Driftless Area of southeastern Minnesota. The third site in the Mississippi Valley grouping is located in a non-alluvial, eolian (dune) context within the Anoka sand plain (Anderson test locale; Figure 3.2-1). The Anderson test locale also includes a known, buried archaeological site (Anderson [21AN0008]) while the other test locales comprising this group are not known to include a previously recorded archaeological site. Regardless of the presence of buried archaeological resources, each of these locales is associated with landforms that have been classified by the Mn/Model LfSAs as having a moderate to high suitability for preserving buried archaeological materials at specific depth ranges within their depositional sequence. The LfSA suitability for site burial, unlike those in the Minnesota and Red river valleys, however, is generally restricted to relatively shallow depths.

Clement Test Locale: Flood Plain (Ridge and Swale) Setting at the Edge of the Mississippi River Channel

Location and Geomorphological Background

The Clement test locale is situated on a relatively broad, moderately fine-grained portion of the floodplain of the Mississippi River a few miles south of the city of St. Cloud in Sherburne County (Figure 3.2-1). The land is privately owned by David Clement, who granted us permission to work on the property. The test locale (Section 8, T110N/R30W) lies along the east bank of the River near the edge of the floodplain and consists mainly of alluvial sediments associated with a ridge and swale landform (Figure 3.3.2-1). The testing area was 40 m by 100 m (131 ft by 328 ft), generally oriented east-west and perpendicular the Mississippi River. The Clement test locale had not been previously tested for buried archaeological resources, although a few known surface sites have been recorded nearby.

The Clement test locale was selected because it is within an area undergoing extensive infrastructure expansion. The site is on an active part of the floodplain of the Mississippi River upstream from Minneapolis-St. Paul. The LfSAs map it as having a moderate suitability for preservation of buried archaeological resources at shallow depths, but a low suitability within deeper deposits. Such suitability is typical for landforms along the upper parts of the Mississippi. In fact, only limited areas of high suitability for preservation of buried archaeological sites occur in the Mississippi Valley, and these are usually associated with valley margin fan settings. Because such landforms were the focus of the Minnesota and Red River valleys testing locales, and they are not common in the Mississippi Valley, we focused on testing a more typical setting. The fact that such settings are rated as having only moderate suitability for preserving archaeological resources may reflect the relatively young age (probably late Holocene) and active flood histories. Presumably, erosion and reworking of sites that may have existed predominated along the Mississippi River. However, although active flooding can be erosional, particularly during lateral migration of channels, parts of such large floodplain complexes can also be constructional and act to preserve sites (Vento and Raber 1990; Bettis and Hajik 1995; Monaghan and Hayes 1997; Bettis and Mandel 2002; Monaghan and Lovis 2005). For example, during channel migration events levees typically form on abandoned scroll bars. Deposition on such levees is dominated by vertical accretion and the development of ephemeral, short-term stable surfaces on the relatively higher ground. These areas are attractive for human occupation, but given the active depositional environment were probably occupied only by small logistical camps or other relatively ephemeral sites. The discovery and evaluation of such sites is important because if they are left undetected a key component of the prehistoric settlement and subsistence system remains unknown. This test locale, therefore, provides the opportunity to test the effectiveness of deep test methods to identify small, transitory sites.

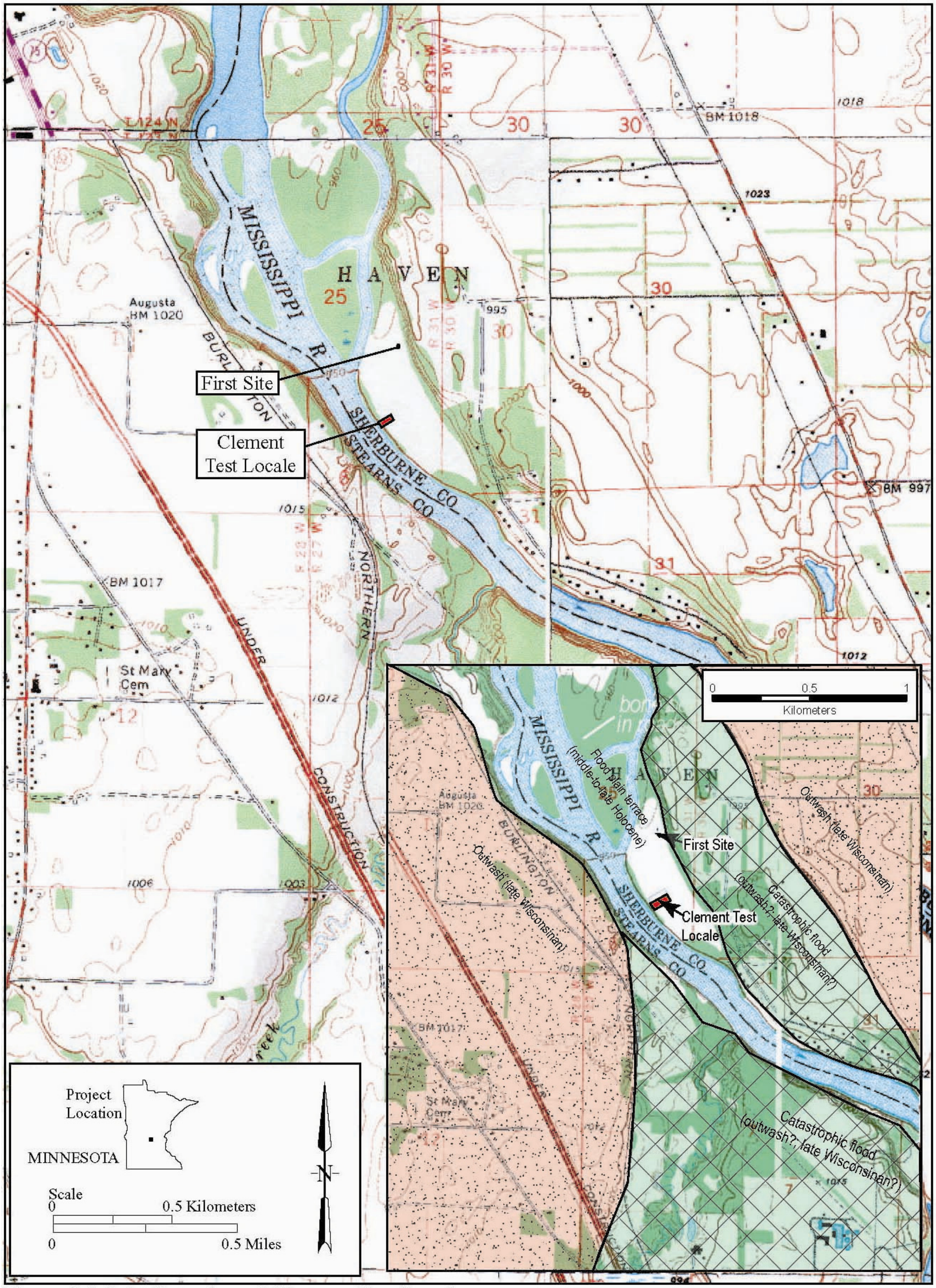

Figure 3.3.2-1. Location of Clement Test Locale

Archaeological Background

Prior to this study, no surface or subsurface testing had been done near the Clement test locale. Interestingly, during the site selection process, a small lithic scatter, informally referred to as the First site (21SH0048) (Figure 3.3.2-1), was discovered about 350 m (1148 ft) north of the Clement test locale during the initial phase of fieldwork. The fact that archaeological materials were found on the floodplain surface bode well for their discovery in the subsurface. Other sites, typically on topographically higher terraces, are located up- and downstream from the Clement test locale and were discussed in Chapter 2.0.

Root River Test Locale: Complex Flood Plain Setting on a Tributary of the Mississippi River Valley

Location and Geomorphological Background

The Root River locale is situated on a broad, relatively complex, moderately fine-grained portion of the floodplain of the Root River, a tributary of the Mississippi River, a few miles west of the village of Houston in Houston County (Figure 3.2-1). The land is privately owned by Wayne Feldmeyer, who granted us permission to work on the property. The Root River forms a deeply eroded, relatively broad valley that drains much of the Driftless Area of southeastern Minnesota. The river has incised a ca 100-m (328-ft) deep trough through mainly Paleozoic silt- and sandstone bedrock, including some high terraces of late Wisconsinan valley-train outwash. These higher terraces are distinct from the Holocene depositional sequence because they typically lie about 30 m (98 ft) above the present valley and are very coarse-grained. The Root River test locale had not been previously tested for buried archaeological resources, although a few known surface sites have been recorded nearby. These are apparently surface sites, and some are located within about 100 m (328 ft) of the testing grid.

The Root River test locale (Section 34, T104N/R7W) lies on the south bank of the river about 150 m (492 ft) from the edge of the floodplain (Figure 3.3.2-2). It consists mainly of moderately fine-grained alluvial sediments. The LfSAs associated most of the northern part of the testing grid with the youngest sequence of the floodplain deposits. The southern one-third of the grid, however, lies at the edge of an older alluvial terrace sequence. Despite the mapped differences, only limited morphological and sedimentological characteristics distinguish these two alluvial sequences. In addition, the southern floodplain margin is made up of sandy textured alluvial fan deposits. The LfSAs show that these deposits extend onto the floodplain from the steep-walled and steep gradient valley that drains the bedrock upland surrounding the Root River valley. Except for the sandier texture, no distinct morphological makers were observed in the field to differentiate fan deposits from floodplain sediments.

The testing grid at the Root River locale was 40 m by 100 m (131 ft by 328 ft). Within the testing area, the soils are generally fine-grained and sit on a gently undulating floodplain with two relative rises on the northwestern and southeastern part of the survey grid. A southwest to northeast trending swale or probable flood chute separates these. The northwestern rise is associated with the most recent episode of floodplain development, while the southwestern is part of the older terrace sequence. The flood chute that separates these rises may have originally

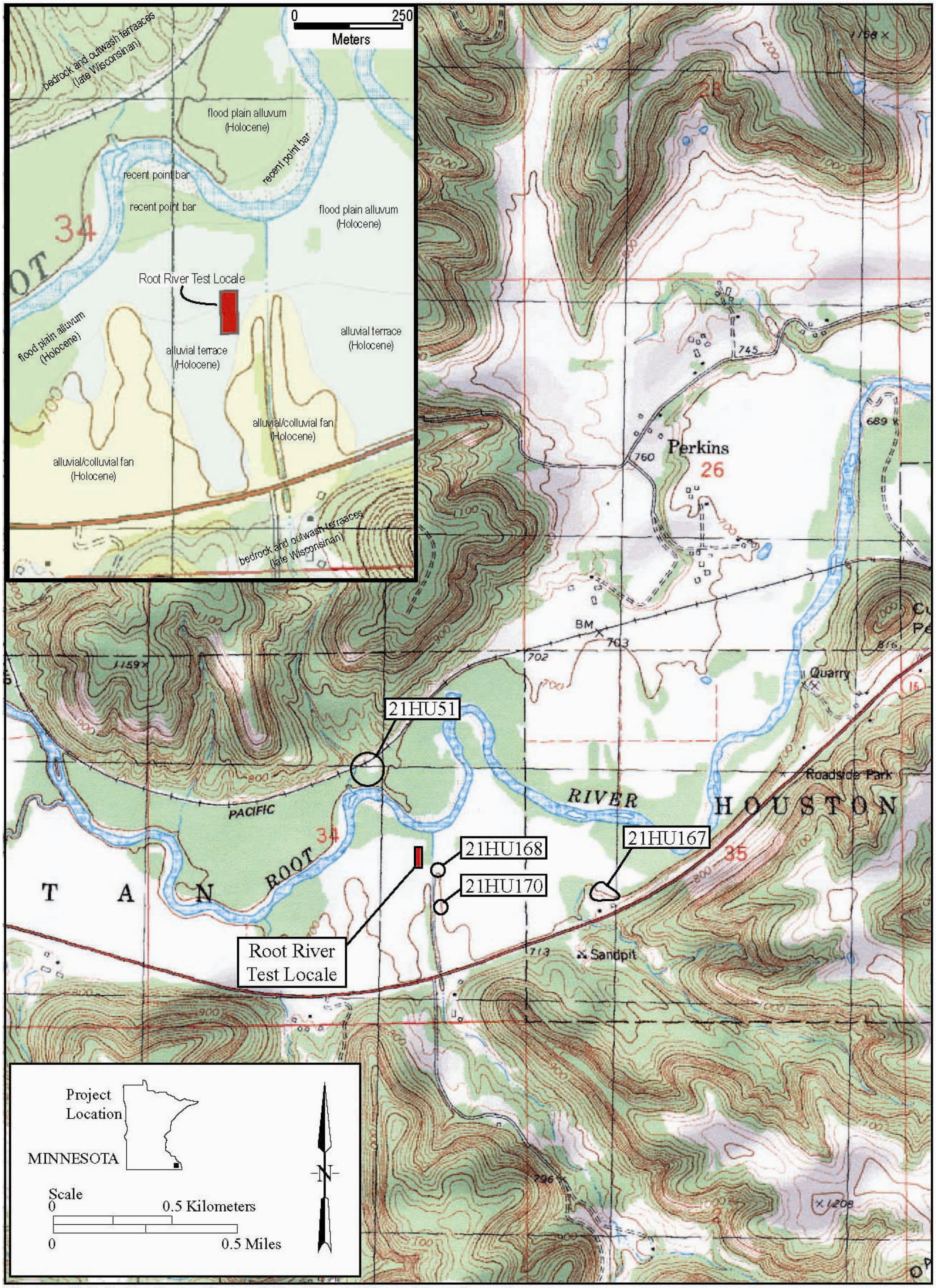

Figure 3.3.2-2. Location of the Root River Test Locale

developed as a swale during a recent phase of channel migration of the Root River. Although this notion is supported by the fact that the flood chute is located along the edge of an older terrace sequence, no other morphological evidence, such as other ridge and swale sequences or evidence of levee formation, was noted on the surface.

The Root River locale was selected for inclusion in this study because of its relatively unique setting in the Driftless Area of Minnesota and because it is probably representative of Mississippi Valley tributary floodplain sequences in the southeastern part of the state. Although not presently undergoing a development boom, development pressures will ultimately force the region to expand its infrastructure. Like the Clement test locale, the Root River test locale is situated on an active part of the floodplain and has been mapped by the LfSAs as having a moderate suitability for preservation of buried archaeological resources at shallow depths. The complexity of the floodplain also was important for inclusion of this area into our study and allowed the evaluation of the deep test methods within a few different, adjacent landforms. For example, although the entire test grid is underlain by deposits exhibiting moderate suitability for preserving buried archaeological deposits at shallow depths, the northern part of the grid, which is made up of the flood chute and youngest floodplain deposits, has a low suitability within its deeper deposits, while the southernmost portion, which included the older terrace landform, has moderate to high suitability in deeper deposits. These data imply that relatively complicated depositional sequences exist in the study area. Relatively deeper vertical accretion sediments apparently dominate in the older terrace sequence on the southern end of the test grid, while shallower sequences, that are probably underlain by high-energy lateral accretion fluvial channel and bar deposits, dominate in the northern part. The presence of other archaeological sites on the surface of the floodplain near the Root River test locale indicates that the area was attractive for human occupation and, consequently, such landforms could include buried archaeological deposits. The test locale, therefore, provides the opportunity to test the effectiveness of deep test methods for detecting the complicated depositional sequence present in the test grid and distinguishing the presence of or potential for preserving buried archaeological resources.

Archaeological Background

The Root River test locale has not been directly tested for cultural deposits, although the surrounding 1.0-mi (1.6-km) radius area has undergone extensive survey and includes four recorded archaeological sites. These four sites contain cultural components that are buried more than 50 cm (20 in) below the current ground surface. For example, the extensive Cherry I site (21HU0051) (Figure 3.3.2-1) has been divided into three sub-areas. These include an artifact scatter located on an intermediate terrace, a habitation area located on a low terrace, and a cemetery area consisting of 11 burial mounds located on a low saddle extending out from the bluff (MHS 1981; Minnesota Department of Natural Resources [MNDNR] 1997:397). Limited archaeological testing was conducted within the habitation portion of the site (MNDNR 1997:397; Tumberg 1997). This testing recovered sand and grit tempered ceramic sherds, prehistoric lithic artifacts, and historic artifacts. Because the prehistoric artifacts occurred between 120 cm and 130 cm (47 in and 51 in) below surface (MNDNR 1997:398), the site has great potential for including extensive buried Woodland cultural deposits (MNDNR 1997:399).

The Skree I (21HU0168) and II (21HU0170) sites are located along the east side of an artificial drainage ditch east of the Root River test locale (MNDNR 1997). The Skree I site is small, (about 30 m^2 [323 ft^2]) and situated on an alluvial fan (MNDNR 1997:392-394). Limited testing revealed a small assemblage of prehistoric artifacts consisting of shell-tempered and other ceramic sherds, a flake, and animal bone fragments. The shell tempered sherds suggest a Terminal Woodland (Oneota; post A.D. 900-A.D. 1000) occupation. The vertical sequence at Skree I consists of an upper 25-cm to 30-cm (10-in to 12-in) thick spoil from the adjacent drainage ditch underlain by a 20-cm (8-in) thick buried A horizon. This A horizon overlays a 30 cm (12 in) of black loam and a basal stratum of very dark gray sandy loam, both of which include the prehistoric archaeological materials. The Skree II site lies on the same alluvial fan as Skree I (MNDNR 1997:395-397), is larger, and contains artifacts (sand and grit tempered cordmarked sherds and a flake) in similar stratigraphic context below disturbed sediment and fill. These sites suggest that Late Woodland or Oneota sites may be buried within the Root River test locale.

The Belongie site (21HU0167) is located along the southern edge of the Root River Valley (MNDNR 1997) and, like the Skree I and II sites, extends across the distal margin of an alluvial fan (MNDNR 1997:387-392). It contains deep cultural deposits that span several cultural periods. Limited testing produced abundant artifacts (i.e., 116 sherds, 466 lithics, 95 animal bones, and 810 historic artifacts). Diagnostic ceramics span the entire Woodland period (MNDNR 1997:391). The upper 40 cm to 60 cm (16 in to 24 in) at the site is marked by a thick dark, sandy horizon that included only historic period artifacts. This is underlain by a 50-cm to 110-cm (20-in to 43-in) thick dark, loamy buried A-horizon that, in turn, overlies a dark brown sand extending at least 2.2 m (7.2 ft) deep. Artifacts were found in general stratigraphic succession. Early Woodland ceramics lie between 195 cm and 220 cm (77 in and 87 in) below surface, Middle Woodland ceramics between 175 cm and 180 cm (69 in and 71 in), and Late Woodland ceramics between 155 cm and 160 cm (61 in and 63 in) and 45 cm and 50 cm (18 in and 20 in) below surface. The fact that cultural materials continued even deeper in the excavations, which were terminated by safety concerns, suggest that a pre-ceramic Archaic component may also be preserved at the site.

Anderson Test Locale: Dune (Eolian) Setting in the Anoka Sand Plain

Location and Geomorphological Background

The Anderson test locale, unlike the other landforms tested during this project, is associated with a dune field within the Anoka sand plain of south-central Minnesota (Figure 3.2-1). The land is privately owned by Marianne and Chris Hoyt, who granted us permission to work on the property. It was chosen for study, in part, because it includes a known, buried archaeological site and because it occurs within a non-alluvial context. It is located a few miles south of the village of Forest Lakes in Anoka County and is situated just south of Howard Lake, an obvious kettle lake formed within a collapsed part of the Anoka outwash plain (Figure 3.3.2-3). The location in Anoka County was also an important factor for inclusion of the Anderson test locale. This area is undergoing extensive development and infrastructure expansion. Given the potential for archaeological site burial within similar eolian landforms, understanding how to evaluate the presence of buried and stratified sites within dune landforms is critical.

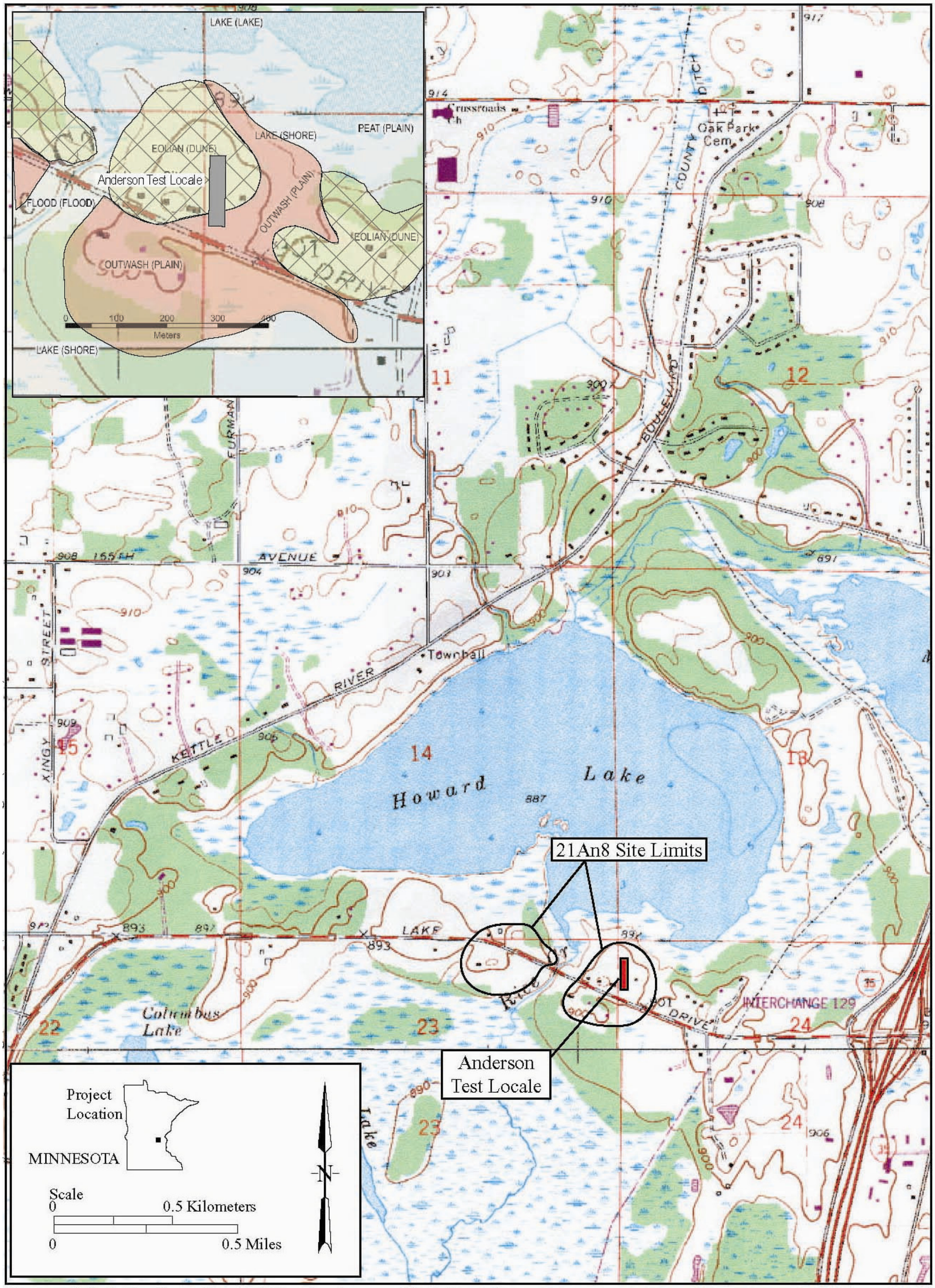

Figure 3.3.2-3. Location of the Anderson Test Locale

The Anderson archaeological site (21AN0008) is a large, 75-ac (30-ha), multi-component complex of archaeological deposits that range from Paleoindian-Early Archaic to Woodland in age. It is found through various parts of Section 23 and 24, T32N/R22W. The test locale is located on the southern slope of a small dune that is perched on sandy-textured glacio-fluvial and/or glaciolacustrine deposits. The test grid was 30 m by 140 m (98 ft by 459 ft) and was oriented north-south along the southern margin of the dune. Although the part of the site directly underlying this grid has never been tested, excavations had been undertaken ca 30 m (98 ft) south (Harrison 1977), while the original site excavations from the 1930's lay a few hundred meters to the west (Wilford 1937).

The Anderson test locale is on a depositional landform that is not alluvial, but mapped by the LfSAs as an area of high suitability for preserving buried archaeological deposits. Furthermore, although the nature and mechanisms for site burial are not clear based on published previous research (Wilford 1937; Harrison 1977), given the association of the site with a dune field, any buried archaeological components probably related to eolian processes. The placement of the testing grid reflected, however, the ephemeral nature of the dunes and other eolian features associated with the Anoka sand plain. The majority of the test grid at the site is located within a mapped eolian sand deposit (probably a shallow dune), except for the most southern margin where eolian deposits are absent and the surface is underlain by glacio-fluvial and/or glaciolacustrine deposits. The differentiation between these two deposits is not clear either morphologically on maps or texturally in field. Presumably, the dune underlying most of the Anderson site is actually perched on similarly medium-to-fine textured, sandy glaciolacustrine sediment and has been formed by erosion and reworking the surface of these underlying sands. Given the suggested age range of the archaeological deposits that apparently have been buried within the overlying dune sequence, the reworking must have occurred at a variety of times during the Holocene.

Two previously recorded archaeological sites have been discovered in similar geomorphological settings near the Anderson Site. These include a Middle Woodland mound complex (Howard Lake Mounds [21AN0001]), which is situated on the north shore of Howard Lake, and 21AN0106, located just south of the Anderson test locale near Lino Lakes (Forsberg and Dobbs 1997). The latter site may also include buried archeological components. In addition, sites of all sizes, purported functions, and ages have been found near the test locale.

Archaeological Background

Prehistoric artifacts have been known from the general area of the Anderson site since the late nineteenth century (Flaskerd 1943), and the site was more or less continually collected by the original landowner, A. H. Anderson, since he began farming. Flaskerd (1943:5) indicates the richness of the site when he states that the Anderson family had collected large quantities of artifacts from the site including nearly complete vessels, 3,000 complete stone artifacts and a large number of broken tools. Professional archaeologists at the University of Minnesota became aware of the site in early 1930s when artifacts, including a Folsom point, were collected from the subsurface during construction of Highway 8 (current County State Aid Highway [CSAH] 23; Kruse 1943; Wilford 1937). Albert Jenks and Lloyd A. Wilford visited the site in 1932 and became convinced that the site contained the types of information necessary for developing a regional cultural chronology. In 1934, formal excavations were undertaken (Johnson 1974; Wilford 1937). The 1934 excavations focused on the eastern part of the site between Rice Creek and the Anderson test locale of the current project, excavating what was ultimately a 344 ft (105 m) long by 8 ft to 20 ft (2.4 m to 6 m) wide area that was 5 ft to 6 ft (1.5 m to 1.8 m) deep (Wilford 1937:22-23). The results of this work played a pivotal role in the formulation of the prehistoric cultural sequence for Minnesota (e.g., Wilford 1941, 1944, 1955).

Wilford (1937:21-25) described stratigraphy at the Anderson site as consisting of an upper, dark brown sandy zone that became increasingly lighter with depth. The base of this zone is about 4.5 ft (1.4 m) below the ground surface and is marked by a series of thin, hard brownish or rust-colored sand horizons, termed water lines. These bands were believed to mark periods of stabilization as the dune feature grew, although they probably are pedogenic soil lamellae associated with groundwater fluctuations. Wilford (1937:21-25) subdivided the deposits into three arbitrary strata in his attempt to identify cultural stratigraphy at the site. He noted that cultural material was most abundant in the second stratum located between about 18 in (46 cm) and 3.5 ft (1.1 m) below the surface. A particularly dense concentration of material occurred in a thin (approximately 2-in [5-cm] thick) zone located between about “16 inches above the highest water line and 3 feet below the surface” (Wilford 1937:23). This latter concentration, which Wilford (1937:23) described as an “irregular layer in which chips, sherds, broken artifacts, and especially cracked and broken rocks were much more numerous than elsewhere,” was termed the habitation layer. This should not be interpreted to mean that artifacts were abundant; in fact, Wilford (1937:24) notes, “the whole site was rather meagerly provided with cultural material.” Importantly, the 1934 excavations indicated that no clear cultural stratigraphy is exhibited at the site. This led Wilford (1937:24-25) to suggest that the site was a single occupation layer that was buried relatively rapidly by eolian processes and that artifacts subsequently were translocated upward and downward within the subsurface sediment matrix.

Despite having combined both the Middle Woodland and Late Woodland occupations of the site, Wilford nonetheless recognized the importance of the ceramic assemblage from the site. In addition to the large quantities of ceramics and chipping debris, Wilford (1937:30-36) also described a wide range of projectile points spanning nearly the entire prehistoric period. About 85 percent of the points were stemmed (including contracting, parallel-sided, and expanding stemmed), while the rest were triangular. A small number of ground stone tools and five copper gorges were also noted in the 1934 excavations. Aside from Wilford’s (1937, 1941, 1944, 1955) work, Anfinson’s ([ed] 1979:95-101) description of Howard Lake ceramics and Flaskerd’s (1943, 1944) summaries comprise the only significant published data from the Anderson site. While these emphasize the Middle Woodland character of the assemblage, they also indicate that significant Late Archaic and early Woodland occupations were also present and support the decreased site use during the Late Woodland noted by Wilford (1937).

Professional work was also undertaken during the mid- to late-1970s at the site in conjunction with road-work along CSAH 23 (Anfinson 1979a, 1979b; Harrison 1977). This consisted of test units along the right-of-way, most of which were placed north of the highway near Rice Creek. Unfortunately, this work has never been fully analyzed and no final report was completed (Anfinson 1979b). The site was also surface collected in 1977, producing about 40 ceramic sherds, a few of which were identified as Middle and Late Woodland, a few tools, and nearly

200 flakes of chert, quartz, and quartzite (Harrison 1977). Both the 1976 and 1977 investigations noted that the site was severely disturbed by highway and residential development.