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THE ARCHAEOLOGY OF CORALVILLE LAKE IOWA VOLUME 2

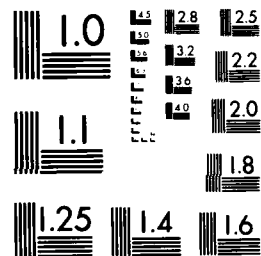
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EVOLUTION OF HOLOCENE LA. (U) GREAT LAKES

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THE ARCHAEOLOGY OF CORALVILLE LAKE, IOWA

VOLUME II: ~~LANDSCAPE~~ EVOLUTION OF
HOLOCENE LANDSCAPES

1986

Prepared By:

Jeffrey D. Anderson
Project Geomorphologist

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and

David F. Overstreet

David F. Overstreet, Ph.D.
Project Manager
Great Lakes Archaeological Research Center, Inc.
7509 West Harwood Avenue
Wauwatosa, Wisconsin 53213

Submitted To:

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building - P.O. Box 2004
Rock Island, IL 61204-2004

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MANAGEMENT SUMMARY

This report entitled "The Archaeology of Coralville Lake - Landscape Evolution" represents Volume II of a seven volume report detailing the archaeological resources of Coralville Lake, Iowa and the planning process for managing those resources. The narrative and data presented in Volume II and Volume VII (Data file for landscape analyses) were collected and presented by Jeffrey D. Anderson who served in the capacity of project geomorphologist. The predictive model of archaeological site distribution was developed, from Anderson's work, by Dr. David F. Overstreet who functioned as project manager.

The project was sponsored by the Rock Island District, U.S. Army Corps of Engineers under the provisions of contract number DACW25-85-C-0049. In part, the contracted investigations fulfill Rock Island District obligations mandated by the National Environmental Policy Act of 1969 (P.L. 91-190), National Historic Preservation Act of 1966 (P.L. 89-665), as amended, Protection and Enhancement of the Cultural Environment (E.O. 11593), Advisory Council's Procedures for the Protection of Historic and Cultural Properties (36 CFR Part 800), Preservation of Historic and Archaeological Data 1974 (P.L. 93-291), and Corps of Engineers Identification and Evaluation of Cultural Resources (E.R. 1105-2-50).

The investigations were undertaken following submittal of a technical proposal in response to a request for proposals. Major work elements include literature and archives investigation, field work consisting of valley transects and excavation units, backhoe trenches, and core and auger investigations, laboratory study consisting of particle size analyses, organic matter content, radiocarbon assay, and subsequent report preparation. Finally, the resulting model of landscape evolution was correlated with anticipated archaeological resources at Coralville Lake and a predictive model of site location was generated.

The resulting management tool incorporates the distribution of various landforms at Coralville lake, their age and an accompanying discussion of processes of formation, degradation, and burial. Emphases are placed upon identifying landscape of known age and extent and the potential for encountering archaeological sites on these landscapes. These data are then integrated within the broader management plan goals and responsibilities. —

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INTRODUCTION:

Prior to completion of this investigation our geomorphic/ stratigraphic understanding of the Coralville Lake project area was insufficient to develop testable models of archaeological site distribution. The studies were initiated following submittal of a proposal in response to request for proposal DACW25-85-R-0028. As identified in the RFP the objectives of the study were to construct a model of landscape development from the late Wisconsinan (approximately 12,000 BP) to contemporary times. Emphasis was to be placed on the Holocene record (10,500 BP to present). The anticipated model was to include detailed chronological data which would serve to illustrate the evolution of this reach (the area adjacent to Coralville Lake) of the Iowa River valley and its adjoining tributary valleys.

Results of the investigation were to incorporate: (1) a map and description of landforms developed during discrete intervals; and (2) correlations of landscapes throughout the project-wide area. A third, less specific, objective was to provide information relating to the age and distribution of landscapes to assist in the over-riding application of managing cultural resources at Coralville Lake, Iowa.

Given these objectives, the following task elements were identified. Prior to conducting any on-site investigations project geomorphologist Jeffrey D. Anderson compiled background information relevant to Coralville Lake interpretations. These investigations ranged from traditional literature and archives search to reviewing project-specific information already compiled by the staff of the Rock Island District Corps of Engineers. These sources included such materials as air-photos which were compiled over a period of years and recent siltation studies. Following the base data compilation Anderson consulted with a number of regional specialists to gain insights relating to broader geomorphic studies and how the results of these studies might be applied to the Coralville Lake project.

Fieldwork was initiated subsequent to the literature and archives work and, generally, entailed the following efforts. First, the project locality was reviewed in a reconnaissance fashion to identify exposures and landforms for more critical and detailed study. Second, a number of archaeological sites were visited with project archaeologists to review stratigraphy, landscape position, and general chronological information.

Intensive fieldwork consisted of valley transects to collect sub-surface information. The sub-surface investigations varied, as one would expect, dependent on the nature and depth of the matrix being examined. Silt probe investigations, bucket auger holes, soil pits, archaeological excavation unit profiles, and back-hoe trenches all served as sources of field data.

Soil samples were returned to the laboratory for particle size analyses, organic matter content, and

radiocarbon assay. Specific methods and techniques applied are detailed in a later discussion in this report.

As part of the comprehensive planning process for cultural resource management at Coralville Lake, all data points were recorded with the aid of a transit, locations were converted to Universal Transverse Mercator coordinates, and ultimately entered into a CADD system data base for mapping hard copy.

Following completion of the geomorphic investigations which represent the major effort discussed in the ensuing narrative, a model of so-called archaeological potential was constructed. The purpose of the model is to serve as a predictive guide to where intact archaeological deposits might to occur. In turn, this information will be applied to making management decisions relating to historic and prehistoric archaeological sites at Coralville Lake. The landscape analyses and predictive model are also useful for focusing research on particular problems of man, climate, and man relationships in the surrounding reaches of the Iowa River valley.

Together, the results of geomorphic and archaeological investigations are applied to the major goal: to determine the kinds and degrees of landscape change which preserved or destroyed archaeological evidence. These phenomena reflect the central task: to describe and map alluvial deposits with the detail required to guide subsequent geomorphic and archaeological studies and for application to the Coralville Lake cultural resources management plan.

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NATURAL HISTORY:

Bedrock Units:

Beneath the deposits associated with Pleistocene glaciation lie carbonate bedrock primarily of Devonian age. The oldest rock units, of Silurian age, are observed in the northeastern corner of Johnson county. Progressively younger units are exposed along a transect from northeast to southwest across the county.

In the Coralville reservoir area the underlying bedrock is primarily of the Devonian System. The Middle Devonian units belong to the Wapsipinicon Formation of crystalline limestone, dolomite, sandy shale, argillaceous limestone and crystalline dolomitic limestone (Hershey, 1969). The younger units of the Cedar Valley Limestone group are seen in many of the bedrock exposures in the Coralville Lake area. These units are composed of crystalline and clastic limestone, dolomitic limestone with coral, and fossiliferous and brecciated limestone.

The Upper Devonian series including the Lime Creek Formation consisting of fossiliferous limestone, fossiliferous gray shale, and massive limestone and dolomite, can also be observed in portions of the Lake MacBride and Coralville reservoir areas. At a distance from the reservoir, in the southwestern part of the county, Upper Devonian shales, dolomites, and siltstones of the Yellow Spring Group are exposed.

Quaternary History:

The Pleistocene:

Considerable debate has ensued with regard to the glacial history of the Pleistocene in east central Iowa. Traditionally, two major glacial stages were considered since only two tills were recognized. These older tills represented deposits from glacial advances during the Nebraskan, and Kansan stages (Leighton, 1916, Alden and Leighton, 1917, Cable, 1921). However, more recent study indicates that multiple tills exist and these represent several glacial advances during the early and middle Pleistocene.

Most of the older studies recognized a post Illinoian unit which was primarily composed of a gravel lag or pebble band. This band was considered to be the upper till in the Iowan area (Alden and Leighton, 1917). The presence of the till remained unquestioned for several decades, but during the 1950's doubts were raised about its existence.

Studies conducted in east central Iowa on erosional remnants (pahas) refuted the earlier claims of an Iowan drift (Ruhe, 1969). These topographically higher landforms are linear and generally are aligned in a northwest to southeast orientation. Transects across several pahas and onto the lower Iowan surface indicate that the pebble band

is not a thin veneer of till. A number of investigators have demonstrated that the formerly called Iowan drift is actually an erosion surface (Ruhe et al., 1965, Ruhe et al., 1968, Vreeken, 1975, Hallberg et al., 1978, Hallberg, 1980). These more recent studies have provided convincing evidence that denies the existence of Iowan drift. The stratigraphic units occurring in the pahas show a 7 to 10 till sequence separated by paleosols and undifferentiated alluvial deposits. The pahas contain more of the Pleistocene record, but do not contain the pebble band formerly believed to be Iowan drift. Furthermore, they correlate stratigraphically with the pre-Illinoian surface seen in southern Iowa evidenced by a resemblance to those units observed further south.

A typical stratigraphic column through the top of a paha would show a surface soil developed in thick Wisconsinan eolian silt and sand. Beneath the loess a basal paleosol of Late Sangamon or Yarmouth-Sangamon age would be encountered. Below this paleosol till and alluvial deposits considered pre-Illinoian in age would be found.

These pre-Illinoian deposits have recently been evaluated by Hallberg (1980) and range from 7 to 12 units of till, stratified alluvial sediments, and organic enriched horizons. Some of the pre-Illinoian tills belong to the Wolf Creek Formation estimated to be about 500 ka (Hallberg, et al. 1984) which consist of the Hickory Hills, the Aurora, and the Winthrop members. Other pre-Illinoian tills belong to the Alburnett Formation.

Although numerous paleosols are evidenced in the pre-Illinoian deposits, at least two are formally named and occur in a known stratigraphic position. The Dysart paleosol is developed in the Aurora till subjacent to the Hickory Hills member. The Westburg paleosol is developed in the uppermost till of the Alburnett Formation. Other undifferentiated paleosols are observed in both the Wolf Creek and Alburnett Formations.

During the Wisconsinan the Iowan erosion surface was being developed in northeastern Iowa. This surface was being cut while loess was being deposited in the region. Unlike the more complete stratigraphic record observed in the paha inliers, the Iowan surface which is capped by Wisconsinan loess truncates older paleosols and till. This is observed near Geneseo, Iowa where the Iowan surface abutting Hayward's paha truncates the the upper two tills at the surface (Ruhe et al., 1968).

The Iowan surface presumably formed from episodes of fluvial erosion and concomitant eolian deposition which began during the Farmdalian about 30,000 B.P. and extended through the Woodfordian. However after the last increment of loessal deposition occurred, about 14,000 B.P., components of the Iowan surface continued well into the Holocene (Ruhe et al., 1968).

The Holocene:

Climatic history:

Atmospheric circulation patterns were greatly affected by the wasting of Laurentide ice to the north of east central Iowa. The early Holocene brought about the persistence of an upper atmospheric circulation pattern dominated by a cool relatively dry northwesterly flow out of Canada (Knox, 1983). Maritime tropical air masses derived from the Gulf of Mexico were effectively blocked by the persistent northwesterly component.

As the Laurentide ice mass wasted further to the north, a more westerly upper atmospheric component penetrated the upper midwest. This intrusion of Pacific-derived air continued to block the maritime tropical air to the south. Hence, the middle Holocene was characterized by warmer and drier conditions which effectively lowered local water tables causing surface destabilization. From 9500 to 4700 B.P. in east central Minnesota there was an increase in the duration of Pacific air producing a 2 inch decrease in precipitation during the maximum penetration of westerly air about 7200 B.P. (Webb and Bryson, 1972).

Holocene climatic changes that occurred in the upper midwest initiated migration and succession of several plant species (Webb, Cushing, and Wright, 1983, Wright 1976a). The early Holocene east to west fluctuations of the prairie forest ecotone suggest changes in the dominant upper atmospheric circulation regimes. The zonal upper atmospheric circulation pattern increased the frequency of warm dry Pacific-derived air masses, causing the prairie/forest ecotone to advance eastward across Iowa prior to 8000 B.P. The waning of Laurentide ice continued during the middle Holocene and by 6500 B.P. the ice had retreated to the Quebec/Labrador plateau. In response to the deteriorating ice mass, the dominant westerly atmospheric component became less persistent in the upper midwest. As a result, the influx of maritime tropical air from the Gulf of Mexico and polar air from Canada began to increase in frequency.

The shift in dominant upper air patterns occurred rapidly between 6000 and 5000 B.P., changing the frequency of air mass dominance toward a more persistent meridional upper atmospheric circulation. Meridional circulation patterns provide the mechanism necessary for the mixing of unlike tropical and polar air masses which results in an increase in the frequency and magnitude of precipitation events (Knox, 1975a).

The late Holocene climate, including contemporary twentieth century climate, is characterized by persistent episodes of either meridional or zonal circulation. The orientation of the upper air jet stream over the upper midwest determines whether the prevailing climate will be relatively cool/moist, cool/dry, warm/moist, or warm/dry (Knox, 1979). Persistence of any one of these climatic scenarios can change the magnitude and direction of geomorphic processes controlling landscape evolution.

Geomorphic Episodes:

Geomorphic responses found in alluvial chronologies are strongly affected by the magnitude and direction of Holocene climatic changes. Alluvial chronologies imply that a shift to drier conditions promotes hillslope erosion, while a shift to wetter conditions institutes hillslope stability and valley incision (Knox, 1984). Whether the geomorphic response is aggradation or degradation apparently depends upon the direction of climatic shift relative to the existing climate, and, on the relative location of stream reach within the drainage net hierarchy (Knox, 1972). Spatially this suggests that in a relatively large watershed such as a 6th order basin (Strahler ordering method), a shift in climate may produce different geomorphic responses in the headwaters than in the middle and lower reaches.

One of the reasons for the apparent episodic behavior in landscape evolution is the lag time produced when vegetation is out of balance with a new climatic regime. A shift in dominant upper air patterns which occurred rapidly between 6000 and 5000 B.P., produced a condition where the established vegetation was not adjusted to the new, more moist, climatic regime. The lag time involving at least 100 years in the adjustment of vegetation (Wendland and Bryson, 1974), produced a biogeomorphic response which initiated lateral reworking of floodplains particularly in southwestern Wisconsin (Knox, 1972, 1976).

Although external (extrinsic) climatic factors often produce episodes of hillslope and/or valley instability, intrinsic factors that periodically exceed thresholds of slope stability will also initiate episodic geomorphic behavior. For example, erosion of alluvial fans periodically occurs. Over time aggradation steepens the fan finally exceeding a threshold slope where incision is initiated (Schumm, 1973). Additionally, sediment storage in a valley occurs through time aggrading the valley slope until oversteepening produces degradation. These are types of intrinsic geomorphic thresholds which produce landform change through time to a condition of incipient instability without a change of external (ie. climatic) influences (Schumm, 1973, 1977:8).

During the early Holocene valley alluviation including alluvial fan development appears to have been proceeding (Knox, 1972, 1976) in many parts of the midwest. For example in the Des Moines River valley, alluvial fan development progressed throughout the early and middle Holocene with stabilization occurring about 4000 years ago (Benn and Bettis 1985, Bettis, 1985). Evidence from Sumner Bog, Bremer County Iowa (VanZant, and Hallberg, 1976), suggests that organic enriched valley fill deposits were accumulating on a sandy Woodfordian terrace during the early Holocene. However, increased aridity associated with the middle Holocene likely changed both vegetation type and density promoting surficial instability. Radiocarbon dates recovered from the bog indicate that the period of maximum dryness occurred between 7,200 and 6,200 B.P. This resulted

in the lowering of local water tables which oxidized organic material and produced incision. The evidence for an episode of erosion was illustrated by an unconformable surface which was later buried by peaty sediments beginning around 6,100 B.P.

Between 6,000 and 4,500 B.P. valley floor sediments were being eroded and reworked through rapid lateral channel migration in western Wisconsin. This fluvial activity decreased from 4,500 to 3,000 B.P. but again intensified after 3,000 B.P. (Knox, 1984). By 1,800 B.P. alluvial valleys in western Wisconsin again stabilized in favor of modest vertical accretion.

In Tama County Iowa, the Thoms basin first reveals a history of valley entrenchment in the form of gullies during the early to mid Holocene. By about 6200 B.P. slope wash deposits began to fill the valley bottom gullies (Vreeken, 1975). Valley alluviation proceeded throughout the remainder of the Holocene in the Thoms basin until recently when agricultural land use promoted an episode of destabilization.

Breakdown of the Holocene based upon the Coralville Evidence:

The breakdown of the Holocene is primarily based upon radiometric and stratigraphic evidence in Coralville Reservoir. A primary element used in delineating the Holocene was based upon the chronology of geomorphic events. The climatic reconstructions were inferred from the geomorphic and radiometric data, since no direct climatic data was obtained during the course of this study.

Differentiation between the early and middle Holocene could not be determined either stratigraphically or radiometrically from the available data. The evidence shows that hillslope erosion occurred throughout the early and middle Holocene. For instance, alluvial fans were developing perhaps as early as 10,000 years ago. In addition, dunes also produced conclusive evidence supporting hillslope destabilization during this period. Further, in the tributaries, hillslope erosion also occurred. These geomorphic episodes are thought to have been in response to a relatively long period of drier Holocene climate.

The late Holocene appears to have begun around 4500BP. This conclusion is based upon fluvial evidence of floodplain abandonment and rapid lateral stream migration. This change in hydrology established the intermediate terrace in the Hawkeye Wildlife Area. The two radiocarbon dates from the north and south ends of the terrace support this interpretation. In addition, a radiocarbon date taken from a sample on the late Woodfordian terrace indicates that surface stabilization and plant colonization occurred around 4600BP. This evidence suggests that around 4600BP climate probably became more moist in the area.

It is important to note that the Coralville area experienced additional hillslope erosion during the late Holocene. The geomorphic evidence shows that hillslope

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erosion occurred after 4500BP, and a more recent episode of deflation happened after 1300BP. These comparatively minor episodes of erosion were probably in response to relatively short periods of drought.

PHYSIOGRAPHIC SETTING AND PREVIOUS INVESTIGATIONS:

Background:

The Coralville reservoir impounds the Iowa river north and west of Iowa city and is a facility designed for flood control, low flow augmentation, conservation, and recreation. The drainage area upstream of the dam is 3115 sq. miles (USACE, 1975), and comprises about 25% of the total watershed drainage area (Figures 1 and 2).

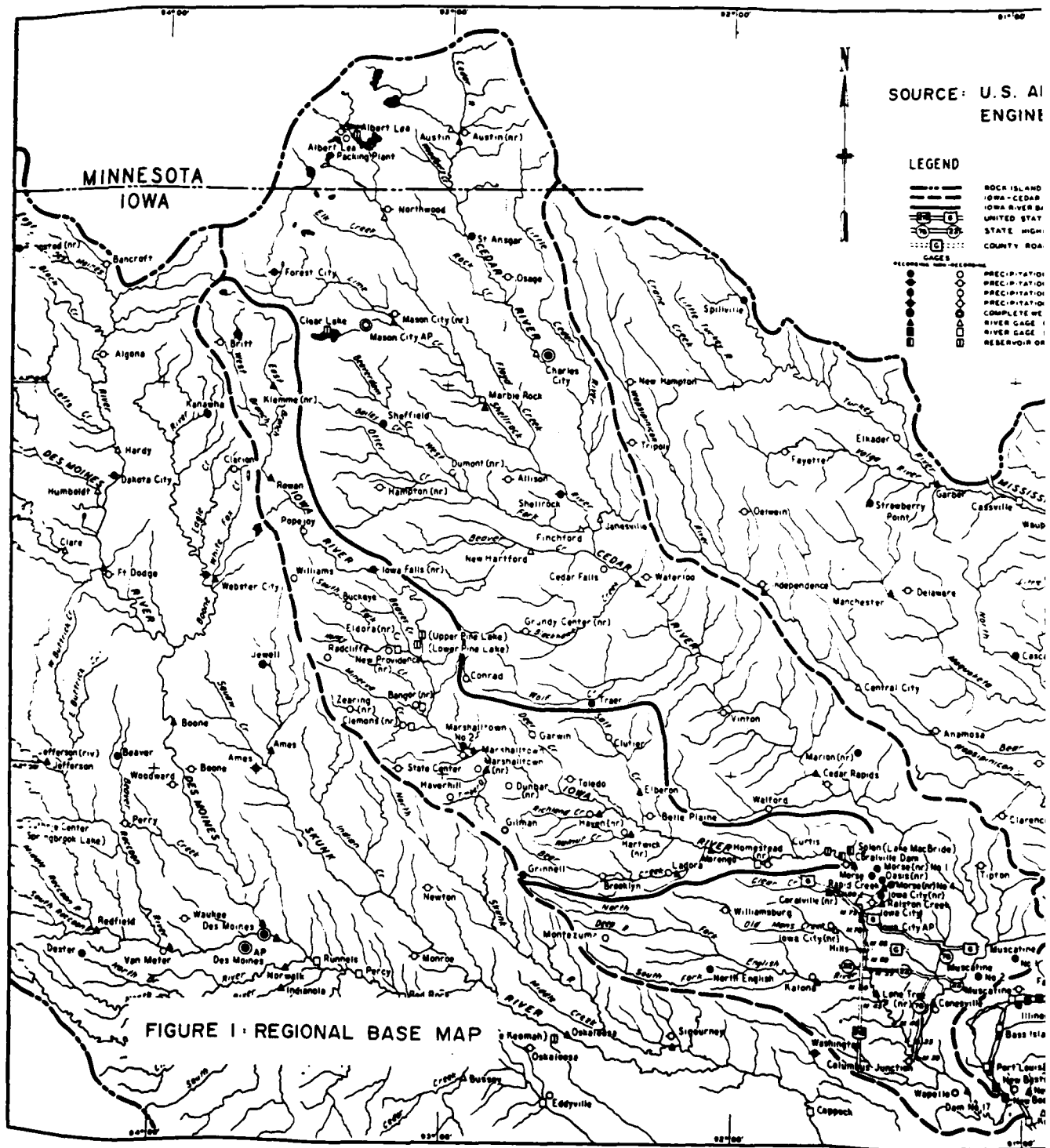
The Coralville area lies within the Iowan erosion surface (Figure 3), and the pre-Illinoian drift region (Ruhe and Prior, 1970, Prior, 1976). Both surfaces are capped by Wisconsinan loess. Older Woodfordian alluvial terrace surfaces that date prior to 14,000 B.P. are also capped by loess. Younger alluvial surfaces of Holocene age are found closer to the Iowa river course.

To the east and south of Interstate 380, the Iowa river valley is confined to a bedrock gorge of presumably Illinoian or earlier age (Leighton, 1916, Salisbury et al., 1968). Bedrock exposures are common in this portion of the reservoir, and consist primarily of carbonate units of Devonian age. Units including the Cedar Valley Limestone group and Wapsipinicon Formation of crystalline and clastic limestone, dolomitic limestone with coral, and fossiliferous limestone are seen in many of the bedrock exposures in this portion of the reservoir. However, in Lake MacBride the Lime Creek and Shell Rock Formations, consisting of fossiliferous limestone, fossiliferous gray shale, and massive limestone and dolomite, can be observed (Hershey, 1969).

Upstream, west of the Interstate, the valley widens and passes through a region of unconsolidated pre-Illinoian drift (Salisbury et al., 1968). This portion of the Iowa river valley is suspected to contain a buried valley with depths of unconsolidated fill of at least 150 feet (Calvin, 1896:48). The wide valley observed in the Hawkeye Wildlife Area is composed of alluvial and eolian surfaces of both Holocene and Wisconsinan ages.

The climate of the Coralville area is humid continental with cold winters dominated by continental polar air masses and warm summers dominated by maritime polar (Pacific) and maritime tropical air masses. The summer average temperature is 73 degrees F. and the average winter temperature is 24 degrees F. Total annual rainfall is about 34 inches with 70 percent of the precipitation occurring between the months of April and September (Schermerhorn, 1983).

Most of the soils in the Coralville area are developed in loess with dark organic rich surface horizons and subsurface argillic horizons. Many of the soils would be classified as Udolls and Udalfs, particularly in the older loess capped terraces and upland areas. However, in areas closer to the Iowa river soils have formed in coarser textured alluvial and reworked eolian sediments and have rather poorly developed subsurface horizons. Many of these soils trend toward Aquept, Ochrept, Fluvent and Psamment suborder classification.



SOURCE: U.S. ARMY CORPS OF
ENGINEERS, SEPT. 1978

LEGEND

- ROCK ISLAND DISTRICT BOUNDARY
- IOWA-CEDAR BASIN BOUNDARY
- IOWA RIVER BASIN ABOVE CORALVILLE DAM
- UNITED STATES HIGHWAY
- COUNTY ROAD
- GAGES
- PRECIPITATION STATION
- PRECIPITATION AND TEMPERATURE
- PRECIPITATION, TEMPERATURE, AND EVAPORATION
- COMPLETE WEATHER BUREAU METEOROLOGICAL STATION
- RIVER GAGE, STAGE ONLY
- RESERVOIR OR LAKE GAGE



VICINITY MAP
SCALE IN MILES



IOWA RIVER, IOWA
CORALVILLE RESERVOIR
WATERSHED MAP
SCALE IN MILES

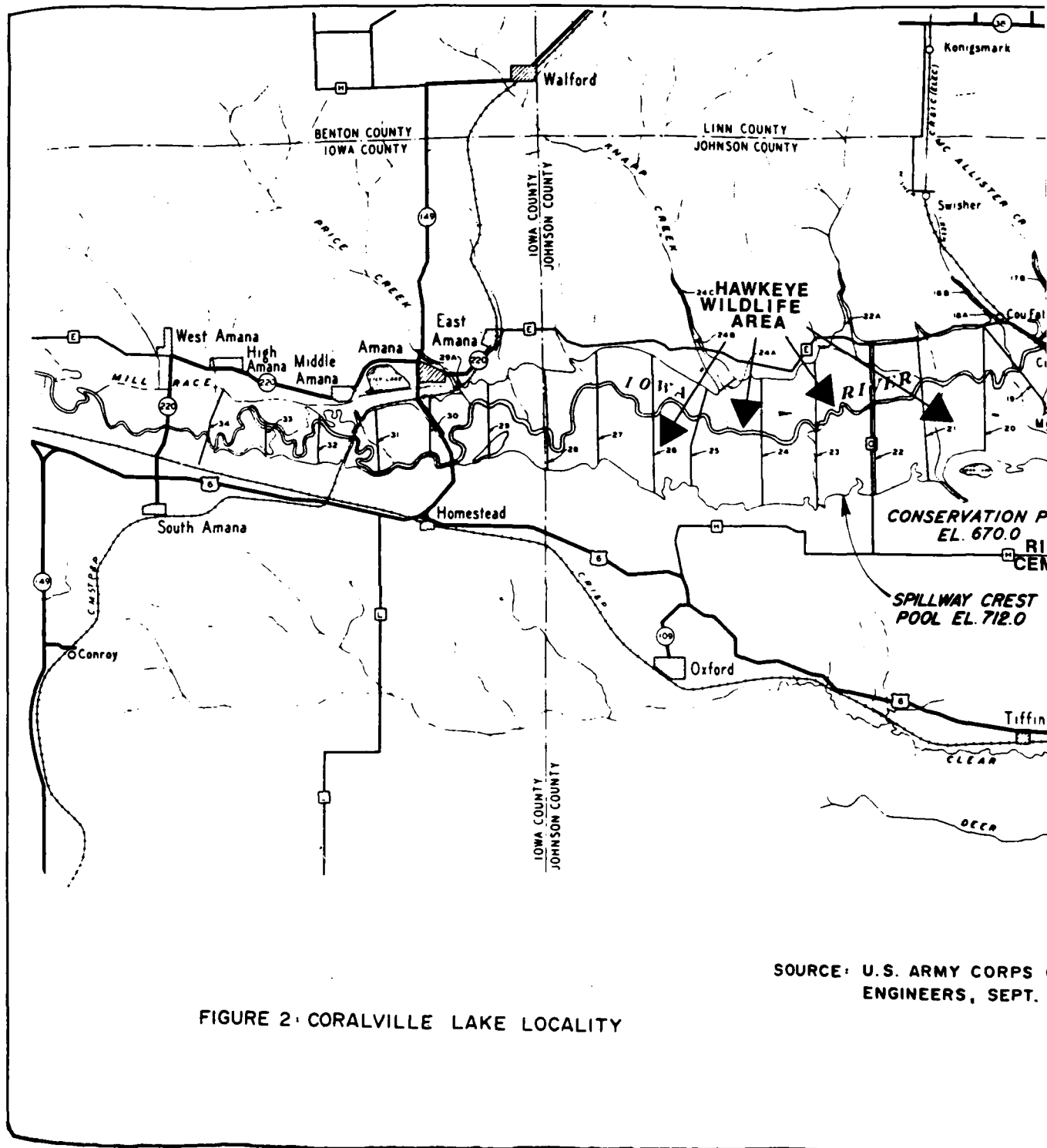
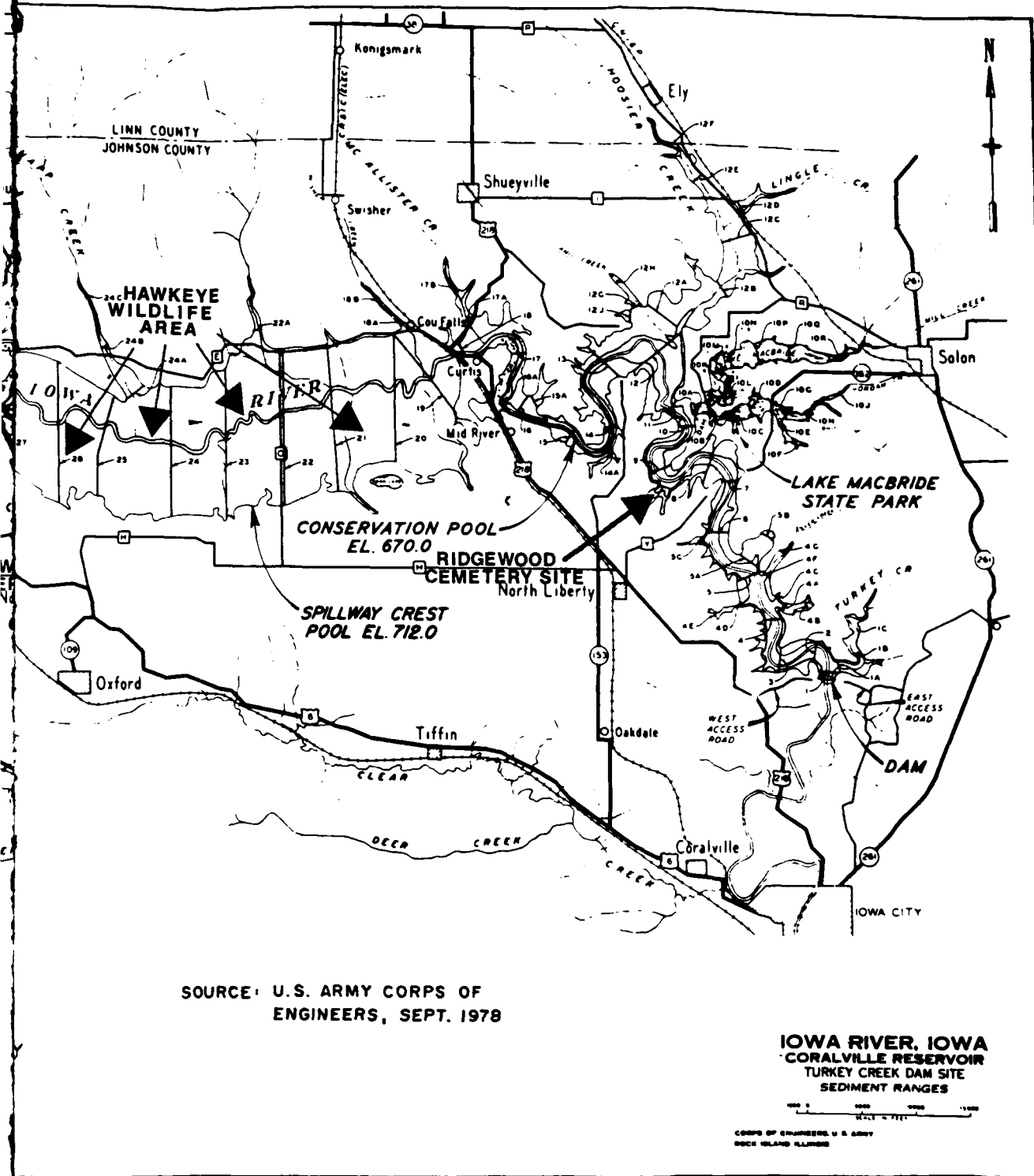


FIGURE 2: CORALVILLE LAKE LOCALITY



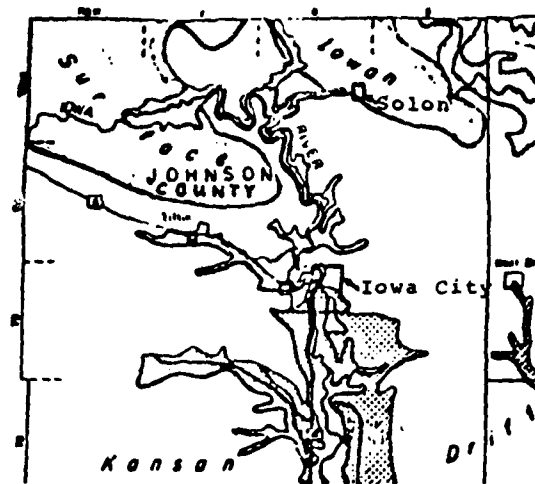


FIGURE 3: Iowan surface and the pre-Illinoian "Kansan" drift plain (after Ruhe and Prior, 1970).

Previous Investigations:

A study of the Coralville Reservoir area by Emerson et al. (1984), included examination of several geomorphic surfaces contained within the reservoir area. From a few boreholes and the existing Johnson county soil survey studies, delineation of a number of "physical environments" were mapped surrounding the Coralville reservoir (Emerson et al. 1984: 17). These mapped units were particularly concerned with surfaces located above the main Iowa river valley and therefore excluded the modern floodplain, the low Holocene terrace, alluvial fans and colluvial footslopes abutting the main valley. Lower Holocene terrace and modern floodplain surfaces adjacent to the Iowa river course are often impounded throughout much of the year, and were simply mapped as floodplain in this former study.

The Floodplain:

Considerable discussion and often confusion surrounds the concept of the "floodplain." This is primarily due to the differences in definition used by investigators of different disciplines or concerns. Engineers and land use planners usually refer to any area that is subject to flooding (Dunne and Leopold, 1978: 428) as the floodplain. This would include areas adjacent the river course that would be flooded only during rare hydrologic events. For example, a 50 year (2% recurrence probability per year) flood event would inundate a relatively large portion of the valley and would be considered as part of the floodplain to the land use planner.

In contrast, the floodplain to the geomorphologist consists of that area adjacent the river course which is inundated frequently in response to the present hydrologic regime. The floodplain in this sense is actively being reworked and constitutes that area which is presently under construction. The floodplain under construction is flooded frequently and at a relatively consistent recurrence interval of 1.5 years in the annual duration flood series (Dunne and Leopold, 1978: 607) and 1.0 years in the partial duration flood series. In the field the floodplain under construction is marked by the top of the fining-upward lateral accretion point bar deposit (Knox, 1984). Consequently, the floodplain to the geomorphologist constitutes a much smaller area and does not include slightly higher alluvial surfaces abutting the modern floodplain surface.

Alluvial valleys often contain multiple relict surfaces that relate to past hydrologic regimes, and in many cases these surfaces show only small topographic changes that are perceptible only through field observations. These more subdued terrace surfaces may be of concern to the archaeologist since they may contain preserved buried surfaces of late prehistoric and historic ages.

CORALVILLE INVESTIGATION METHODOLOGY:

Goals and Objectives:

The primary goal of this study is to develop a comprehensive evolutionary landscape model that can be applied toward effective cultural resource management. The model focuses on determining the geochronology of the Coralville Reservoir area particularly in the more complex and dynamic alluvial settings. The research concentrates on the broad valley of the Hawkeye wildlife area. Then the study evaluates a tributary reach downstream in the Iowa river gorge. The objective is to reconstruct a detailed landscape chronology in valley settings where the potential for preserved archeological site burial from Holocene alluvial fill deposits is high.

In order to achieve this goal, a program was used to incorporate intensive indirect and direct field methodology with appropriate laboratory procedures. Synthesis of these procedures has produced an evolutionary landscape model based upon direct empirical studies which can be employed as a tool for the cultural resource manager.

The following methods and techniques were applied in field and lab investigations. These methods and techniques are reviewed here to allow for evaluation of the data base used to support subsequent conclusions relating to Coralville Lake landscapes. In addition, future research directed in Coralville reservoir may wish to corroborate subsequent research methodologies with those presented in this study.

Preliminary Site Determination:

In order to choose areas that would be suitable for study, a number of literature and archive sources were examined. During May 1985, several visits were undertaken to the Corps of Engineers, Rock Island District headquarters in order to study the available resources already compiled on the reservoir. One resource which proved extremely helpful was a set of black and white 1937 aerial photographs of the reservoir area. These photos provided useful information about the Hawkeye Wildlife area before impoundment. At that time much of the Wildlife area was under heavy cultivation with the exception of a narrow strip of land either side of the main Iowa River channel. This strip was composed of mature woodland vegetation and in most cases extended a few hundred meters from either side of the channel margin.

The 1937 air photos showed numerous paleochannels that, by the 1985 study, had all been filled with historical sediment. In fact, the more recent, better quality, 1984 color air photos showed no sign of many of these relict channels. In addition, the U.S.G.S. 7.5 minute topographic quadrangles lack contour intervals sufficiently small to reflect the relict channels. Consequently, the 1937 photos

were extremely helpful in detecting land use changes over the course of 48 years. The photos aided in identifying areas of potential study, particularly along paleochannel margins, and by recognizing areas where agricultural land use has promoted severe deflation.

These air photos were used in conjunction with Corps of Engineer plane table maps with a horizontal scale of 1 inch to 200 feet and a contour interval of 2 feet. The maps were also extremely helpful since they provided confirmation of the 1937 photos and were used to accurately locate sites (such as paleochannel margins) for field study. The plane table maps also provided survey benchmark elevations. With the exception of our backhoe trench #1 which was surveyed to a culvert elevation, the remainder of the core, pit, and trench elevations in the Hawkeye Wildlife area were correlated with a benchmark on the bridge that crosses the Iowa river along county road O.

After the maps and photos were studied, this information was brought to the field and on-site observations were made in the Hawkeye Wildlife area and downstream in the Iowa river gorge. The on-site observations included borrow pit and stream bank exposures, and numerous silt probe test cores placed on the different terraces.

Field investigations:

Upon completion of the preliminary work, field investigations began with detailed descriptions and sampling across the Hawkeye Wildlife area. The work included sampled and described profiles across the wide Iowa river valley along 10 transects. Field work then continued in the 4th order tributary (Ridgewood Cemetery) downstream in the Iowa river gorge. After 3 valley transects were studied in the tributary, the final stages of field investigations concluded with 4 backhoe trench excavations at selected locations in the Hawkeye Wildlife area.

Subsurface investigations along these transects were accomplished through soil pit excavations, bucket auger and silt probe coring. In many cases, a soil pit was first dug, then the profile was extended with the bucket auger, and finally, the silt probe was used to reach a maximum profile depth.

These profiles were sampled down to the limits of the bucket auger but in many cases were described to the bottom of the profile by means of the silt probe. Samples were taken within soil horizons and in the parent material(s) on the basis of textural units. Profile descriptions included color, texture, structure, cutans if present, consistence, special features, effervescence and/or pH, and boundary.

During the course of the field investigation, the transects were surveyed in order to plot surface topography and subsurface horizons and sedimentary units. This more detailed work was done in order to provide the most accurate stratigraphic correlations across the main valley and in the valleys of the Ridgewood tributary. With the exception of

one soil pit (Co. Rd. E Fan #1) below Trench #1 (CFS), every core and soil pit along the transects, and all of the trenches were surveyed. In addition, several points between profiles along the transects and trenches were surveyed. This was accomplished through the use of a 5" transit and metric stadia rod. In the Hawkeye Wildlife area elevations along the transects were tied into benchmarks obtained from the (USACE) plane table maps, while in the tributary valley the elevations were tied into the reservoir water surface elevation which was verified at the project operations office (spillway).

The backhoe trenches were studied in a similar manner. The 4 trenches varied in length from 5 to 76 meters and were all located in the Hawkeye Wildlife area. Sampling was conducted along the trench where profile changes could be observed. Additional descriptions of the trenches were used in conjunction with the sampled profiles for the purposes of landscape reconstruction.

Photographs were taken during the field investigations which provided an additional aid for site and profile reconstruction. The soil pits were dug in such a manner as to provide a south aspect for optimal photographic exposure. Closeup shots of the profiles illustrating examples of micromorphologic features (such as post-settlement alluvial laminae, argillans, silt caps, etc.) were taken in order to retain a permanent record of features observed in the field for future reference.

Laboratory Methodology:

Laboratory procedures included particle size and organic carbon determination. The method used for determining the relative proportion of grain sizes in the sample was accomplished through the hydrometer method (Bouyoucos 1936). Organic carbon was determined by the Walkley-Black titration method (Allison, 1965).

The hydrometer method was slightly modified to minimize the possibility of inaccuracy from either operator inconsistency or from laboratory temperature fluctuations. The samples were first weighed and if they contained relatively high organic matter, they were pretreated with a 35% solution of hydrogen peroxide. Organic enriched samples from the surface horizon were usually treated unless they were severely eroded. The treatment continued until reaction ceased, then the sample was placed in the convection oven to dry overnight.

The oven dried samples were then gently crushed and reweighed to exactly 30.00 grams on a digital "Precisa" electronic balance. Each sample was then treated with 100 ml. of sodium hexametaphosphate (a defloculating agent), and placed on a mechanical "Eberbach" shaker overnight. The samples were then screened through a #10 (2mm) sieve, poured into 1000ml. volumetric cylinders, and filled with distilled water to the 1 liter mark. The samples were agitated with a stirring rod for 1 minute and the hydrometer readings were taken at 2, 4, 8, 15, 30, and 60 minutes; 2, 4 and 7 hours.

Temperature of the solutions was recorded in conjunction with each reading in order to compensate for room temperature fluctuations.

Following completion of the hydrometer readings the samples were wet sieved to segregate the sand fraction. The wet sieving procedure included fractionation by a #40 (420 micron, 1.25 Phi), #60 (250 micron, 2.0 Phi), and #230 (63 micron, 4.0 Phi) sieves. These fractions combined with the greater than 2mm sediments were oven dried, weighed and recorded. The raw particle size data was sent to Professor James C. Knox at the Geography Department, University of Wisconsin, Madison for computer processing with the aid of specially-designed software.

Organic carbon determination began by oven drying an approximate 1 gram sample. The sample was then crushed to a less than 0.5mm fraction. Exactly 0.5 grams of sample was weighed for most samples, although samples containing high organic matter content were weighed to 0.25 grams. The sample was placed in a 250ml erlymeyer flask and 10 ml of reagent grade potassium dichromate (Mallinckrodt brand) solution was combined with the crushed sample. Next, 20ml of reagent grade (Mallinckrodt brand) 96% sulfuric acid was poured into the flask and gently mixed with the sample/dichromate solution. The solution was placed in a fume hood for about half an hour. Another flask was prepared as above without the soil sample to be used to standardize the reagent grade (Mallinckrodt brand) ferrous sulfate.

After removal from the fume hood, distilled water was added to the flask up to the 250ml mark. Each sample received 5 drops of ferrion indicator and was place on a magnetic stirrer to mix the solution. While the stirrer was operating the solution was titrated with the standardized ferrous sulfate until the end point (designated by a maroon color change) was reached. The volume of ferrous sulfate used in the titration was recorded and through mathematical calculations the percent organic matter was determined.

A total of 21 samples were submitted to Beta Analytic, Inc. for radiocarbon assay. Of the 21 samples 3 had insufficient carbon for dating. These 3 samples were collected from lower units along the Trench 3 Dune profile and near the base of Trench 4 and were considered to be of Woodfordian age.

HAWKEYE WILDLIFE AREA:

Introduction:

The Hawkeye area is a complex mosaic of landforms which have evolved during the Wisconsin and Holocene. These landforms, produced by fluvial, eolian and gravitational processes, have been subjected to periods of stability evidenced by soil profile development and instability, evidenced by terrace formation, valley fill components, dunes and fan development. The Hawkeye with its considerable diversity of natural landscapes is essentially composed of a floodplain, four terraces, colluvial footslopes, alluvial fans, dunes, and interdunal depressions. This diversity is illustrated in Figure 4 which provides a detailed map showing the distribution of landscapes. This figure has also been digitized and placed in the CADD data base for Coralville Lake (see Volume VI).

The southern margin of the wildlife area is occupied by the loess mantled Wisconsin terrace. This terrace has been capped by numerous Woodfordian dunes which rise about 20 feet above the terrace. The dune and interdunal depression studied in this project illustrated multiple episodes of hillslope erosion and depression filling which apparently have occurred throughout much of the Holocene.

Located about 5 meters below the loess capped terrace is the late Woodfordian surface (Figures 4 and 5). This surface appears to have been active sometime after loess fall had ceased in the region, but was abandoned by about 11,000 B.P. This terrace has been subjected to repeated reworking both from eolian and biopedoturbative processes. Non-stratified small scale dunes, considerably smaller than the dunes seen to the south on the higher Wisconsin terrace, are observed on this surface. Furthermore, depressions have formed in areas of eolian scour and have been subsequently filled with finer grained sediment.

Below the high late Woodfordian terrace lies the intermediate terrace that was active floodplain from about 11,000 BP to about 4500 BP (Figure 6). Similar to the adjacent higher terrace along the south end of the Hawkeye, this terrace has a reworked surface component. However, in contrast to the adjacent higher terrace, the surficial reworked unit is not nearly as thick and the morphology of the intermediate terrace shows little or no small scale dune development.

Along the north end of the Hawkeye the characteristics of the intermediate terrace are considerably different compared to that seen on the south end. The terrace has been either eroded through lateral channel migration during the late Holocene or has been buried by alluvial fans entering the valley. Where fans bury the terrace the alluvial units have not been reworked and appear to be preserved.

The low terrace was the active floodplain from about 4500 BP, and has a different sedimentological profile

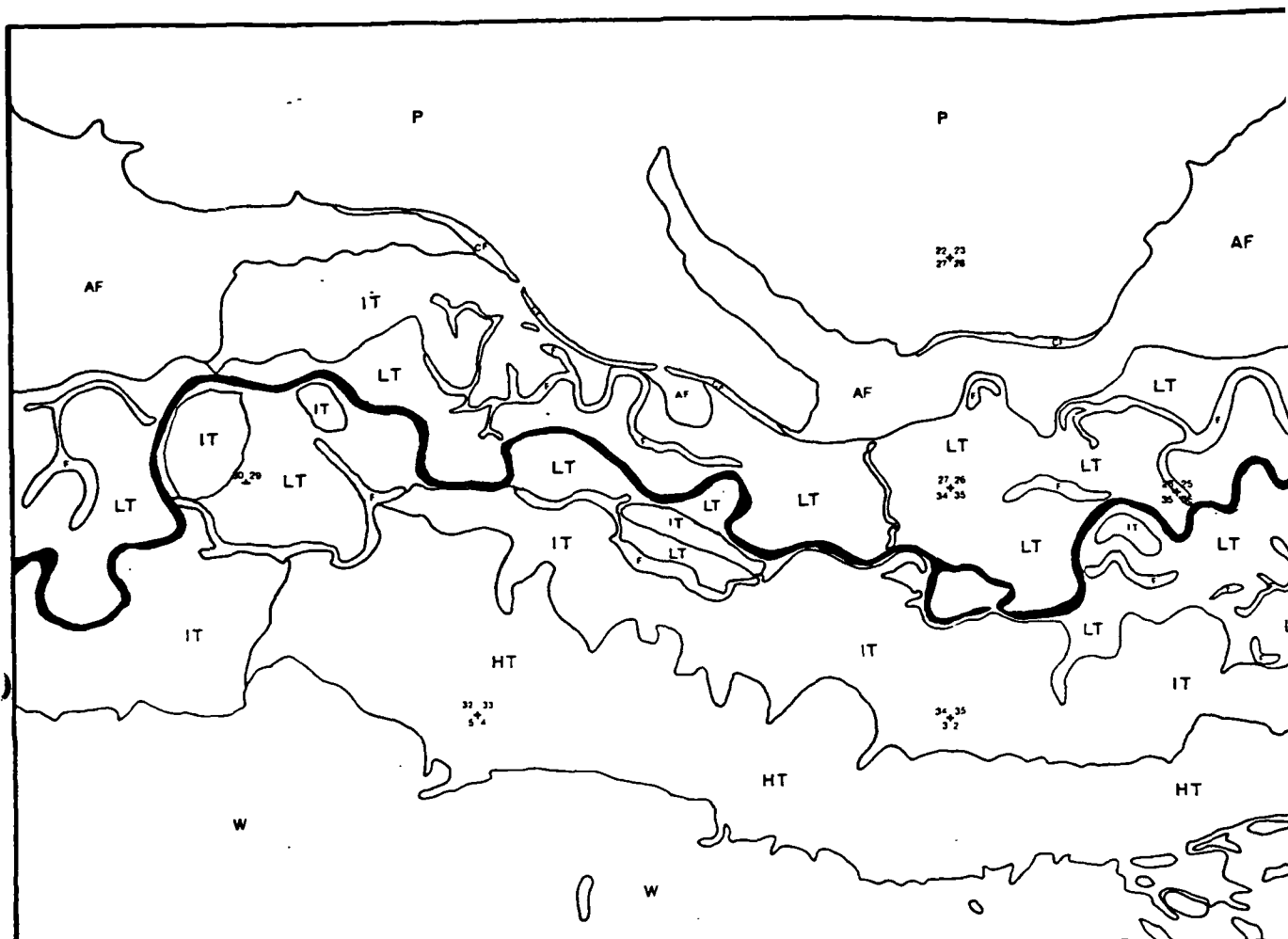


FIGURE 4: HAWKEYE WILDLIFE AREA SURFACES

SCALE 1:24,000

F • FLOODPLAIN

LT • LOW TERRACE MIXED LATERAL & VERTICLE ACCRETION DEPOSITS (LATE HOLOCENE)

IT • INTERMEDIATE TERRACE THIN (< 1M) REWORKED EOLIAN MANTLE OVER ALLUVIAL SAND (EARLY & MIDDLE HOLOCENE)

HT • HIGH TERRACE THICK (> 1M) REWORKED EOLIAN MANTLE OVER ALLUVIAL SAND (LATE WOODFORDIAN)

W • MID-WOODFORDIAN & OLDER IOWAN SURFACES (WISCONSINAN TERRACE)

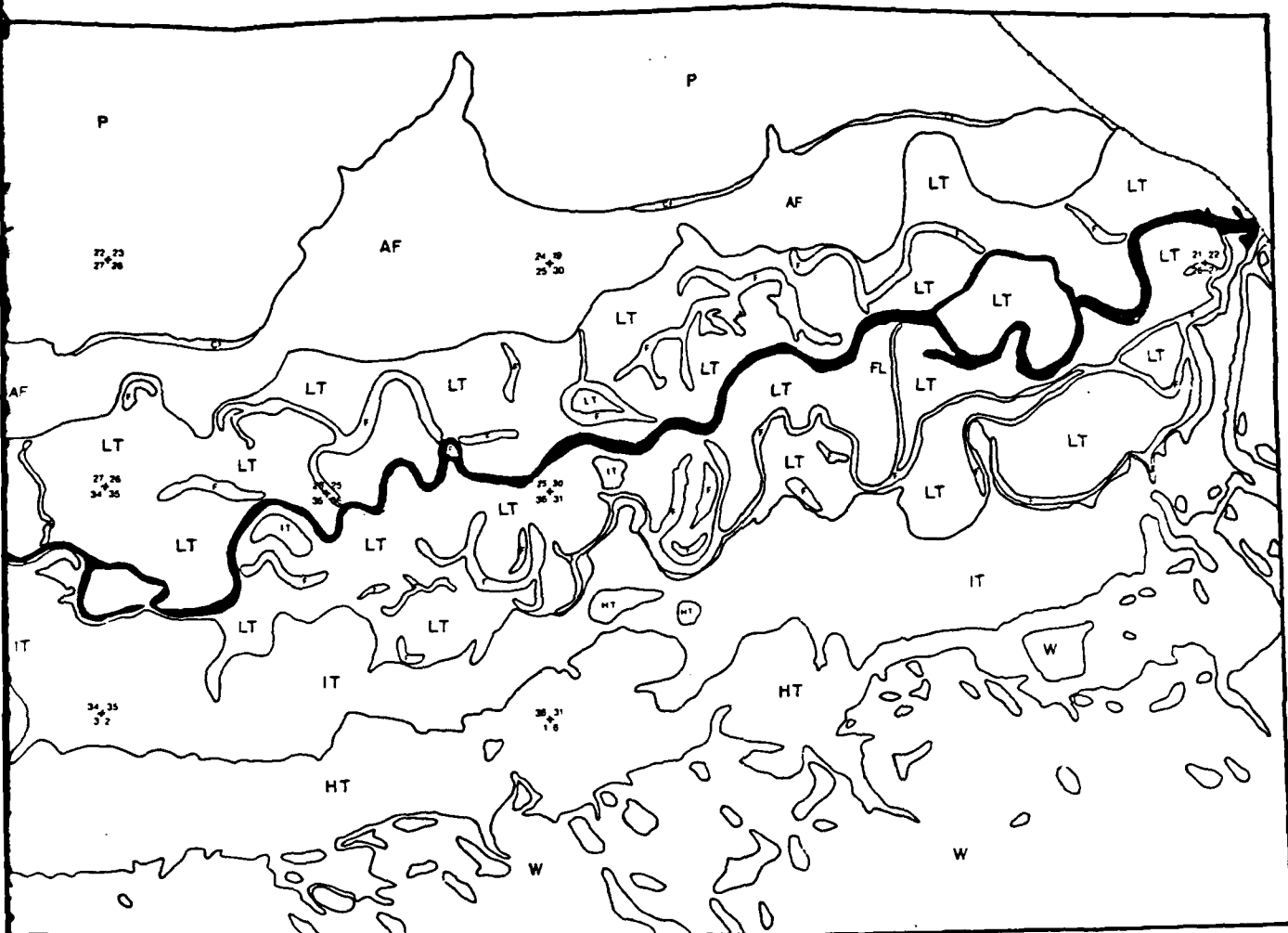
P • PRE-ILLINOIAN AND IOWAN SURFACES (capped by wisconsinan loess)

AF • ALLUVIAL FAN

D • DUNES

CF • COLLUVIAL FOOTSLOPES

11382



ATE HOLOCENE)

ALLUVIAL SAND (EARLY & MIDDLE HOLOCENE)

AL SAND (LATE WOODFORDIAN)

RACE)

an loess)

GENERALIZED VALLEY CROSS
HAWKEYE WILDLIFE AREA
VALLEY TRANSECTS "C"

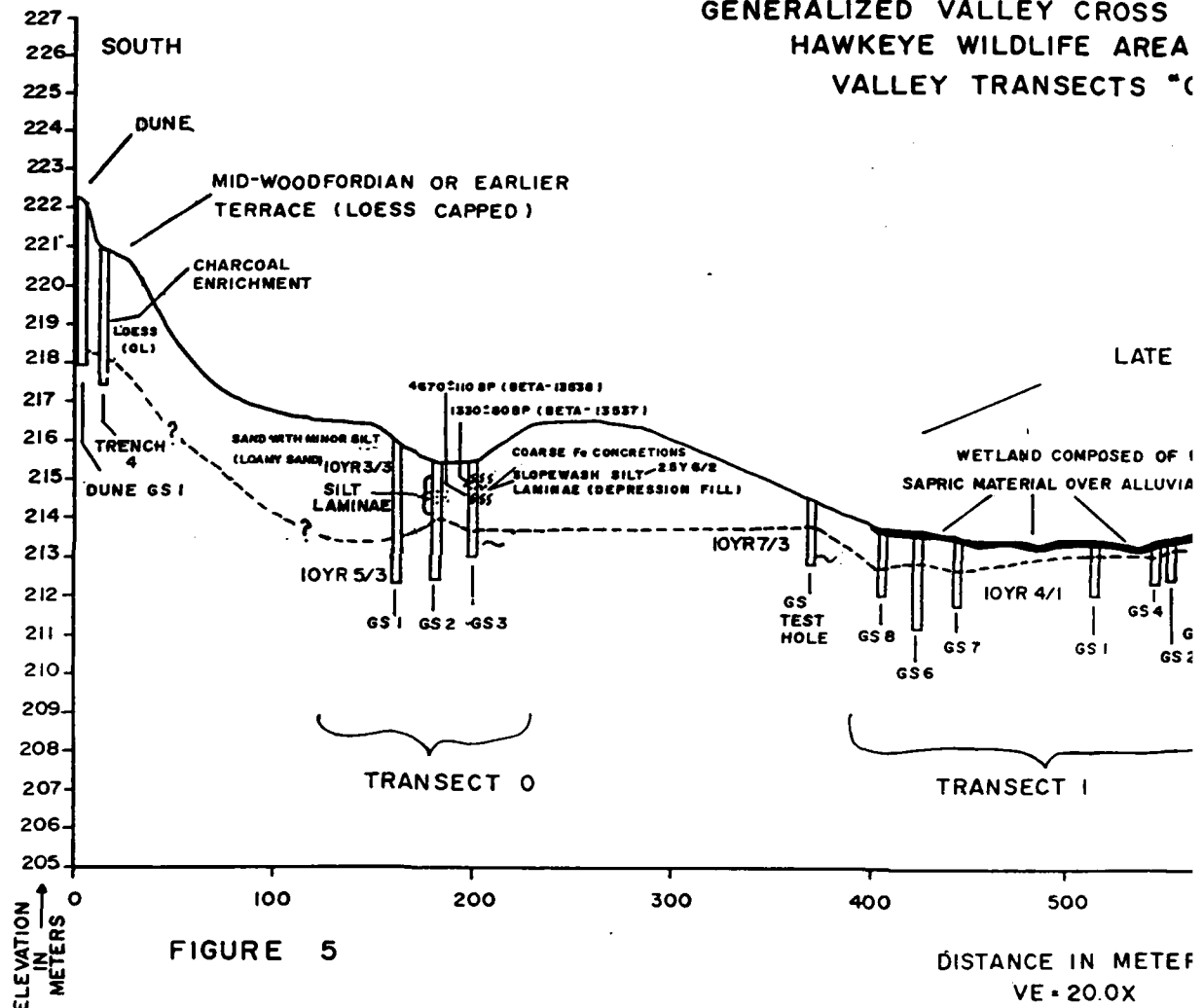
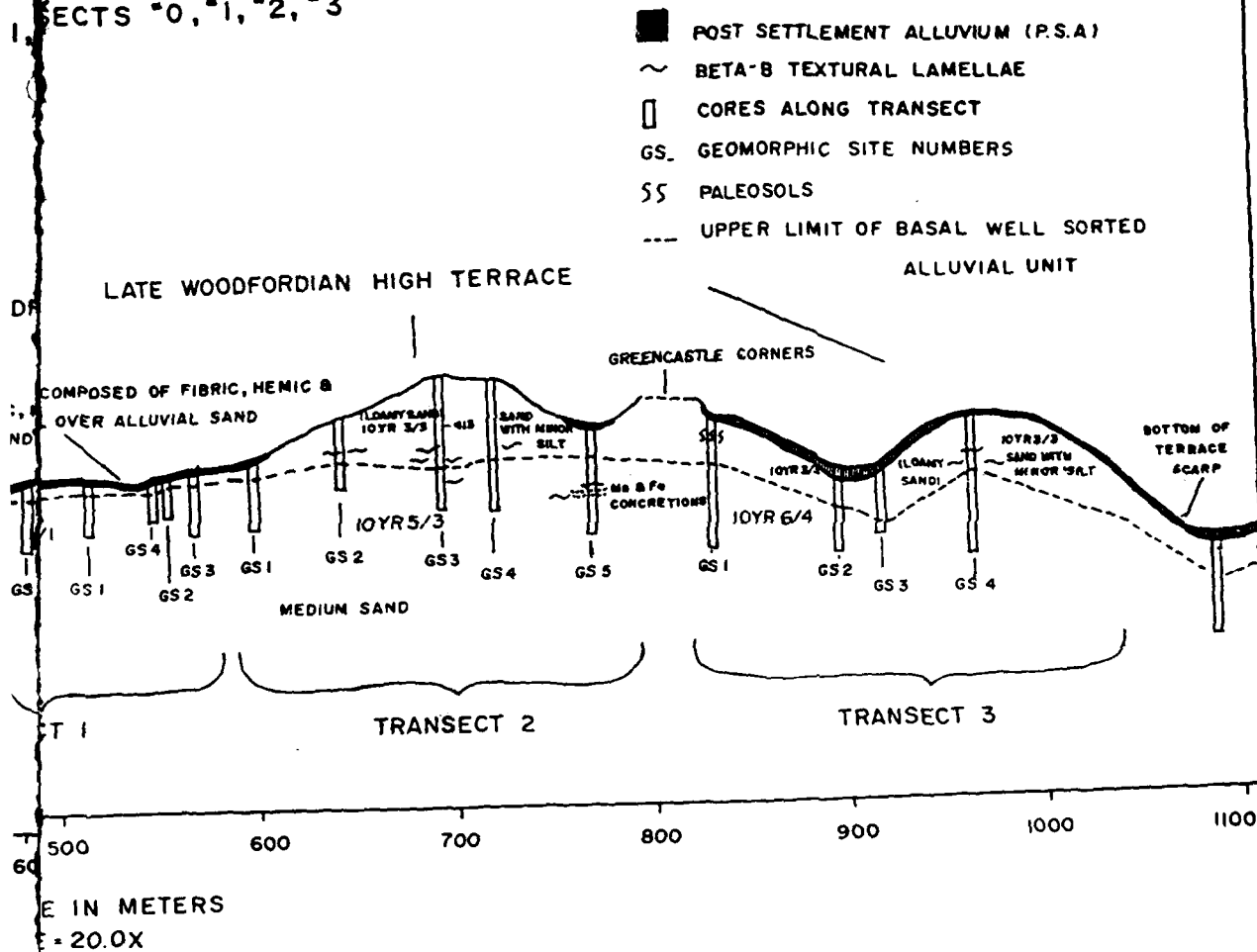


FIGURE 5

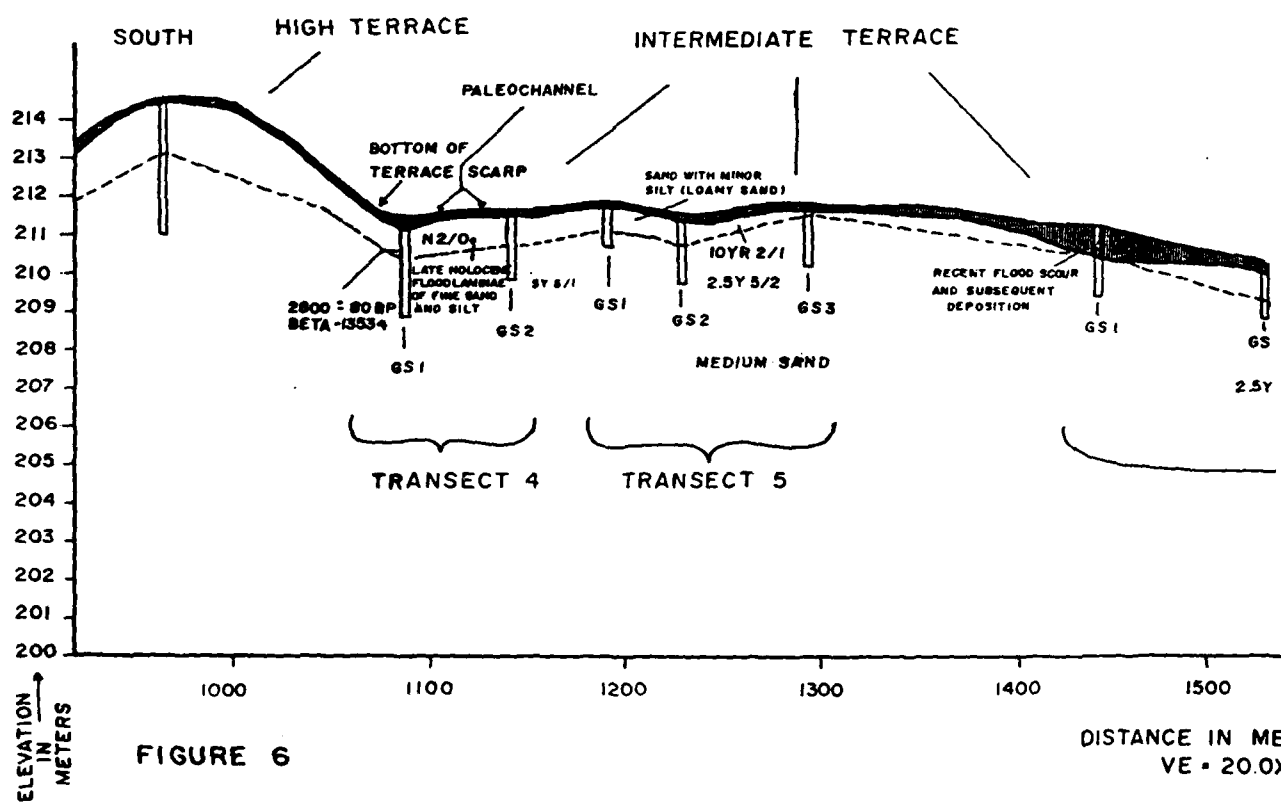
DISTANCE IN METERS
VE = 20.0X

CROSS SECTION
OF THE AREA
TRANSECTS "0," "1," "2," "3"

NORTH

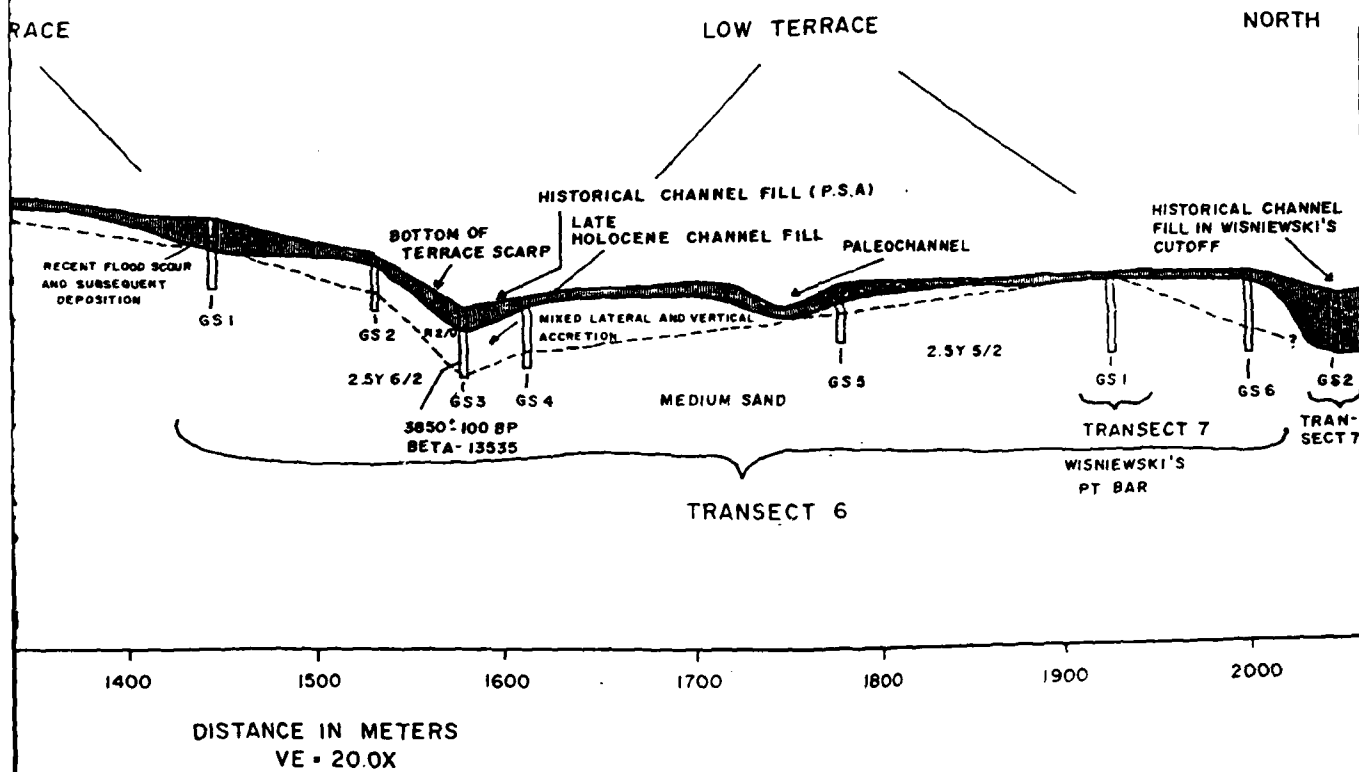


GENERALIZED VALLEY
HAWKEYE WILDLIFE
VALLEY TRANSECT



GENERALIZED VALLEY CROSS SECTION
HAWKEYE WILDLIFE AREA
VALLEY TRANSECTS "4," "5," "6," "7"

- POST SETTLEMENT ALLUVIUM (P.S.A)
- ~ BETA-B TEXTURAL LAMELLAE
- CORES ALONG TRANSECT
- GS. GEOMORPHIC SITE NUMBERS
- UPPER LIMIT OF BASAL WELL SORTED ALLUVIAL UNIT



composed of mixed lateral and vertical accretion deposits (Figures 6 - 8). Rapid lateral stream migration during the late Holocene has produced numerous relict channels. These are observed occupying the low terrace. In addition, this terrace provides evidence suggesting that floodplain aggradation has occurred sometime during the last few thousand years. This aggradational episode may have been in response to minor climatic changes which seem to have occurred very late in the Holocene (Knox, 1985).

Abutting the north valley wall of the Hawkeye are valley fill components consisting of alluvial fans and colluvial footslopes (Figure 8). These geomorphic units coalesce forming a complex array of footslopes, steep and low angled fans. These units bury components of both the low and intermediate terrace, and likely bury older valley components. The fans and footslopes have probably formed both progressively and episodically throughout the Wisconsinan and Holocene in response to climatic changes. These changes in climate have affected upslope vegetation type and density and subsequent hillslope stability. Although the evidence at this point is not conclusive, stabilization of these valley fill components has apparently occurred late in the Holocene.

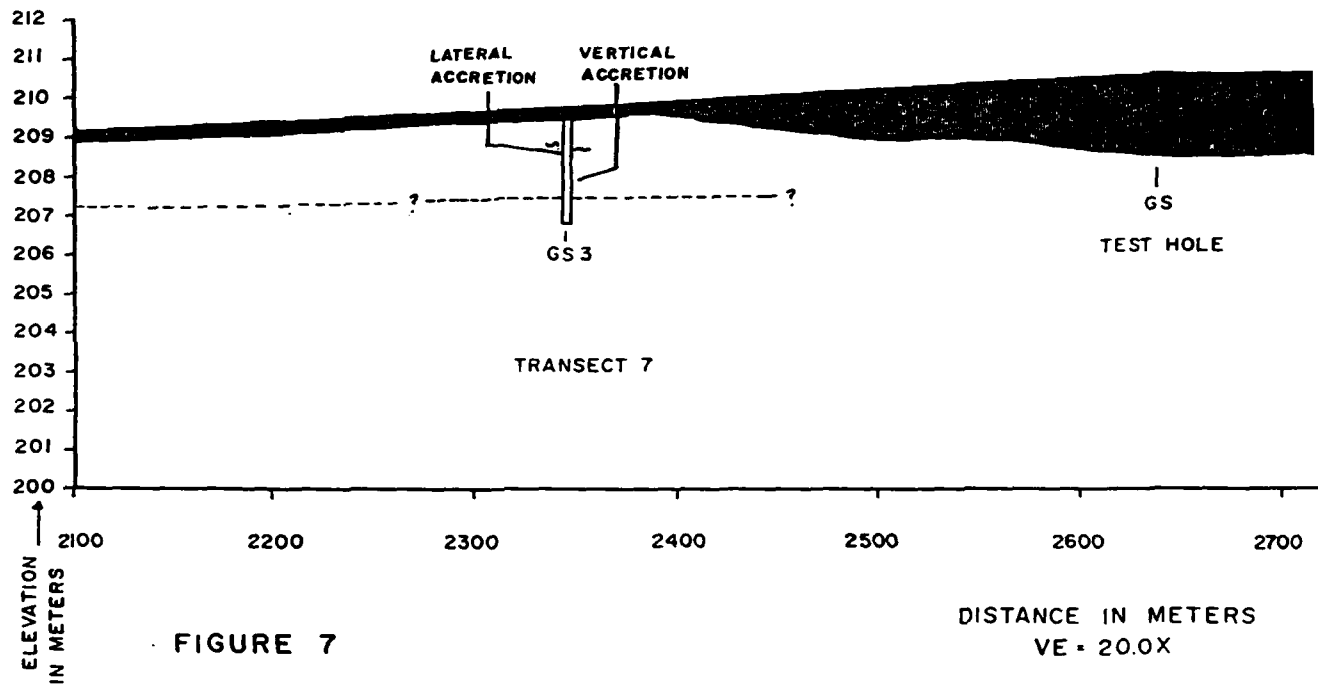
The following discussion is organized in a manner which first provides an overview of each of the geomorphic surfaces identified in the Hawkeye, is followed by site-specific examples along trenches and transects in support of the general conclusion reached, and concludes with a summary of the evidence presented. For the reader who wishes to further investigate the evidence and conclusions reached in this presentation, more detailed data are presented in the data file entitled "The Archaeology of Coralville Lake, Iowa Volume VII: Landscape Analysis Data File". This volume contains raw and reduced data from a total of 39 sampled geosites. Profile descriptions, particle size plots, organic matter plots, and radiocarbon data, are contained in this 293 page volume.

Identification and Distribution of Post Settlement Alluvium (PSA) in the Hawkeye Wildlife

Historical Background and Field Observations:

The post-settlement alluvium (PSA) in the Upper Mississippi Valley and its tributaries is a result of Euro-American settlement and subsequent land use. Destruction of the natural vegetation cover has exposed the easily transported organic rich silty pre-settlement surface horizon. Mobilization of this surface unit by both fluvial and eolian erosion has exposed the less permeable clay enriched subsurface horizons. The first major impact upon the landscapes of the Upper Mississippi Valley was intensive near surface mining exploration, beginning in the early to middle 1800's. Later, as these reserves became exhausted, agriculture became a key factor in mobilizing sediment from the uplands. In nearby southwestern Wisconsin, the

GENERALIZED VALLEY CROSS SE
HAWKEYE WILDLIFE AREA
VALLEY TRANSECTS "7," "8

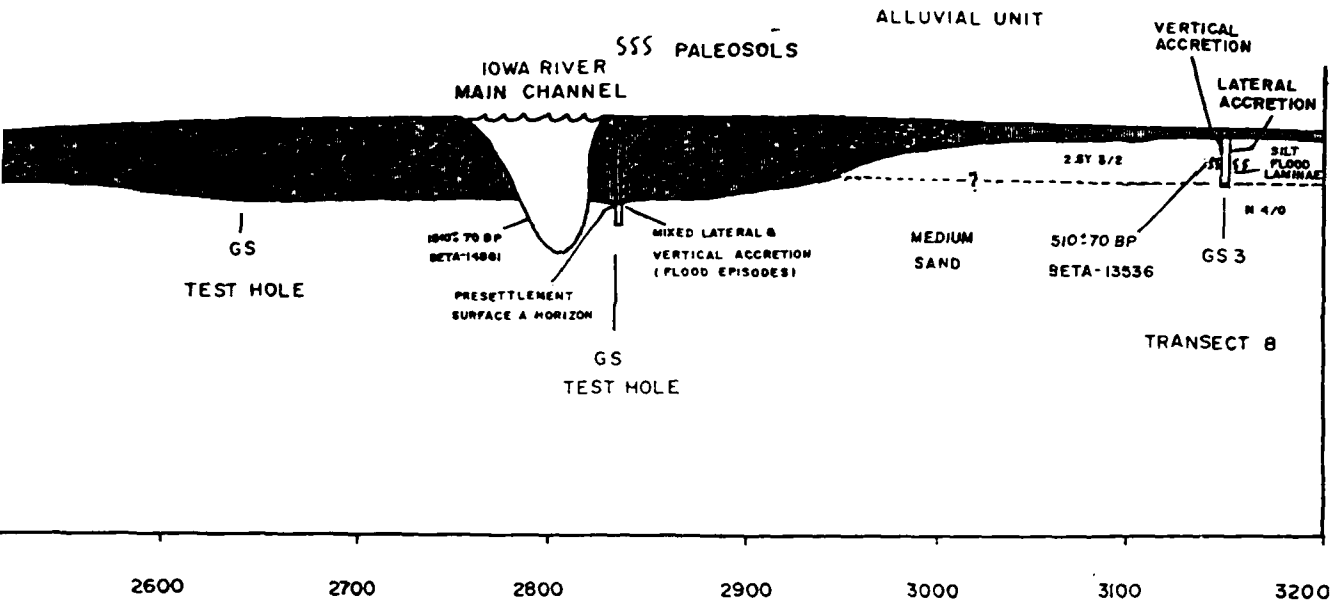


ZED VALLEY CROSS SECTION

EYE WILDLIFE AREA

EY TRANSECTS "7," "8

- POST SETTLEMENT ALLUVIUM (P.S.A.)
- ~ BETA-B TEXTURAL LAMELLAE
- CORES ALONG TRANSECT
- GS_ GEOMORPHIC SITE NUMBERS
- UPPER LIMIT OF BASAL WELL SORTED



DISTANCE IN METERS
VE = 20.0X

SOUTH

GENERALIZED VALLEY CRC
HAWKEYE WILDLIFI
VALLEY TRANSECT

- POST SETTLEMENT ALLUVIUM (P.S.A)
- ~ BETA-B TEXTURAL LAMELLAE
- CORES ALONG TRANSECT
- GS_ GEOMORPHIC SITE NUMBERS
- SS PALEOSOLS
- UPPER LIMIT OF BASAL WELL SORTED ALLUVIAL UNIT

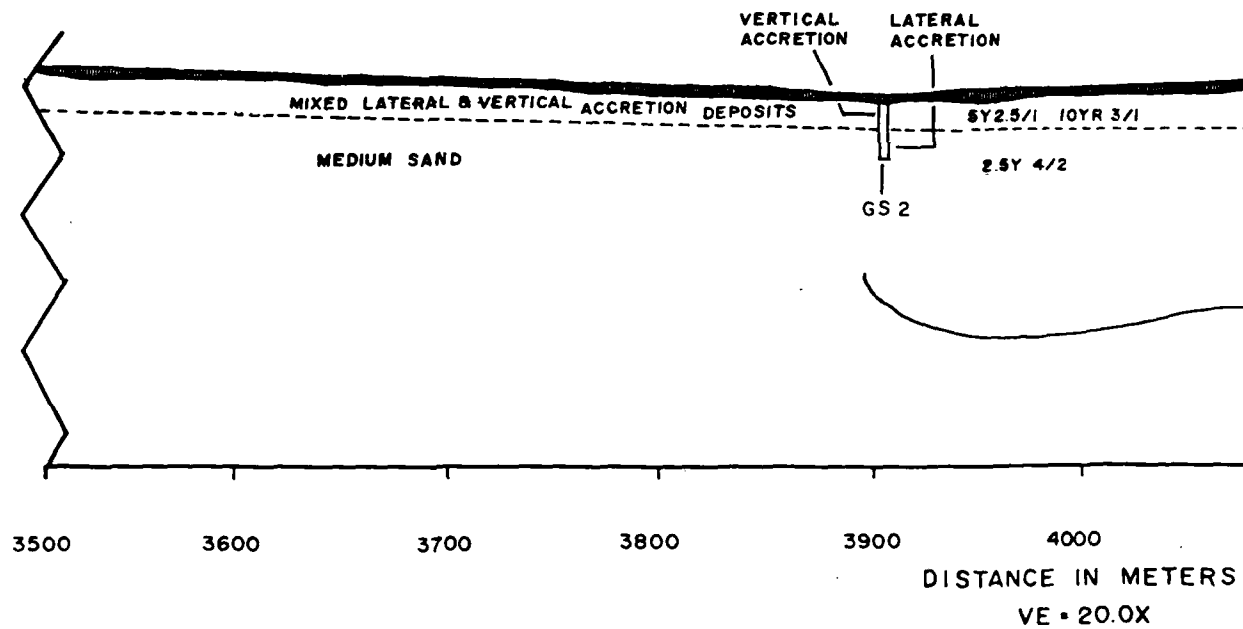
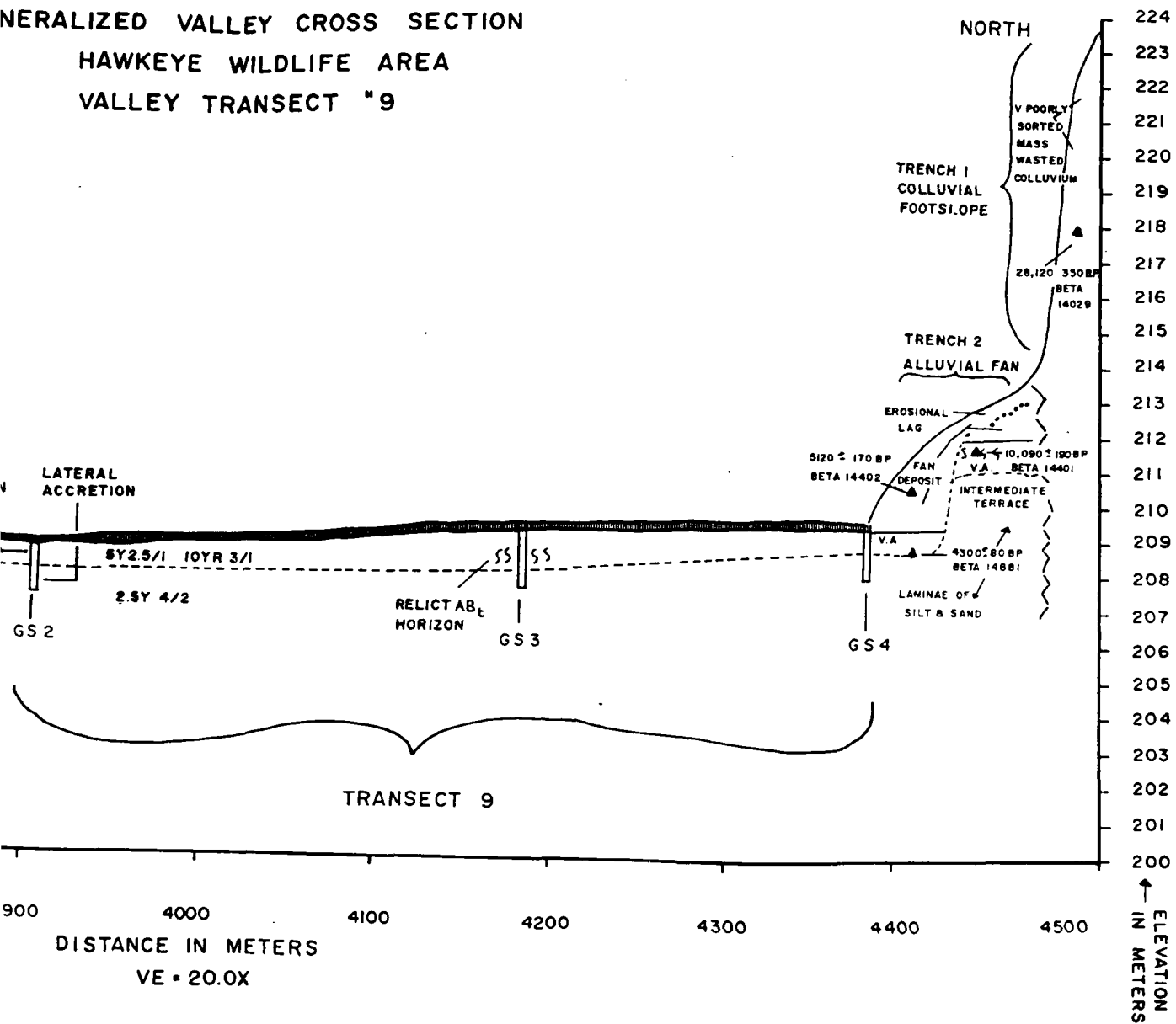


FIGURE 8

GENERALIZED VALLEY CROSS SECTION
HAWKEYE WILDLIFE AREA
VALLEY TRANSECT "9"



introduction of corn to the highly dissected Driftless Area uplands initiated a period of maximum environmental degradation from the 1870s through the 1940s (Knox 1977).

In the Hawkeye area, agricultural land use and, more recently, reservoir impoundment have been the primary causes of historical erosion and sedimentation. These historical deposits found in the preserve, are usually silty although they may include both coarser and finer textures. They are not found on the highest Wisconsinan surface but they occupy the lower three terraces and floodplain. Generally, they occupy the surface constituting a unit of variable thickness, but tend to concentrate in main valley depressions (Figures 5, 6, 7 and 8). A number of diagnostic tests were used in the field to positively identify the presence and thickness of this surficial historical unit.

Historic sediments often occur as laminae (laminated bands) of variable thickness. Relatively thick lamina may be a centimeter or more if a surface is inundated for relatively long periods such as in meander cutoffs, chutes and depressions seen on the low terrace and floodplain. At TR 7 G.S. 2, TR 8 G.S. 2, and TR9 G.S. 1 which are located in relict channels on the low terrace, the thickness of some of the historical flood laminae averaged about 10cm. However, more commonly, the lamina are thinner and represent inundation over a shorter period of time or deposition from smaller flood episodes containing lower sediment loads. Many of the areas within the low terrace illustrate historical deposits occurring in thin bands usually about 1 mm. thick. However, historical deposits rapidly thicken within a few hundred meters of the present river course (Figure 7).

In addition to the diagnostic parameters of sedimentology and morphology, the historical unit can also be identified by color. Distinguished from most presettlement surface horizons (black 10YR 2/1), this unit usually has a brown (10YR 3/3-4/4) color, provided the sediments have not been affected by the local water table. However, in many cases the presettlement surface A horizon has been truncated through agricultural practices, deflation, or from reservoir related fluvial erosion. In other cases, the historical deposit is organic enriched and characterized by a black N 2/0 or 10YR 2/1 color, which makes them indistinguishable from the black presettlement surface horizon.

Because color alone may provide insufficient information, additional field determination included the testing for carbonates. This was accomplished by applying a weak hydrochloric acid solution (14%) to the sample. Historical sediments are often calcareous because of the presence of limestone and dolomite bedrock and unleached loessal deposits which have been eroded historically from tributaries. from Agricultural liming practices provide an additional source of carbonates which can be easily mobilized. If unleached carbonate sediments are present the sample will effervesce, a parameter that usually identifies a surficial post settlement deposit.

If the sample does not react to the hydrochloric acid, the pH of the sample may also be used to identify a historical unit. Compared to the underlying presettlement soil, the pH of the PSA is usually much higher. Generally, the pH is greater than 7.0 and usually closer to 8.0. This is in contrast to the presettlement soil which has been subjected to leaching over a longer period of time and will often have a pH less than 7.0.

The identification of PSA in the field is critically important in the study of the Hawkeye Wildlife Area. Nonetheless, determination of the PSA thickness is not always easy. Reasons include: 1) the presettlement A horizon may be eroded therefore using color may not be useful; 2) the color of the historical deposit and the presettlement surface horizon may be the same; 3) the PSA and presettlement sediments may be of comparable texture rendering useless sedimentology as a diagnostic tool; 4) slow vertical accretion of historical fine grained sediments, which could be identified by thin laminae, may be rapidly destroyed by rigorous annual vegetation root growth and soil animal mixing and finally; 5) the historical sediments may not be calcareous or may be slightly acid and show the same pH as the presettlement surface. Thus many different field techniques were employed to identify PSA and determine its distribution within the limits of the Hawkeye Wildlife Area.

Discussion:

This aspect of the study produced some interesting conclusions about the distribution of PSA in the Hawkeye Wildlife Area. First, this historical deposit can be found on most of the surfaces in the Hawkeye but the deposit is not of uniform thickness across the wide valley. Instead, the historical material tends to concentrate in abandoned channels, chutes, and depressions which are seen primarily on the low terrace. Also, the area immediately adjacent to the active main channel has formed a natural levee composed of a 1.5 meter or thicker PSA deposit. Thick PSA deposits along the main channel were also indicated in the Coralville sedimentation resurvey of 1975 (USACE, 1978:plate 64). It is in these low lying areas on the low terrace (considered as the floodplain) and along the contemporary river course that PSA concentrates in thicknesses often greater than 2 meters. Nearby areas on the low terrace, which are slightly higher, the thicknesses of the deposit may be considerably less than 0.5 meter.

On the intermediate terrace, overall thickness of the PSA unit is less, but again, can be found concentrated in the the lower lying areas. On the high terrace, generally, only the depressions show appreciable amounts of PSA. The Wisconsinan surface yielded no evidence of PSA deposited from the main Iowa River channel. However, locally mobilized slopewash sediments and eolian components comprise the historical materials seen on this surface. The fact that the historical sediments tend to concentrate and do not

constitute a continuous uniform unit capping the surface is similar to what is reported in nearby northwestern Illinois and southwestern Wisconsin (Magilligan, 1983, Overstreet, 1985, Anderson, N.D).

The Wisconsin Loess Capped Surface:

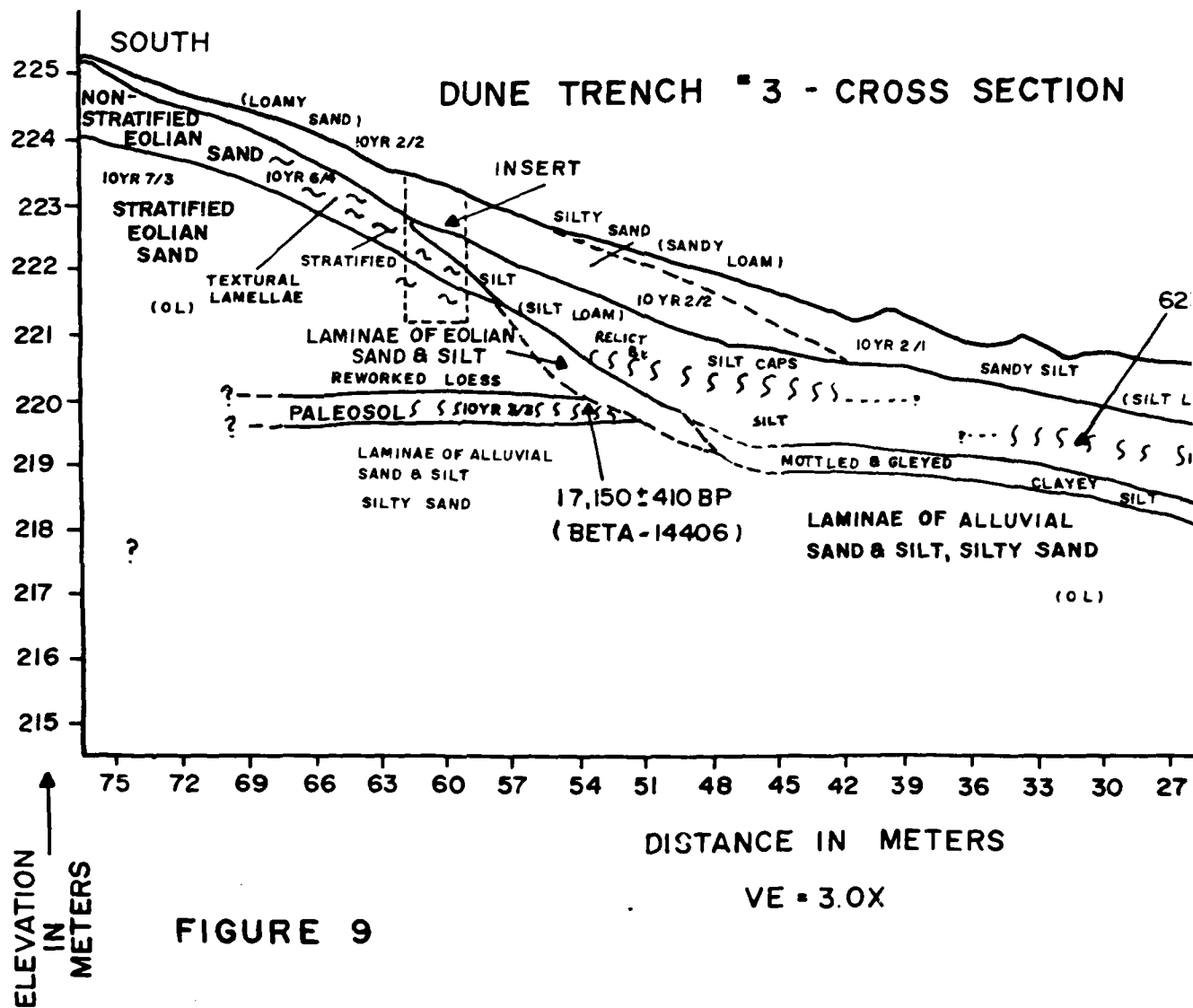
Along the southern margin of the wildlife area the highest terrace surface of at least mid Woodfordian or older age is found. This loess capped surface is characterized by numerous eolian dunes and depressions between (interdunal) dunes. Evidence now available suggests that the dunes are of mid to late Woodfordian age because underlying one of the dunes is a weak organic carbon enriched paleosol dated to 17,150 \pm 410 BP (BETA- 14406). The evidence indicates that the dunes may have developed over a very short period of time between increments of loess fall. In a broader regional context the weak soil seen below the dune and dated 17,150 years ago may correspond to one of the increments of loess fall that culminated around 18,300 years ago at Salt Creek in Tama County (Ruhe, 1969, Vreeken, 1975).

The elevation of this terrace is about 218 meters (ASL) which is the upper limit of coarse grained alluvial sediments observed in the cores and trenches. This alluvial surface is then overlain by a fine grained gleyed fill component of presumed alluvial origin and capped by eolian units of fine sand, and coarse silt. However, the stratified dune sand is positioned between loessal increments. The evidence indicates that the dunes developed after an earlier loess fall and were then later capped by one of the final increments. Since then, the loess cap has been reworked and incorporated into a depression interdunal valley fill.

The valley fill contains paleosols, one dated to 6230BP, which is stratigraphically continuous along the small first order valley, while another of unknown age is probably older. An episode of early Holocene valley incision is suspected but has not been identified. The evidence is inconclusive but currently indicates that Holocene sediments have been locally reworked from immediately upslope and upvalley and have been stored in the depression.

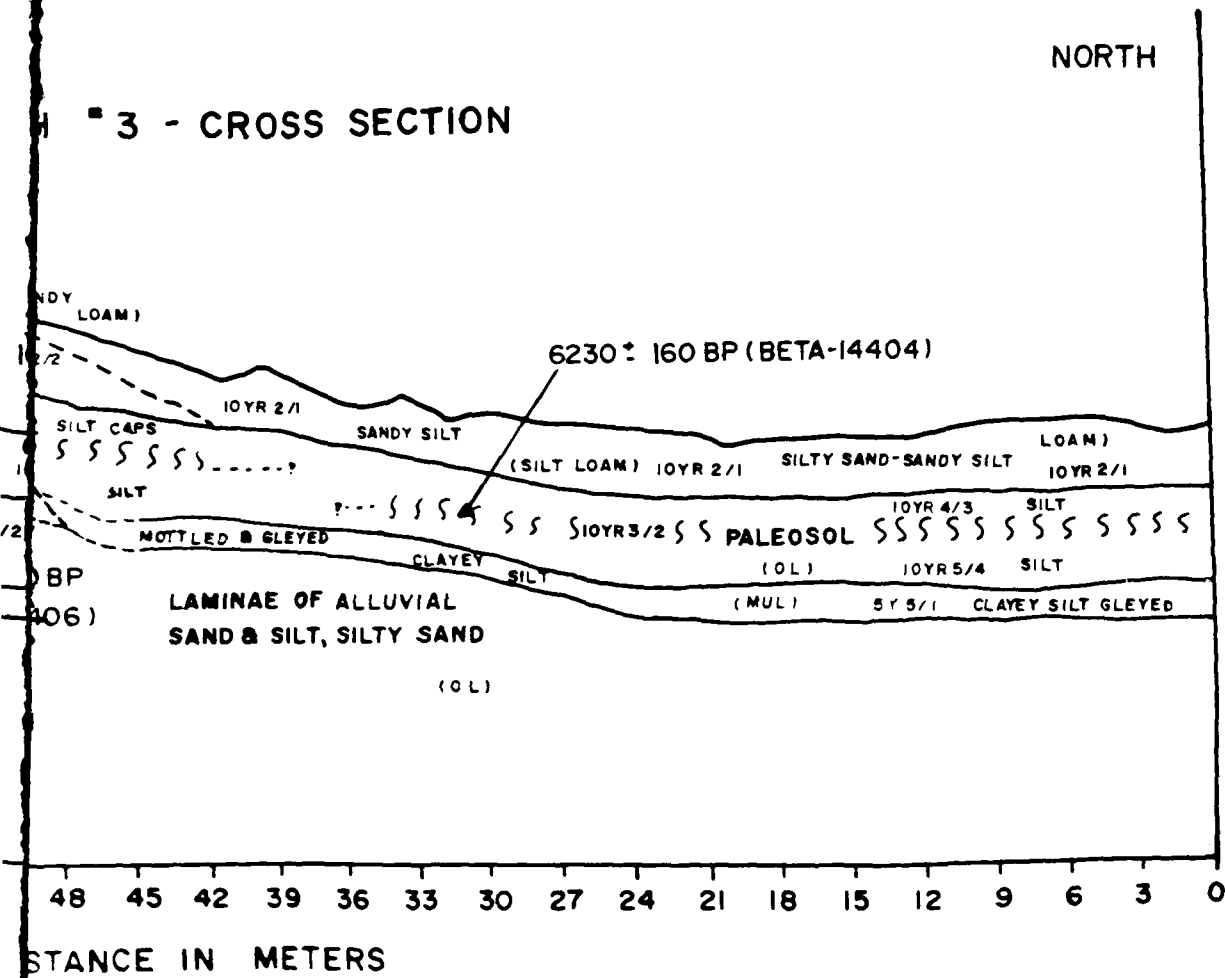
Trench #3:

A 76 meter backhoe trench was excavated beginning near the dune crest and extending into a dunal depression (Figure 9). In order to insure safety the depth of the trench varied but in several places along the trench the depth extended well below 2 meters. In order to resolve some of the questions surrounding the chronology of geomorphic events, the silt probe was used to core through the bottom of the trench. For example, the lateral distribution of the paleosol dated 17,410 years ago was an important horizon to map. Consequently, where it was not exposed in the trench upslope from 53.5 meters, the probe was used to identify the



NORTH

3 - CROSS SECTION



unit up to about 66 meters. Further upslope the probe could not penetrate to depths necessary for the identification of this unit.

From the available information the dune appears to have developed sometime after 17,410 years ago but before the last increment of loessal deposition in the area. The dune has undergone severe modification during the Holocene, particularly through the early and mid Holocene.

The initial evidence supporting this interpretation is seen near the dune crest where a general A-C soil profile can be observed. A description of the profile at 73 meters shows an organic enriched surface A horizon, subjacent to a plowed horizon. Single grained, nonstratified coarse and medium sand which has been mixed through floral and faunal activity, extends to a depth of 1 meter. Below this point, stratified dune sand is observed. This profile exhibits no evidence of B horizon development. But further downslope along the trench, B horizon development was observed evidenced through the appearance of textural lamellae.

At 69 meters the first textural lamellae (beta B horizon) are observed and increase in thickness and density while continuing downslope. The implication is that further upslope the dune crest has been unstable perhaps repeatedly during the Holocene, because the beta B lamellae have either not had sufficient time to develop or they have been truncated. At the 60 meter point along the trench information relating to the erosional history of the dune becomes more evident and increasingly complex.

The insert (Figure 10) shows several erosional episodes seen as three major erosional lag components. Additional evidence suggesting that the morphology of the dune was considerably different is seen in the two lower stratified sand units. The textural lamellae show multiple orientations which suggest that the former, presumably earlier Holocene surface of the dune, particularly near the crest, was considerably steeper.

For example, in the lowest unit textural lamellae show three major orientations. One relict orientation is conformable with a former surface slope considerably steeper than the contemporary slope and shows the typical wavy pattern usually seen in these lamellae. A second orientation follows the textural discontinuities between individual steeply dipping sand laminae and does not show the characteristic wavy appearance commonly seen. A third orientation is more conformable with the contemporary surface slope and shows a much lower angle and wavy appearance.

In the overlying stratified eolian unit a similar pattern can be observed in the multiple oriented textural lamellae. Once again, one of the orientations is conformable with a steeper relict surface while the other two orientations either follow textural discontinuities in the sand laminae or are contemporaneous with the present modern surface. Both the upper and lower stratified sand units are separated by a coarse erosional lag component.

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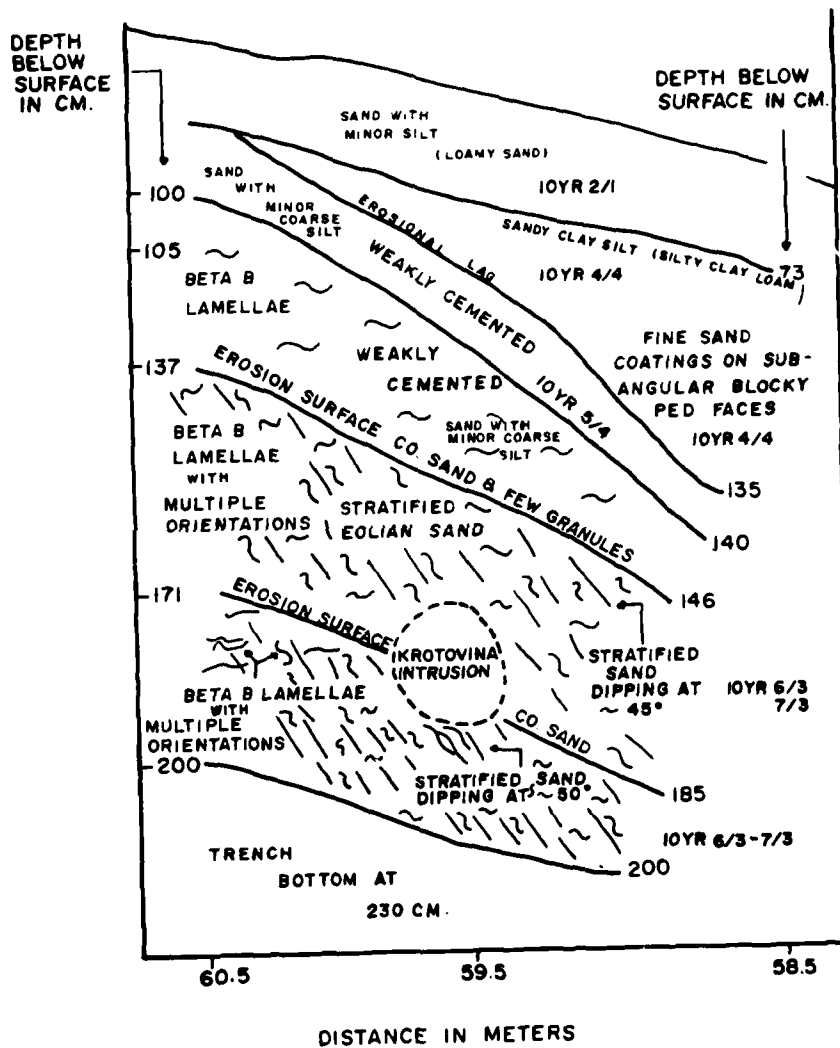


FIGURE 10

Above these lower two stratified units is one of weakly cemented nonstratified sand, probably reworked, that contains minor coarse silt and textural lamellae. These lamellae are conformable with the contemporary surface. This unit is in turn overlain by a texturally similar unit, although, no beta B lamellae can be observed. Another erosional lag separates this unit with an overlying wedge of reworked silt (silt loam) which begins at about 60 meters along the trench, then rapidly thickens and continues downslope to the lower end of the trench.

The surface component is composed of reworked sand with minor (about 15-20%) silt, containing relatively equal proportions of coarse, medium and fine sand. Stratigraphically this unit is seen on the surface throughout the trench transect. Near the dune crest the unit is thinner and has a higher proportion of sand to silt (loamy sand) but toward the depression this surficial unit becomes thicker, darker (organic enriched) and siltier. This unit can easily be distinguished from the subjacent reworked silt filling the depression and along the dune margin.

This surficial unit contains both a biotic and eolian component which has acted to rework the sediments. Krotovina are frequently seen in this uppermost unit. However, in a few cases, as seen in profile at 31.5 meters, slopewash silt laminae can be observed.

From about 60-45 meters along the trench another complex series of hillslope erosional episodes is evidenced. The result of the erosion can be seen (profile 53.5) through steeply dipping laminae of eolian sand and slopewash silt. These sediments truncate a considerably older surface dated 17,150BP. Above this erosional unit lies a paleosol of unknown age which contains common flecks of charcoal, and is stratigraphically ca. 1.0 meter above the soil dated 6230BP in the valley fill. This paleosol of unknown age is in turn overlain by a comparatively well developed relict Bt horizon. This horizon seen between 80 and 177 cm below the surface probably represents a considerable portion of the Holocene and is much better developed than the relatively weak Bt horizon seen above the dated 6230BP surface. The implication is that the stratigraphically higher paleosol of unknown age probably pre-dates the 6230BP date seen in the valley, but is of Holocene age and considerably younger than the basal soil date of 17,150BP.

From about 0 to 45 meters along the trench the thickest depression valley fill component is observed. The depression appears to have accumulated reworked sediments during episodes of hillslope instability throughout the Holocene. The source of the silty fill unit in this first order valley is locally derived from upslope and upvalley. Flecks of charcoal were observed throughout most of the silty matrix. The matrix is oxidized and leached of carbonates. Similarly, pH recordings were 6.8 or lower and in many 6.0 or less. This line of evidence suggests that the loessal matrix has experienced weathering either at or close to the surface during the Holocene thus supporting the

hypothesis that these sediments have been reworked downslope or down valley.

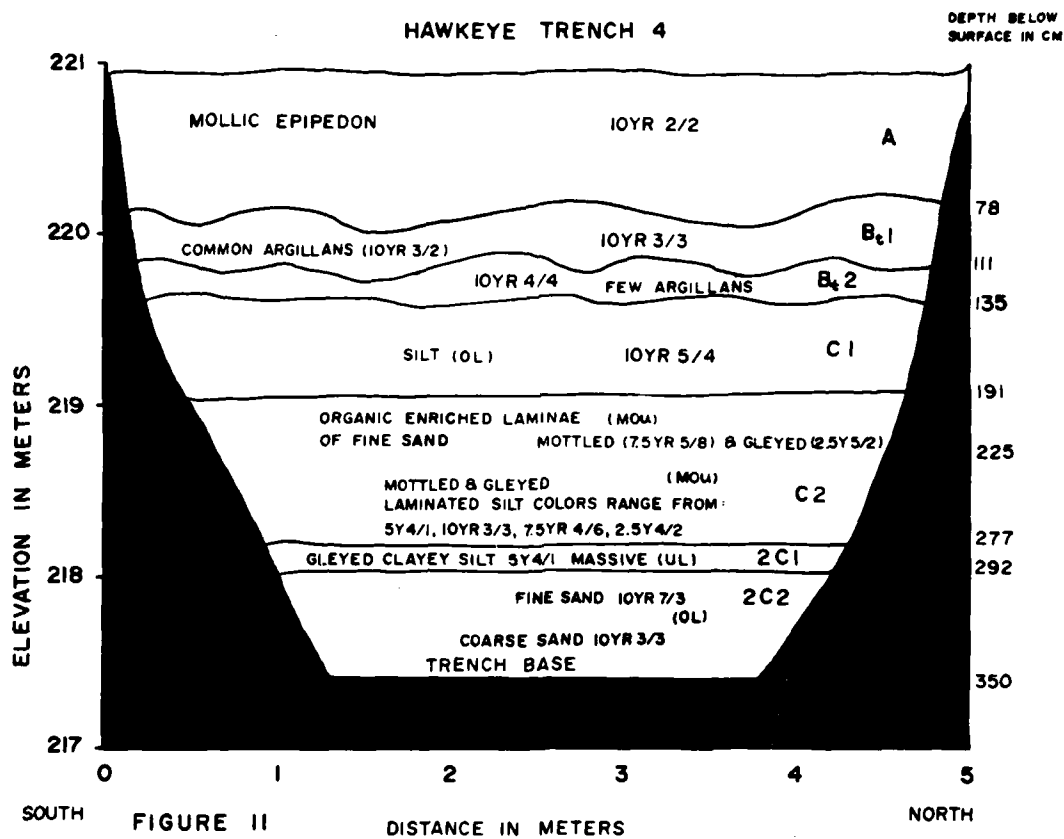
A paleosol, radiocarbon dated at 6230+/-160BP (BETA-14404), is a prominent morphologic feature of the local alluvium. The relatively darker (10YR 3/2) organic enriched surface horizon of the paleosol contains numerous flecks of charcoal. These pieces of charcoal may have been eroded from the dune slope during an episode of hillslope erosion. The charcoal has likely contaminated the soil date. As a result, surface stabilization and soil development, probably occurred later than the date would indicate. Therefore, the 6230 date may actually be more compatible with a period of rigorous mid Holocene hillslope erosion and valley filling, with stability and A horizon development occurring considerably later, possibly around 5000 or 4500 years ago. Following hillslope stability and concomitant soil development another episode of hillslope erosion occurred. This is evidenced by an additional valley fill unit of silt burying the dated 6230BP surface. It is not clear that a surface A horizon ever developed in this uppermost silt unit. No surface horizon is evident, however, a weak Bt horizon showing few argillans and silt caps is observed in most of the valley profiles. In all cases along the trench, there was no abrupt erosional lag component identified at the contact separating the contemporary surface sandy silt (loamy) unit and the subjacent reworked silt. Rather the contact between these two units showed a pedogenically produced clear wavy boundary very unlike the abrupt contacts seen further up in the trench profile where erosion surfaces are more characteristic.

The basal units found in the valley fill in the lower reaches of the trench include a leached gleyed clayey silt underlain by alluvial laminae of sand and silty sand. At 60 meters an attempt was made to trace the lower gleyed clayey silt unit beneath the dune with a silt probe. The paleosol dated 17,150BP was reached but depth of the core was still located above the elevation of the gleyed unit. Below the paleosol, fluvial deposits were encountered.

Trench #4:

Trench 4 lies on the Wisconsin loess capped surface about 245 meters west of dune trench #3, and about 15 meters from the terrace scarp separating this terrace from the lower late Woodfordian surface (Figure 11). The surface is capped by about 277cm. of fine sandy and coarse silty loess. An Argiudoll is developed in a 2 meter thick increment of loess which is oxidized and leached. Below the solum from 191cm to 277cm, stratified loess increments are unleached.

A radiocarbon assay sample was submitted from 220 to 225cm in an organic enriched laminae containing charcoal, but carbon content was insufficient for dating. The two lower basal components are both leached and are composed of a gleyed clayey silt and below, a unit of alluvial laminae ranging from coarse to fine sand.



Discussion:

The basal components of both the valley fill seen in trench #3 and in trench #4 is a leached gleyed clayey silt which is underlain by alluvial flood laminae ranging from coarse sand to silty sand. A number of observations have been made regarding the lower alluvial units. The sedimentological sequence of alluvial flood laminae overlain by a leached gleyed clayey silt has been reported at two other test holes (see Volume VI for precise locations) on the Wisconsinan surface.

One test hole, located 77 meters upvalley and west of trench #3, showed a similar sedimentological sequence. This silt probe core reached the gleyed clayey silt unit at an elevation of 218.64 meters and the underlying alluvial sand at 218.30 meters. Trench #4, located 245 meters west of trench #3 on the same Wisconsinan surface, reaches the gleyed clayey silt unit at 218.19 meters and the lower alluvial unit at 218.04 meters. Another silt probe test hole located 564 meters east of trench #3 encountered the gleyed clayey silt unit at 218.21 and the subjacent alluvial unit at 217.71 meters.

The elevation of the gleyed unit from trench #4 to a distance 809 meters (just over 1/2 mile) east to the silt probe test hole varies only 0.44 meters. In fact, the elevations of this gleyed unit at either end of this east/west transect are 218.19 and 218.20 meters. Similarly, the elevations of the subjacent alluvial unit vary little along the half mile transect, whereas the surface elevation varies considerably. The surface elevation at trench #4 is 220.96 meters (724.75') but rises to just over 225.82 meters (740.69') near the dune crest then descends at the east end of the transect to 219.12 (718.71'). There is good stratigraphic evidence that the gleyed clayey silt and the underlying alluvial unit represents the same units seen along the east/west transect on this terrace.

The chronology of events seen from the available data indicate that the oldest unit encountered is the alluvial unit located beneath the dune and identified from a silt probe core at the 60 meter mark along the trench. This unit is probably of early Woodfordian age and is overlain by fine grained sediments which contain a soil dated 17,150BP. The surface elevation of the soil is 219.86 meters (721.14'). The soil was buried by later dune deposits. The source of the sand was local and probably derived from modest fluvial erosion of the active Wisconsinan floodplain (Iowan surface development). Upon cessation of floodplain incision, alluviation from flood episodes followed by fine grain fluvial deposition apparently occurred. These apparent younger fluvial components are seen as the basal alluvial sand and gleyed clayey silt found in the interdunal depression of trench #3, in trench #4, and in the two silt probe test holes. The top of the gleyed unit has an average elevation about 1.5 meters lower than the 17,150BP surface. Floodplain abandonment probably occurred shortly after the

last increments of loess deposition which capped the Wisconsin terrace and dunes probably between 14,000-15,000 years ago.

The evidence is inconclusive whether or not erosion of older fill deposits occurred in the interdunal depression during the late Woodfordian and early Holocene. Other studies conducted in small drainages in eastern Iowa (Vreeken, 1975, Van Zant and Hallberg, 1976) provide evidence supporting an episode of early or mid Holocene incision.

One line of evidence suggests that the valley has been a post-loessfall sediment trap accumulating reworked silt from upslope and upvalley. Along the lower reaches of the trench which traversed about 2/3rds of the distance across this first ordered valley, no gully fill episodes or erosional lags were identified. This would suggest that the valley has stored reworked sediments derived from upvalley and upslope sources.

In contrast, if the basal component of gleyed clayey silt underlain by alluvial sand seen along the east west transect represent the same units, then characteristics of the immediately overlying deposit along the transect should provide some identifiable similarities. The deposit directly overlying the gleyed clayey silt on both ends of the half mile transect (silt probe test hole and trench #4) show a loessal deposit which is either unleached, stratified, or has an alkaline pH. The indication is that these directly overlying units have experienced little if any weathering or reworking.

While the valley fill component seen overlying the gleyed clayey silt deposit in trench #3 is different. Below the dated surface of 6230 BP the sediments are oxidized, leached and mildly acid to neutral. Without a doubt, this massive silt unit has experienced weathering. However, structural and textural components associated with pedogenic development occur only in the upper part of the paleosol.

Based upon available data it is suspected that this unit observed in trench #3, was not deposited during the final increments of loess fall in this valley but has been reworked into the valley sometime prior to 6230BP, perhaps earlier during the middle Holocene. Evidence of upslope erosion is overwhelming. As a result, a hiatus is suspected from the end of loess fall to the middle Holocene in this small valley. Although sufficient evidence, is lacking, it is suspected that incision has mobilized earlier valley fill sediments. The stratigraphically higher paleosol located along the margin of the dune (profile 53.5) of unknown age may provide a key date useful in the chronology of earlier Holocene events.

After the episode of middle Holocene valley alluviation a period of hillslope stability occurred initiating soil development sometime after 6230 years ago. This stable episode may have occurred in response to a change toward a more moist climate. However, this period of stability was interrupted by another episode of hillslope erosion and valley filling with reworked silt. Finally, a component of

fine sand, probably reworked eolian, was introduced into the coarse silty matrix and was followed by stability and renewed soil development. Based upon the relative degree of soil development observed above the dated surface of 6230BP, the upper units of silt and sandy silt have probably been stable for a few thousand years.

The Late Woodfordian High Terrace:

This younger terrace, is about 5 meters below the Wisconsinan surface. Based upon a radiocarbon date on the intermediate terrace, this surface was the active floodplain sometime between the end of loess fall (approx. 14,000BP) and before the beginning of the Holocene. Evidence supporting the approximate age of this surface is first observed from the lack of a surficial loess cap. Second, a radiocarbon date of 10,050BP was obtained from the intermediate terrace which has been buried by an alluvial fan along the north end of the Hawkeye. This date places the age of the high terrace as older and substantiates the claim that it was constructed during the late Woodfordian (Figure 5). This surface was active when the Des Moines Lobe was in central Iowa. The Iowa river provided drainage for the Lobe, but to what degree this affected the Hawkeye wildlife area is unknown.

The surface of the high terrace is characterized by a generally thick mantle of oxidized reworked silty sand. The reworked surface probably has evolved in response to drought which presumably occurred during the Holocene. When climate became drier, changes in flora or complete desiccation of ground cover, apparently acted to destabilize the surface.

An additional component responsible for reworking this surficial deposit has been induced through mixing of the soil pedon from biopedoturbative processes. On one hand, this relatively loose coarse textured highly permeable unit is sensitive to drought, while on the other hand, this unit is easily mobilized and promotes soil animal mixing activities. As a result, this deposit has been destabilized and mixed, probably several times, throughout the Holocene. This is especially true during the mid Holocene when eolian activity progressed in the upper Mississippi Valley (Knox, 1985).

The high terrace shows a striking resemblance to the Osceola and Red Oak Island terraces located in the upper Mississippi Valley (Overstreet, 1984b, Overstreet et al., 1985). The textural data demonstrate that the surface component, especially along transects #2 and #3, is composed of a medium fine sand with minor silt (loamy sand). The silt fraction is generally from 10-15% of the total sample with about 50% of the silt composed of coarse silt (4-5Phi). However, in the depressions and where textural lamellae are observed, the proportions of these fractions change significantly. The individual sand grains show iron oxide coatings which suggest that the sediments have been located at or near the surface and have been exposed to chemical weathering for a significant period of time.

This is in contrast to the subjacent, less oxidized, lower unit composed of better sorted medium sand. Generally this unit has individual sand grains with little or no oxide coatings (clean) and has a silt component less than 10% of the total sample. In most of the profiles the upper unit grades into the alluvial sand. If the profile is not located in a terrace depression, the boundary between the units is generally gradual or diffuse and not marked by an abrupt contact.

Textural lamellae often occur below the surface of the high terrace. Generally, the lamellae begin in the vicinity where the upper and lower units come in contact and continue well into the alluvial well sorted sand. Given adequate time, illuvial zones eventually segregate into incipient but distinct clay-band horizons in sandy well-drained soils (Berg 1984: 45). However, the lamellae are not always present in the profiles.

The sedimentological assemblages, the textural lamellae and gradual boundary from the upper to the lower units are similar characteristics seen on other high terraces in the upper Mississippi valley. Considerable evidence shows that these other high terraces in the Mississippi valley have undergone severe landscape modification and surface instability affected by drought and faunal mixing during the Holocene (Overstreet, 1984b, Overstreet et al., 1985).

Transect 0:

Cores taken along this transect on the high terrace traversed a small terrace depression. The depression likely represents a small mid Holocene blowout which was later filled with slopewash alluvium from an adjacent Wisconsinan dune and subsequent filling from deflated eolian sediments. With the exception of G.S.#1, the other 2 profiles produced evidence of slopewash in the form of leached silt laminae dipping downslope into the depression from the direction of the nearby dune. The depression contained 2 paleosols both of which were radiocarbon dated.

The profile seen at G.S. #3 has a surface component composed of reworked sediments to a depth of 32cm. A buried A horizon begins at the top of the slopewash silt. The silt unit including the laminae extends from 32-94cm, where contact with another former surface developed in a reworked eolian component. This component contains a relatively high proportion of coarse silt and fine sand. The basal unit is composed of alluvial laminae grading into medium fine terrace sand.

The laminae characterizing the second unit (from 32-56cm) in the profile are absent in the buried surface A horizon due to the apparent effects of soil animals and root activity. This buried horizon has been radiocarbon dated at 1330+-80BP (BETA-13537) from a depth of 43-48cm. Below the root zone of the buried surface horizon, the abrupt contact with well preserved slopewash laminae is observed.

The laminae are deoxidized and leached, extremely well preserved, and slightly indurated. The subsurface buried

horizon from 56-94cm. is acid with a pH of 5.5 and has abundant iron (Fe) concretions, some of which are pebble sized. Dark (10YR 2/1) cutans are seen below 75cm in the paleosolum.

Below the laminated silt unit is another surface which is composed of silty sand (loam) and probably constitutes an earlier reworked surface. This second buried organic enriched surface from 94-117cm. has been radiocarbon dated at 4670+/-110BP (BETA-13538). By 135cm. this unit grades into alluvial terrace sediments composed of silt, fine and medium sand.

This profile indicates that multiple episodes of Holocene erosion and deposition have occurred on the high terrace, at least at this site. It appears that during the early and middle Holocene this surface was often unstable and episodically prone to eolian scour. With the change in upper air circulation patterns from a drier more westerly component toward a more moist meridional circulation pattern, early scour into the terrace sediments with subsequent eolian deposition was replaced by stability and soil development. The more moist conditions characterizing the early part of the late Holocene were perhaps responsible for raising water tables sufficiently to promote surface stability and organic matter production. This series of events would help to explain the radiocarbon date of 4670BP seen 100 cm below the present surface.

The episode of upslope erosion which is seen at this site as thin laminated depression fill silt occurred after 4670BP. This depression fill event must have occurred over a relatively short period of time since the structural integrity of the laminae has been well preserved. One explanation behind the formation of this depositional unit is that sediments eroded earlier in the Holocene may have been stored near the base of the slope, still upslope from the depression. Then with the increased frequency and magnitude of storms beginning the late Holocene, these formerly stored sediments may have been mobilized and transported into the depression.

This laminated fine sandy silt (silt loam to loam) must have been stable for a significant period of time which in turn promoted pedogenic development. At the top a well developed A horizon is dated at 1330 +/-80BP (BETA-13537). Clay skins are observed in the lower part of the paleosolum and reflect a significant period of landscape stability.

The unit occupying the modern surface is composed of the reworked eolian silty sand (sandy loam) which is seen occupying most of the surface of the high terrace. This unit, which is comparable to other portions of the high terrace, contains a higher proportion of fine grained sediments and represents another period of surficial instability. The radiocarbon date obtained immediately below this unit indicates that surface instability and reworking occurred late in the Holocene, sometime after 650 A.D.

Transect #1:

This transect was taken across another much larger depression on the high terrace. The morphology of the depression as seen from aerial photographs, the USACE plane table maps, and from the field resembles that of a relict channel. However, further stratigraphic investigations indicate (fig. 2) that this apparent channel may also represent an area characterized by eolian scour. This is first based upon the elevation of the basal alluvial unit which is seen close to the surface (less than 1.0 meter). And secondly, with the exception of a higher proportion of fine grained sediments, the unit directly overlying the basal component texturally resembles the surface unit seen topographically higher and away from the depression (TR 2 G.S. 2-5).

Although there are no radiocarbon dates to substantiate this claim, the surface component along transect 1 probably began to accumulate organic material late in the Holocene in response to higher water tables and increased precipitation with subsequent landform stability. Even though the morphology of the depression resembles that of a paleochannel, no channel fill fine grained alluvial units were identified in any of the 8 profiles taken along the transect. Rather, any fine grained materials were found in a somewhat poorly sorted silty sand matrix which is more indicative of a mixed reworked unit.

Based upon the surface morphology, it is certain that this is a relict channel. However, the channel was probably scoured during the early and middle Holocene based upon the textural and stratigraphic evidence. Severe alteration through reworking and deflation have seriously affected any previous sedimentary structures associated with abandoned channels.

Transects #2 and #3:

These transects extend across the remainder of the high terrace surface which is characterized by small scale Holocene dunes and depressions, again, indicative of periodic surficial reworking. This portion of the high terrace is occupied by two units. The upper unit is composed of a oxidized silty sand which grades into a lower unit of well sorted alluvial sand. Several indications suggest that episodes of surficial instability have occurred repeatedly during the Holocene: first, the undulating surface morphology of the terrace; second, the lack of long term profile stability and pedogenic development seen particularly in the upper portion of the eolian unit; third, the occurrence of a weakly expressed paleosol seen in only one of the profiles; fourth, the absence of textural lamellae in some of the terrace depressions; and fifth, scour into the lower unit observed in one of the depressions.

The surficial unit is homogeneous, composed of reworked sand with minor silt to silty sand (loamy sand to sandy loam). The thickest deposits of this unit are observed on

the small dunes occurring within the high terrace margin. Conversely, the depressions show the thinnest deposit of this upper unit. Stratigraphic evidence from transect #3, G.S. 2 and 3 shows that the position of the lower alluvial unit is considerably lower compared to most of the other profiles. This suggests that the depression probably is derived from scour and has been subsequently filled with reworked sediments. Additional evidence of scour is a lack of textural lamellae in the depression which can be seen in many of the other topographically higher profiles.

At Transect 3 G.S. 1 a weakly expressed paleosol was observed beginning at 40 cm. This is indicated in the field by a change toward a darker color. In the laboratory data an increase in carbon content is noticed between 50-100cm. This surface was not dated but it is believed that the overlying eolian sediments are young and may relate to the episode of deposition seen capping the surface at transect 0 G.S. 3. That profile showed a surface eolian component younger than 1330BP.

In sediments that are extremely well drained and slightly acid, such as the profile seen at transect 3 G.S. 1, organic material would tend to leach out of the profile quickly. Upon burial, the organic material in A horizons commonly does not persist (Birkeland, 1984:30, Holliday, 1983:55) probably a result of oxidation, microbial activity, and other processes.

In contrast, the contemporary surface A horizon may be quite young representing only a few hundred years. Surface A horizons develop rapidly in humid and subhumid environments (Hallberg *et al.* 1978; Schafer *et al.* 1979). Mollic epipedons can develop in as little as 100 years (Holliday, 1983:55). As soon as stability occurs and pedogenesis begins organic content increases rapidly. After several centuries A horizons reach equilibrium between additions of organic material accumulating on the surface and losses of eluvial humus down through the profile Bockheim (1980), Buol, Hole, and McCracken (1980: 13). Parsons, Scholtes, and Riecken (1962) suggest a steady state exists in A horizon development on 1000 year old Indian mounds in northeastern Iowa.

Discussion:

The general lack of soil profile development is related to the overall absence of fine grained sediments; from the incipient instability of the easily reworked surficial terrace sediments; and from the presence of soil animals which tend to mix these loose coarse textured soils. Biotic activity has played an active role mixing material (Hole 1981) from this horizon with material from adjacent horizons.

The transects taken across the high late Woodfordian terrace indicate, that periods of eolian scour and deposition have occurred, perhaps in response to Holocene climatic and subsequent vegetation changes. The only evidence that indicates landform stability is the textural

lamellae primarily observed at considerable depth below the small dunal landforms. Weakly developed lamellae have been shown to develop within a 2300-3500 year time period on dunes in the Lake Michigan area (Berg, 1983). Similarly, the lamellae have been shown to develop in less than 4000 years in the semi-arid regions to the south (Gile, 1983, 1979). This indicates that at least the lower part of the profiles where the lamellae occur have probably been stable for at least the last few thousand years. However, the surface component has likely been reworked at least once and perhaps several times during the past few thousand years.

The Intermediate Terrace:

From the high terrace elevation of 213 meters, there is an approximate two meter drop to 211 meters onto the intermediate terrace (Figures 6 and 8). Transects numbers 4, 5, and the first two sites of transect 6 were taken across this terrace on the south side of the main Iowa river channel. The intermediate terrace is not well represented along the north end of the wildlife area. There are two basic reasons for this. First, the Iowa river has reworked much of the north side of the valley during the late Holocene. Second, alluvial fans have buried remnants of the terrace along the north valley wall so that its true distribution is unknown.

Currently, only two radiocarbon dates have been obtained from the terrace. The first, 2800+-80BP (BETA-13534), was taken from the bottom of organic enriched sediments which were stratified with late Holocene flood laminae (transect 4 G.S. 1). This relatively young date represents a climatological and hydrological parameter where precipitation became sufficient to initiate organic matter production and flood episodes late in the Holocene. A second much older date was obtained from this terrace was buried beneath alluvial fan deposits. This date of 10,090+-190BP (BETA-14401) was taken from a paleosol developed in vertical accretion silt and clay which was in turn overlain by alluvial fan deposits.

Two more dates of 4300+-80BP (BETA-14880) and 3850+-100BP (BETA-13535) were taken from the low terrace where it abuts the intermediate terrace margin. Both of these dates were in organic enriched fine grained channel fill with one of the fills overlain by an alluvial fan. The radiocarbon chronology suggests that the intermediate terrace was the active floodplain sometime before 10,090BP and was abandoned before 4300BP. The present information suggests that this former floodplain was under construction throughout the early and probably most of the middle Holocene.

The fluvial response to a climatic shift from a persistent zonal regime toward a meridional atmospheric circulation pattern was abandonment of the floodplain through vertical incision. After establishment of the intermediate terrace, rapid lateral stream migration reworked the valley floor sediments. The former persistent

zonal component which promoted air mass dominance from a drier westerly Pacific source was replaced by a meridional circulation pattern which characteristically juxtaposed unlike maritime tropical with continental polar air masses producing an increase in the frequency and magnitude of storm and flood events.

The fluvial response in the Tall-Grass Prairie and Midwest to this change in air mass frequency was a widespread episode of lateral channel migration and incision, initially between 6000-4500BP (Knox, 1983, 1984). In the Des Moines river valley, floodplain abandonment and incision occurred around 4000BP. The lower intermediate terrace became the active floodplain from 4000BP to about 750BP (Benn and Bettis, 1985:13, Bettis, 1985:32).

Where the intermediate terrace is exposed along the south side of the Hawkeye Wildlife area, it has a thinner reworked eolian surface component. This is in comparison to the higher late Woodfordian terrace. In addition, the small scale dunes seen on the high terrace are not found on the intermediate terrace.

In contrast, along the north end of the Hawkeye, evidence suggests that the intermediate terrace to some degree has been buried by alluvial fan deposits. This was observed in the Trench 2 Fan where the surveyed terrace elevation very closely matched the elevation seen to the south. Here the terrace is preserved beneath the fan deposits and shows a profile which has been preserved. As a result, the morphological characteristics of the terrace show textural and structural components considerably different from what is observed on the terrace seen to the south.

The Intermediate Terrace Along The South End of The Hawkeye:

Transects 4 and 5:

Transect 4 begins immediately below the terrace scarp from the late Woodfordian high terrace. In the field a paleochannel was identified abutting the higher surface. G.S. 1 was cored through the organic enriched peaty channel fill deposits into the lower sand unit. Below the PSA and silt unit which extends to a depth of 45cm, is a unit composed of laminae of fine sand and silty peaty sediments. The organic enriched silt units decrease in frequency with depth and are absent by 105cm. The individual laminae vary in thickness from less than one centimeter to about 2cm. A date of 2800 was obtained from a sample near the base of this unit from 80-90cm. Since the young date is considered unconformable with the age of the intermediate terrace, the fine sand laminae must represent sediment delivered to the relict channel during periods of high magnitude discharges late in the Holocene.

The USACE plane table maps and air photos show that this portion of the terrace juts out onto the area occupied by the low terrace. Areas immediately west and northeast of

this site on the low terrace have been reworked by lateral channel migration during the late Holocene. The laminae of fine sand, thin silty peat units, and later vertical accretion silt must represent a situation where the main channel was reworking the floodplain (low terrace) close by, hence, the intermediate terrace paleochannel served as an overflow channel during relatively frequent high magnitude floods. The periods between floods were apparently of sufficient duration for peat development to progress. Then another high magnitude discharge overflowed into the intermediate terrace paleochannel depositing an additional lamina of fine sand. Organic matter accumulation progressed while finer grained sediments began to dominate the fill in the relict channel. Apparently sometime after 2800BP the main channel was cut off and ceased delivering sediment to this portion of the intermediate terrace.

This sequence of events indicates that the Iowa river was actively reworking the floodplain around 2800BP. This renewed fluvial activity through lateral stream migration may represent an increase in the magnitude of the mean annual flood. Alluvial systems have been shown to adjust to relatively modest changes in temperature and precipitation by initiating an episode of lateral stream erosion (Knox, 1984).

Below the modest cap of PSA the intermediate terrace has a unit composed of silty sand (sandy loam). This somewhat poorly sorted unit is similar to the surface component seen on the high terrace. However, on the intermediate terrace, this unit is considerably thinner (generally less than 0.5 meters) and has a slightly higher silt and clay component. In addition, on the intermediate terrace these sediments are generally less oxidized, particularly where the local water table has more directly affected the profile.

In transect 5 G.S.1, this unit is characterized by a silty sand (sandy loam to loamy sand) with an oxidized color of 10YR 4/6 from 16-45cm. Texturally, the silt constitutes less than 20% of the sample while the clay less than 10%. This textural assemblage is similar to what is observed in the surface reworked unit of the adjacent late Woodfordian high terrace. The interpretation is that this surface component has likewise been reworked and mixed from eolian and from faunal activity. This surface has been exposed for a considerable portion of the Holocene and during episodes of drought and desiccation the surface has probably been unstable.

Below this reworked unit is the characteristic basal alluvial unit seen throughout the valley. In some profiles stratified flood events are implied and evidenced by laminae of fine, medium and coarse sand while in others the unit is nonstratified. Topographically lower compared to the high terrace, this unit is generally more affected by the local water table which is seen through mottling and gleying.

The Intermediate Terrace Along the North End of The Hawkeye:

The distribution of the intermediate terrace along the north end of the Hawkeye is unknown. This is due to the fact that alluvial fans escaping lateral stream erosion during the late Holocene have buried components from the intermediate terrace. This was the case seen in the Trench 2 fan where the intermediate terrace has been buried by alluvial fan deposits. The radiocarbon date of 10,090+-190BP (BETA-14401) was taken from a sample in a soil developed in vertical accretion fine grained sediments and was subsequently overlain by fan material.

Since the terrace appears to have been buried for a significant portion of the Holocene perhaps beginning in the early Holocene, it has not been affected by surficial instability and remains well preserved. Consequently, this surface, where buried along the north end of the wildlife area, appears to retain many of its initial alluvial characteristics. In comparison, the terrace surface seen on the south end has a modified surface composition due to direct exposure to vastly different climatic circulation patterns throughout the Holocene.

Discussion:

The intermediate terrace was the active floodplain from at least 10,090BP based upon the radiocarbon date obtained along the northern valley margin. Since the headwater reaches of the Iowa river drained recently glaciated landscapes of the Des Moines lobe (Kemmis *et al.*, 1981: 6), the terrace may be older and date to the late Woodfordian (14,000-11,500). Although the events surrounding the abandonment of the late Woodfordian high terrace and activation of the lower intermediate terrace are less certain, valley incision and abandonment of the high terrace may be in response to the final stages of glaciation and meltwater discharge associated far upstream along the margin of the Des Moines lobe.

After incision on the high terrace created the intermediate terrace as the active floodplain the degree of post incision aggradation on this surface is not clear. No paleosols or other evidence were inset into the terrace components at the sites studied. This suggests that episodes of stability followed by aggradation may not have occurred.

The terrace was the active floodplain until about 4500BP or possibly earlier. Older floodplain remnants, particularly along the north valley wall, were apparently not reworked but instead buried and stabilized by mid Holocene alluvial fan development. These older components show relatively undisturbed alluvial units. In contrast, along the southern margin of the terrace the alluvial sediments have been reworked through surface instability and from biotic mixing.

Clearly, the intermediate terrace was abandoned prior to 4300BP and likely resulted from a change in prevailing

upper atmospheric circulation patterns which in turn changed the frequency and magnitude floods. The change from a persistent zonal circulation pattern which promotes a drier westerly component to a meridional pattern which favors a north/south component increased the size and occurrence of storms and floods. Since vegetation was initially not adjusted to this change in prevailing upper air regimes, the hydrologic response was seen through entrenchment and less certain, valley incision and abandonment of the high terrace may have been in response to the final stages of glaciation and meltwater discharge from far upstream along the margin of the Des Moines lobe.

After incision on the high terrace created the intermediate terrace as the active floodplain the degree of post incision aggradation on this surface is not clear. No paleosols or other evidence were inset into the terrace components at the sites studied. This suggests that floodplain abandonment with subsequent active lateral reworking on the lower floodplain surface.

The Low Terrace:

The low terrace which lies about 2 meters below the elevation of the intermediate terrace is a surface that has been active during the late Holocene (Figures 6, 7 and 8). The low terrace was formerly mapped as floodplain in a previous study by Emerson et al. (1984). The Soil Survey of Johnson County also mapped this unit (Schermerhorn, 1983) as floodplain or alluvial soils (Fluvaquents). For agricultural land use and management procedures the terrace was mapped in this manner because the soil units are so changeable from season to season that there is little justification for forming separate mapping units from its components (Hole and Campbell, 1985:118).

In reality, the low terrace includes at least a portion of the present floodplain under construction. As a result of impoundment the modern geomorphic floodplain has aggraded where inundation of the low terrace is an annual event thereby making the distinction between floodplain and low terrace difficult. This study differentiated the two surfaces by using the USACE plane table maps, the USGS topographic quads, field inspections, and USACE air photographs to identify relict channels, depressions and chutes on the low terrace and classified these surfaces along with the active main channel as "floodplain".

The field inspections showed that these low areas on the terrace have been filled with large volumes of PSA. Along with the area immediately adjacent the active main channel, cores in relict channels at sites TR 7 G.S.2, TR 8 G.S. 2, and TR 9 G.S. 1, produced depths of PSA significantly greater than 1 meter. Areas like these were used to define the floodplain and differentiate it from the low terrace.

Differentiating the floodplain from the low terrace is important since the terrace includes a considerable portion of the late Holocene record. For example, a radiocarbon date of 3850BP+-100BP (BETA-13535) was obtained from organic

enriched fill deposits in a paleochannel which abuts the intermediate terrace on the south side of the Hawkeye wildlife area (Figure 12). A second older date of 4300+-80BP (BETA-14880) was obtained from a channel fill unit which has been buried by alluvial fan deposits along the north valley margin. The radiocarbon date of 4300BP gives a minimum date for the age of the low terrace. Abandonment of the intermediate terrace onto the lower terrace surface probably occurred earlier, between 4500-6000 BP.

The low terrace contains a mosaic of different aged late Holocene surfaces some of which have been buried by both Holocene and post-settlement floodplain aggradation. For example, an organic enriched horizon dated 510+-70BP (BETA-13536) has been buried by over 1 meter of late Holocene lateral and vertical accretion fluvial deposits. Another date of 1510BP+-70BP (BETA-14881) was obtained from a log 40cm below the presettlement A horizon along a main channel bank. This exposure represents a portion of the low terrace which is actively being eroded through lateral incision. The evidence clearly indicates that the low terrace has experienced periods of aggradation very late in the Holocene.

Other evidence suggests that lateral stream migration has reworked the valley floor sediments earlier in the late Holocene. Apparently, rapid lateral erosion occurred from 4300 to 3850 based upon the two radiocarbon dates in the channel fill units seen from opposite ends of the valley. In addition, a second period of intensified fluvial activity seems to have occurred later based upon the 2800BP date in flood deposits seen on the intermediate terrace. It appears that lateral stream erosion was actively reworking portions of the intermediate terrace along the southern margin of the Hawkeye. Periods of high magnitude discharge overtopped the intermediate terrace reactivating a considerably older relict channel.

Transect #6:

This transect begins on a portion of the intermediate terrace (TR6 G.S.1) which has been first scoured then capped with post settlement flood deposits. This occurrence of flood scour with subsequent deposition is common along the margin between the intermediate and low terrace. An archaeological site (13JH 500) where cultural materials have concentrated as a lag component is similarly located along the margin separating the two terrace surfaces.

Below the terrace escarpment is the paleochannel which was dated at 3850BP. The paleochannel had first been filled with 143cm of Holocene fine grained channel fill, then this deposit stabilized, forming a surface A horizon. More recently, historical floods have capped the surface with 43cm of PSA.

The first two sites along the transect are located along the margin of the intermediate and low terrace and show evidence of considerable historical scour with

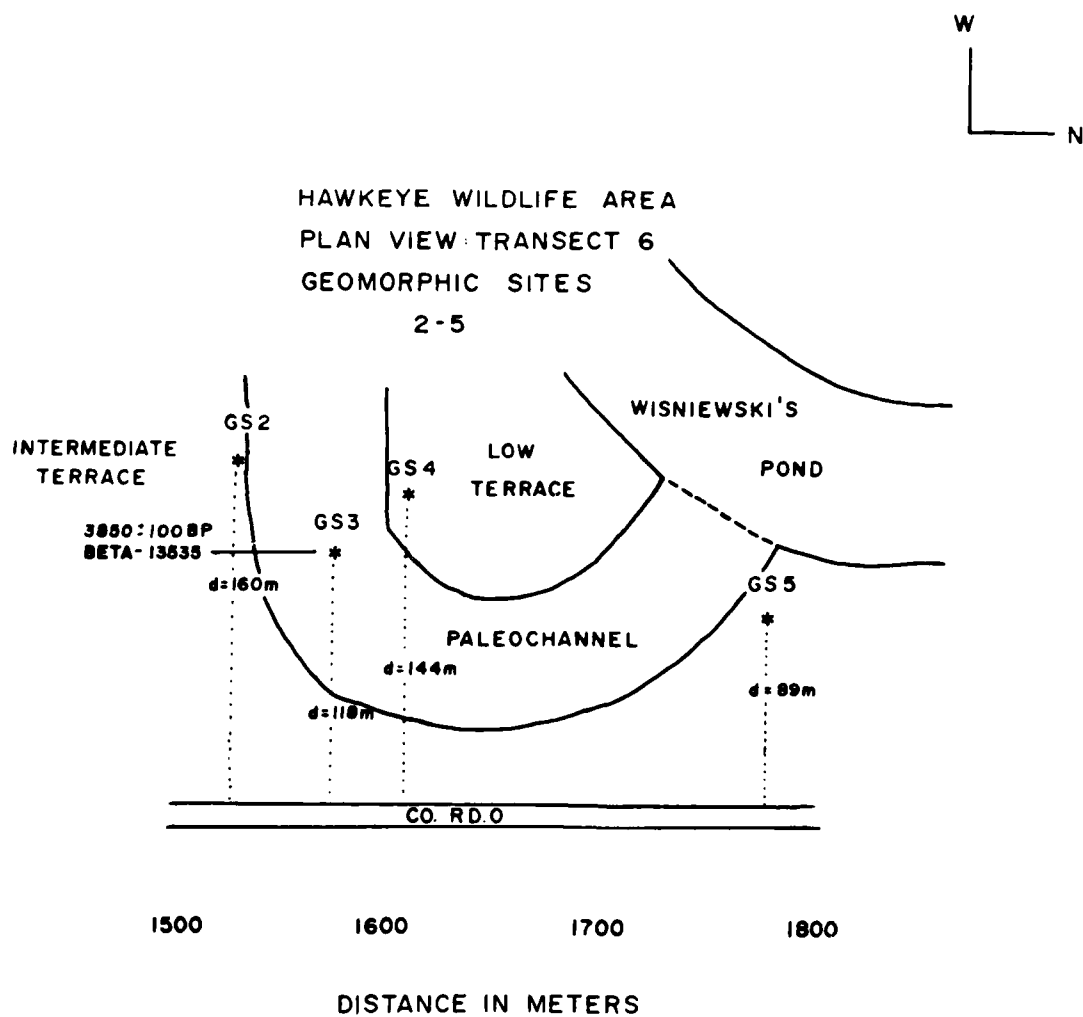


FIGURE 12

subsequent deposition. This is also the case with site 5 which provided evidence of historical surface erosion and sedimentation. But unlike the other cores along this transect, site 5 produced textural Beta B lamellae from 74-154cm.

Two other profiles (G.S. 4 and 6) observed along the transect, show a general profile of late Holocene lateral accretion coarse grained sediments with an overlying vertical accretion fine grained unit. The fine grained unit is principally very late Holocene vertical accretion fine grained silt and clay which is capped by a surficial component of fine grained PSA laminae. These sites, located close to the outer meander bend of Wisniewski's Pond show this characteristic profile.

Earlier in the historical period the pond was the active Iowa river channel (Figure 13). The map, which dates to 1897 or earlier shows that the Iowa River course was more sinuous. It recently has experienced straightening and many of the previous meander loops have been subsequently cut off. This probably relates to land use changes associated with the destruction of the natural vegetation cover which in turn has increased the frequency and magnitude of floods (Knox, 1977). By 1937 the USACE air photos show that many of these meander loops have been cut off.

Transect #7:

This transect included cores along the extensive point bar which was constructed when the Iowa River occupied Wisniewski's Pond. The first site is relatively far out on the point bar while the other two sites were further up onto the bar and closer to the present main Iowa river channel. Unlike sites 1 and 3, site 2 was taken along the margin of Wisniewski's Pond and showed PSA to a depth significantly greater than 1 meter, while the other two sites had considerably less significant PSA deposits.

The profile from G.S. 1 had a thin mantle of 11cm of PSA. Below the PSA the normally observed A horizon was absent from the profile and had been truncated by historical flood episodes. The profile shows the typical lateral accretion point bar sequence that fines upward. In addition, the profile shows two weak textural lamellae above the coarse parent material.

Unlike the first profile along the transect, G.S. 2 is located along the margin of Wisniewski's Pond and is composed of historical deposits. The flood laminae vary in thickness but are commonly about 1cm. Some of the laminae are calcareous while others are not.

The last core taken along the transect showed a different profile from that of the other two. This core is located farther up onto the point bar and closer to the active main channel. Remarkably, the surface was capped by only 10cm of PSA below which an A horizon could be observed. The unit below the PSA, and extending to a depth of 133cm, showed a fining upward point bar sequence. This sequence ended with an abrupt contact and buried the underlying

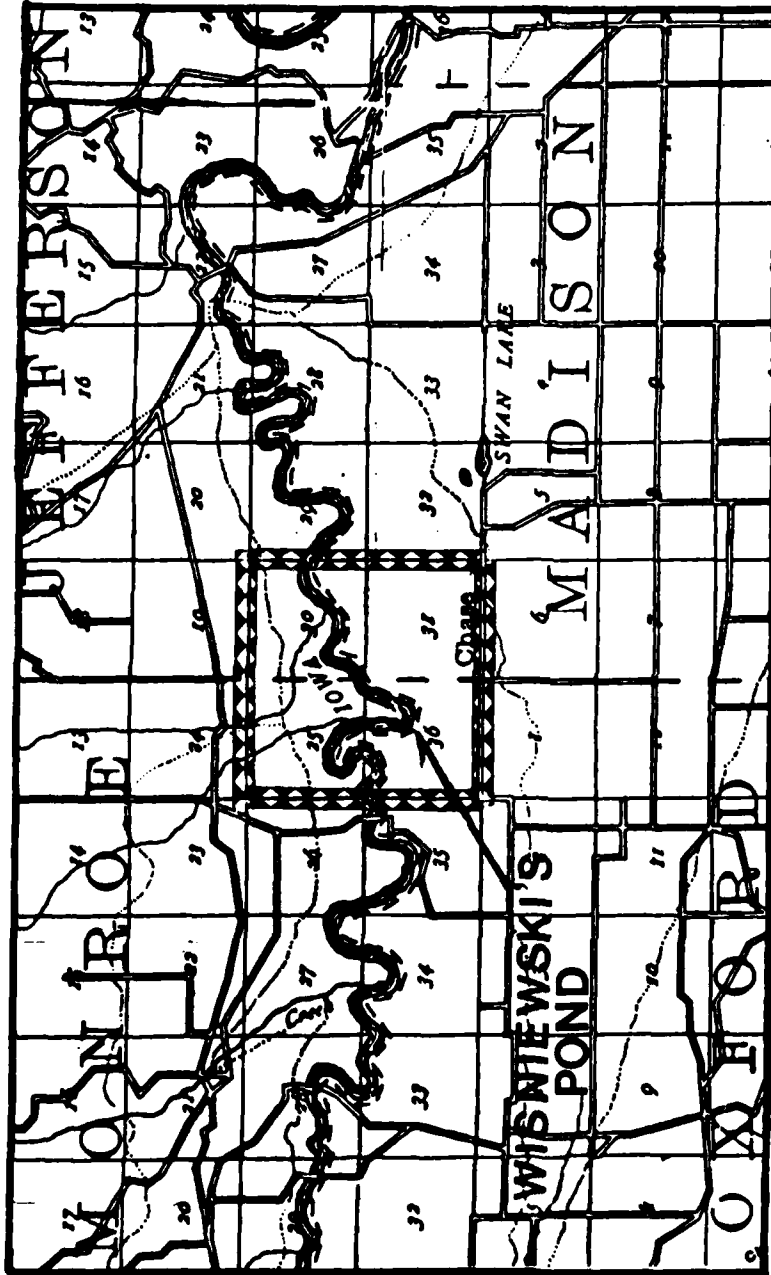


Figure 13: Position of the Iowa River in the Hawkeye Wildlife Area prior to 1897. (Note the more sinuous channel pattern and that Wisniewski's Pond was the active channel, after Calvin, 1897).

mottled and gleyed clayey silt which continued to a depth of 235cm. Then another abrupt contact with medium and coarse sand was observed to a depth of 295cm. The mottled and gleyed clayey silt apparently represents a channel fill episode which subsequently was buried by aggrading lateral accretion point bar sediments.

This profile represents one of significant age and illustrates that aggradation of the floodplain occurred during the late Holocene. Even near the end on the relatively younger portion of the point bar at TR7 G.S.1, the evidence seen from a single textural lamella indicates that this point bar has been stable and has undergone pedogenesis for a considerable length of time. The indication is that the Iowa river occupied Wisniewski's Pond for a considerable length of time before abandonment 50 to 80 years ago.

Further evidence is seen from transect 6 where some of the profiles show significant pedogenic development. Others, particularly those of TR6 sites 1, and 5, TR7 sites 1 and 2, show severe erosion and/or sedimentation from historical events. Although no subsurface argillic horizons were identified, a surprising number of profiles show cambic development evidenced by translocated illuvial humus coatings which moved down channels, and weak textural lamellae. In addition, many of the profiles showed only modest historical modification. Consequently, from the observations made along transects 6 and 7, the severe effects from post settlement processes in many cases appear highly localized.

Transect 8:

Transects 8 and 9 cross the low terrace along the north end of the main Iowa river valley. Transect 8 is a short east/west transect composed of only two profiles. One core was located in the center of a relict channel while the other was located on the inside of an old meander loop.

The profile from the core taken in the relict channel shows at least 362cm of PSA. The post settlement flood units varied in thickness with some of the individual units exceeding 10cm. Two elderly local informants stopped by and mentioned that during the 1930's they used to fish the cut off channel for bullheads in the spring. Today the channel is hardly distinguishable in the field from the low terrace and could not be seen from county road "O" which is only 100 meters away. In fact, the channel had to be located by using the USACE plane table maps and 1937 air photos since the recent air photos provided no indication of an abandoned river course.

A second profile was taken from inside the old meander loop and produced a radically different profile. The surface is capped with only 12cm of historical alluvium while the underlying A horizon appears to have experienced modest predepositional erosion. A point bar sequence where cambic pedogenic alteration is observed forming the solum of the upper unit. Below 57cm. to a depth of 130cm a vertical

accretion unit can be found evidenced by thin silt laminae less than 1mm thick with some laminae organic enriched. A radiocarbon date sample from 100-120cm was taken and yielded a date of 510+-70BP (BETA-13536). Below the silt was the characteristic well sorted basal sand.

This profile further illustrates that floodplain aggradation progressed during the late Holocene. In this case occurring very late judging by the radiocarbon date. In addition, the preceding core taken from the abandoned channel further substantiates that considerable quantities of PSA are generally of local distribution, most of which remains stored in the numerous relict channels that characterize the low terrace.

Transect 9:

This transect, which is also located in the north end of the main valley on the low terrace, reflects characteristics similar to the other transects along the low terrace. For example, site 1 which was located in an abandoned channel produced large amounts of PSA. Site 2 on the inner part of the relict meander loop produced only modest amounts of PSA.

In contrast to the other transects across the low terrace, the soils seen on this end of the valley show more profile development. They have apparently had more time to develop and therefore appear to be older. This is based upon soil morphology and leaching which is evidenced by pH changes through the profile.

Like transect #8 the first site along transect 9 was located in a relict channel, and similarly showed great depths of post settlement alluvium. At least 260cm of historical sediments have been recorded from the silt probe core taken in the channel. Like other thick historical deposits seen in the floodplain, these units varied in thickness with some units over 10cm thick.

Site 2, on the other hand, showed only about 15cm of historical deposits. Individual flood laminae identified at the site were composed of silt and varied in thickness from 2mm to less than 1mm. Below the historical sediments was a basal lateral and overlying vertical accretion component. Sequans or iron (Fe) coatings of bright orange color (7.5 YR 4/8-10) were observed in the solum coating many root holes and ped faces. The genesis of these coatings is unclear. However, their distribution along the former root channels producing highly oxidized colors may relate to the type of chemicals manufactured during breakdown and decay of the plant root system.

Continuing north on the low terrace toward the valley wall the remaining profiles along the transect show a similar sedimentological sequence to site 2. This is especially seen in site 4. Both sites 3 and 4 show less than 20cm of PSA capping the surface, with a coarse grained basal unit grading into an overlying fine grained unit.

In contrast, a noticeable difference in profile characteristics is seen at site 3, particularly when

compared to sites 2 and 4. For example, site 3 shows a thicker fine grained component which extends to 152cm. The presettlement solum is developed in vertical accretion deposits with minor fine to medium sand. The upper part of the profile has been apparently stable for some period of time based upon the cambic B horizon development seen from 38-74cm. However, below 74cm a slightly darker and more clay enriched horizon is seen until 97cm. The clay enrichment continues to about 130cm, then an increase in overall particle size extends to the base of the profile.

This profile at site 3 either represents a channel fill episode subsequently buried, or pedogenic argillic development. Evidence from the particle data indicates pedogenic development in the form of a textural B horizon below 74cm. In addition, morphologic characteristics in the form of soil structure substantiate this claim. Meanwhile, the basal alluvial terrace sediments are approximately at the same elevation as that of site 2, but are lower than that observed at site 4.

Through the mapping of this surface and the associated subsurface components, there appears to be a minor increase in surface elevation (Figure 8) from site 2 to site 4 along this transect. From the air photos, topographic and plane table maps, this portion of the low terrace has certainly been reworked since intermediate terrace abandonment. However, located close to the steep valley wall the potential for slope wash sedimentation is high. Site 3 may represent a late Holocene surface which has been buried from both side slope sedimentation and from vertical accretion deposits. The alluvial basal sand component is higher at site 4 suggesting that site 3 may represent a buried relict channel fill.

Discussion:

The low terrace contains a mosaic of different aged deposits. The surface contains sediments of both lateral and vertical accretion that have generally not experienced the surficial reworking seen on the intermediate and high terraces. This may be attributed to the relatively young age of the surface and to escaping earlier Holocene dessication and drought. Capping the terrace sediments is a mantle of PSA of highly variable thickness. The PSA has generally concentrated in the abundant low lying areas (floodplain).

After intermediate terrace abandonment prior to 4300BP active lateral migration reworked the valley bottom. Apparently a second episode of channel migration occurred around 2800BP. This second episode appears to have concentrated more activity along the southern margin of the terrace since older soils, and buried terrace components are more common along the northern valley margin. Later, an episode of valley alluviation occurred based upon the radiocarbon chronology and presence of buried soils.

At the time of European settlement the Iowa river had a more sinuous channel pattern. But historical land use

modification has increased the frequency and magnitude of floods. This increase in floods has led to a straightening of the river course and the cut off of many meander loops. This change in the river course occurred between 1897 and 1937, and has produced additional abandoned channels that have served as sediment traps for post settlement alluvium. abandoned channels which have served as sediment traps for most settlement alluvium.

Alluvial Fans and Colluvial Footslopes:

Numerous alluvial fans are observed along the northern margin of the Hawkeye Wildlife area and represent a very complex array of both depositional and erosional events. Upon entering the main valley, these deposits form small steep angled fans at the base of low ordered drainages and coalesce with colluvial footslopes. Further out onto the valley much broader and larger low angled fans are observed. Late Holocene channel migration on the low terrace has reworked a portion of the low angle fans, however a significant number of them have escaped lateral reworking.

The present study reveals information from two areas along the northern margin of the Hawkeye, with one area representing a coalescing steep angled fan and footslope, while the other represents a low angle fan. This portion of the valley is characterized by a very wide range of depositional landscapes seen through the coalescing fans and footslopes, and through tributary terrace/fan complexes.

The low angle fans along the north valley wall which have not been reworked are likely to contain buried intermediate or older terrace components. This was encountered in trench 2 which contains an intact intermediate terrace deposit. Furthermore, periods of fan stability indicated by soil development, and instability seen through truncated soils and erosional lags, have apparently occurred on the lower angled fans. In contrast, the smaller steeper fans seem to have developed progressively through time without episodes of stability or incision. Only incision from historical land use has been identified on the steeper fans.

County Road "E," Fan #1:

A total of three silt probe cores and one soil pit provided the data from this site. It is located in a landscape position composed of coalescing footslopes and fans. Upslope from the soil pit a colluvial footslope is inset against the valley wall. This footslope is where backhoe trench 1 is located. The profiles from the fan at this location did not reveal a palaeosol. This indicates that the fan developed progressively but over a sufficiently short time period as to inhibit soil profile development until termination of the depositional episode. In addition, there is no evidence of erosional lag components, or buried relict Bt horizons in the profiles. Apparently the fan developed over a relatively short time period, then

stabilized enabling pedogenesis to initiate profile development.

The fan sediments are in contrast to the underlying terrace deposits seen in the Fan #1 profile. This profile shows a surface depositional component seen as a lag, where the surface A horizon has been totally truncated through agricultural land use and reservoir erosion. The surface erosion has cut into the EB horizon and by 22cm the Bt horizon is exposed. The Bt horizon shows weak argillan development to a depth of 121cm then clay skins cease and structure becomes massive. The somewhat poorly sorted fan material, as seen from the textural data, continues to a depth of 258cm where an abrupt contact with the well sorted alluvial terrace component is observed.

From the base or bottom of the profile at 602cm to 258cm the alluvial chronology shows a basal lateral accretion coarse unit which is in turn overlain by flood deposits composed of coarse silt and fine sand. Above this from 410cm to 430 cm is an apparent vertical accretion fine grained unit with some organic carbon inclusions. It is thought that the small amount of organic matter does not represent a datable buried surface. The organic matter plot does not show an increase in carbon content in this alluvial unit. Above this unit valley alluviation proceeded and is observed through flood episodes in the form of laminae of silt and sand followed by the upper alluvial unit of vertical accretion silt and clay.

This profile indicates that the fan sediments probably represent one continuous episode of aggradation. Upon cessation of sediment supply coincident with upland stability, soil profile development began on the fan. These events, however, occurred after an episode of valley alluviation which is seen from the fluvial deposits beneath the fan. Since lateral stream migration on the low terrace has incised into this portion of the north valley margin, it is believed that the fan has buried the low terrace component. This would chronologically place this episode of fan development during the late Holocene. Even though radiocarbon dates have not provided a more exact chronology, evidence from the soil profile indicates that fan stability probably occurred late, perhaps around 4000BP. The evidence is the relatively few weakly developed clay skins seen along the ped faces. Clay skin development indicates significant long term stability and has been shown to develop between 1000 and 2,500 years in northeastern Iowa (Parsons et al. 1962).

Trench 1 (CFS):

Upslope from the fan and directly abutting the valley wall are colluvial footslopes. These depositional features continuously are found abutting the valley wall along the northern margin of the Hawkeye wildlife area. One small but deep trench was dug into one of these footslopes (Figure 14).

HAWKEYE TRENCH I

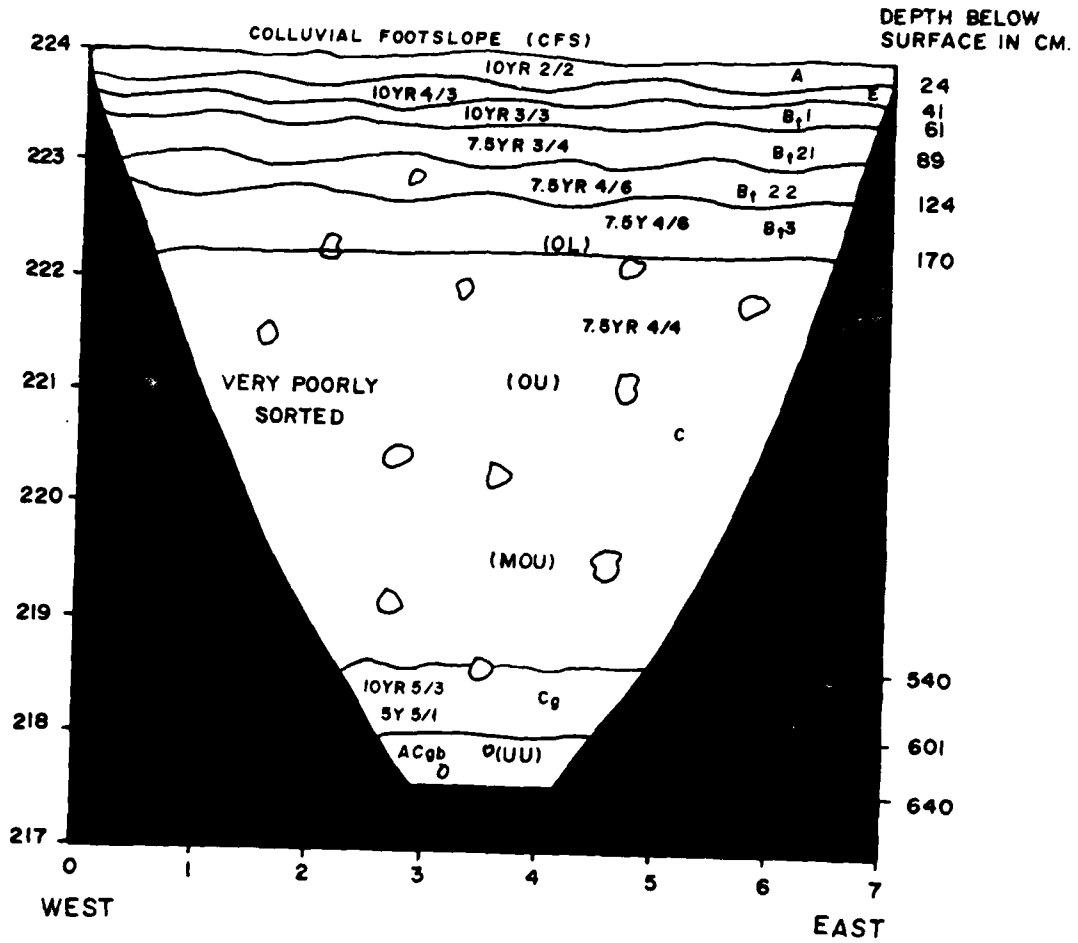


FIGURE 14

The trench extended the profile to a depth of 6.40 meters. The profile consisted mainly of very poorly sorted mass wasted till and loess over an organic enriched Farmdalian surface of similar textural composition. The surface A horizon showed only slight erosion which appeared anomalous considering the steep slope. Much of the surface horizon was composed of slopewash laminae less than 1mm thick and consisted of reworked loess. Below the surface horizon was a well developed eluvial (E) horizon characteristic of a stable forest (Hapludalf) soil. The subsurface horizon illustrated the best developed Bt horizon seen throughout the entire project area. Extremely thick dark (10YR 3/3) argillans are observed totally coating ped faces in the Bt horizon. In addition, Bt structure was extremely well developed.

The solum is developed in reworked loess and a mixture of very poorly sorted mass wasted till and loess. Below the solum the oxidized mixture becomes calcareous and remains so to the bottom of the profile. Reduction begins to occur by 540cm and by 610cm below the surface the sediments are unoxidized and unleached and contain an organic enriched valley fill component. Similar to above, the fill has a mass wasting component and the textural data shows that it remains very poorly sorted. A radiocarbon date of 28,120+-350 (BETA-14029) was obtained from a sample in this unit.

From the radiocarbon date and the well developed surface soil profile, this particular footslope probably developed during the Woodfordian or earlier, produced by a climate favorable to periglacial mass wasting conditions. The basal component containing organic matter and plant remains indicates that a Farmdalian soil developed in earlier mass wasted valley fill colluvium. Then mass movement of colluvial materials progressed, burying the Farmdalian soil, probably during the Woodfordian. Similar evidence from Grant County Wisconsin shows that extreme mass movement of materials from steep hillslopes occurred during the Woodfordian after 20,000BP (Knox, 1982).

A second footslope exposure in a borrow pit located near the intersection of Co. roads E and O along the north end of the Hawkeye, showed a similar profile to that of trench 1. But unlike the 6.4 meter trench, this borrow pit cut only exposed about 2 meters of the profile. The sediments from the cut were oxidized mass wasted colluvial loess and till. The solum was leached while parent material remained unleached.

It is not known whether all of the footslopes along the northern margin of the Hawkeye are of pre-Holocene age. However, it is suspected that many of these slopes evolved during the late Wisconsinan when periglacial mass wasting conditions existed in the upper Mississippi Valley (Knox, 1982, 1985).

Trench 2 (Fan):

This trench is located a few hundred meters east of the intersection of Co. Rd. O and E along the north end of the

Hawkeye wildlife area (Figure 8). The fan drains a small 3rd ordered valley and abuts the valley wall. The trench begins about mid fan and extends longitudinally down toward the distal end. At least two episodes of upland erosion expressed by fan development can be identified along the trench. The episodes of fan deposition are separated by an erosional lag which is observed by a discontinuous pebble band. The intermediate and low terrace components are buried beneath the fan sediments. The evolution of the fan shows an episode of fan deposition, incision and a second episode of deposition (Figure 15).

A total of three profiles were sampled for laboratory analysis along the longitudinal axis of the fan. Toward the north end of the trench, the basal alluvial deposits of silt and sand are components of the intermediate terrace. The surveyed elevations demonstrated that the top of the coarse grained alluvial unit closely corresponds to the elevation of the basal alluvial unit seen across valley on the intermediate terrace. In contrast to the reworked surface silty sand unit seen to the south, the vertical accretion deposit buried by the fan is preserved. A soil has developed in this slightly less than 1 meter thick deposit, and is dated (10,090+-190BP).

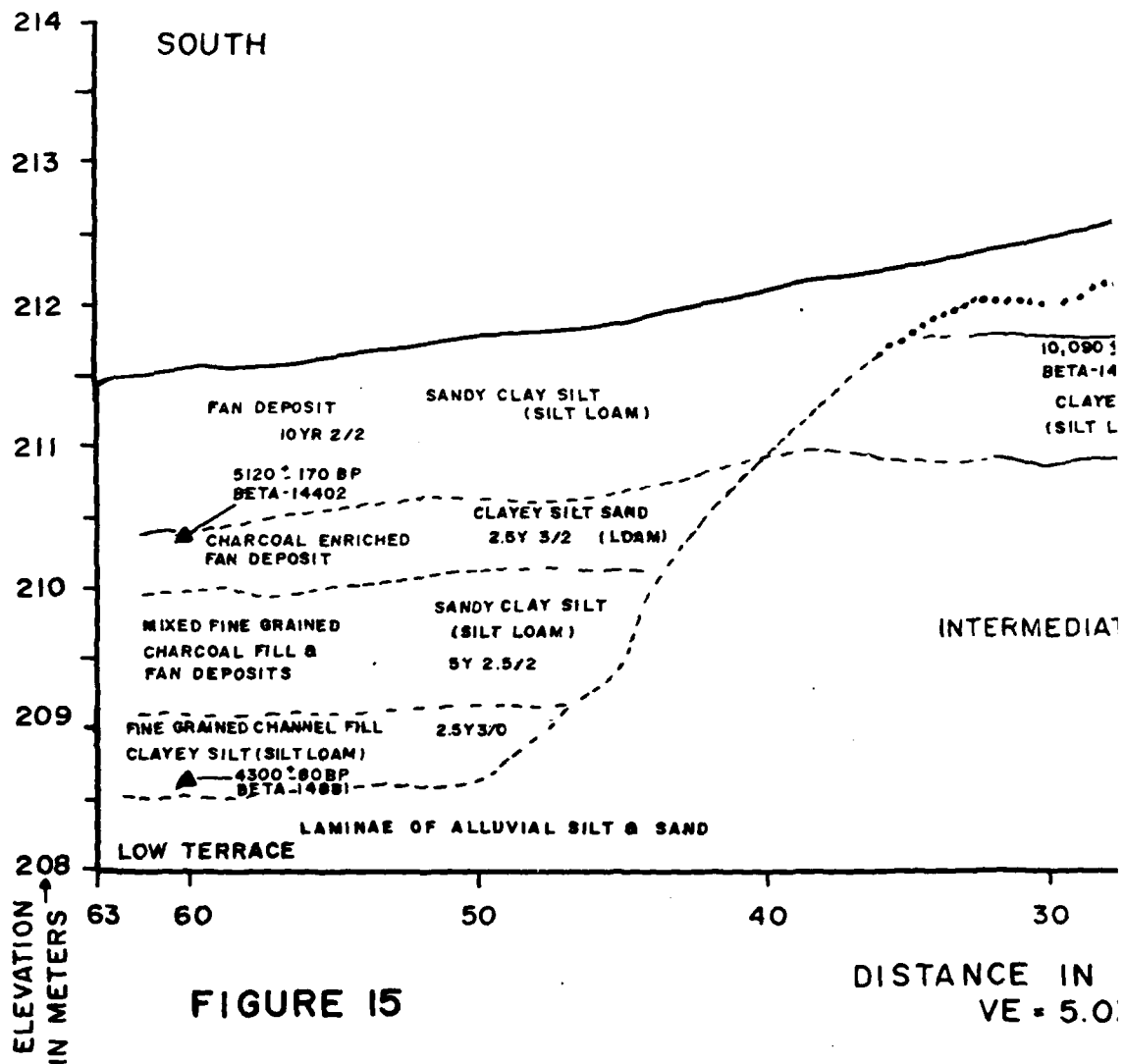
Overlying the soil are somewhat poorly sorted fan sediments. The sediments can be divided into two units which are separated by an erosional lag. The lower of the two units has a relict BE and Bt horizon and probably was an Alfisol while the upper unit shows a less developed soil and trends toward an Inceptisol. The profile seen down the trench at 22 meters shows a similar profile.

At the other end of the trench at 61 meters a considerably different profile is observed. In this case the fan deposits bury a low terrace channel. A date of 4300+-80BP was recorded in fine grained channel fill just overlying the coarse basal alluvial unit. Above the fill is a mixture of fan and fill deposits, then a coarser poorly sorted reworked fan deposit which was dated at 5120+-70BP. This unit was probably reworked from immediately up fan and constituted a former surface which has since been mobilized into the buried low terrace channel. This unit is then capped by a final episode of fan deposition with the contemporary soil developed in this material.

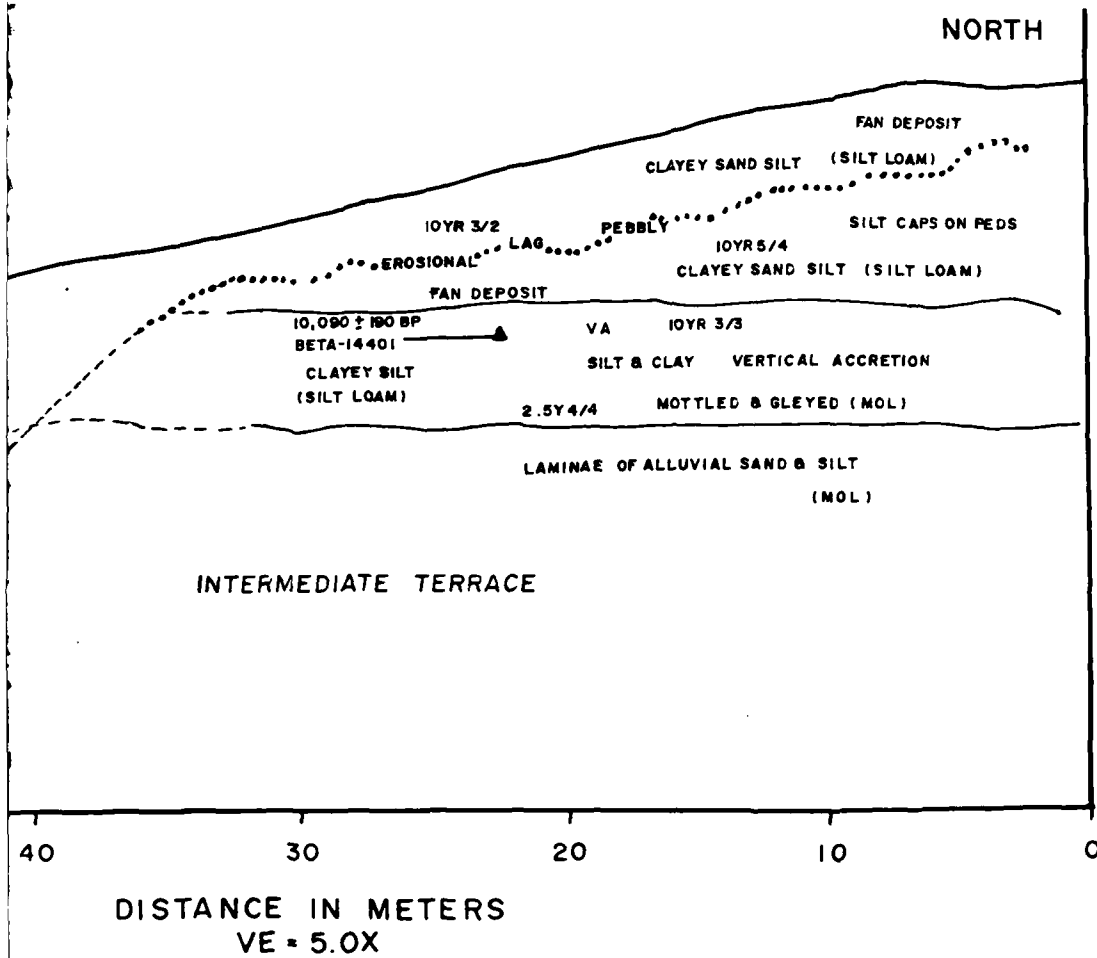
Discussion:

A generalized reconstruction of late Wisconsinan and Holocene geomorphic events can be made along the north valley wall margin of the Hawkeye Wildlife Area. The evidence obtained from trench #1 suggests that a Farmdalian soil developed in older probably mid-Wisconsinan mass wasted materials. A period of stability ensued in the valley fill colluvium which can be seen through the development of organic enriched soil dated at 28,120BP.

ALLUVIAL FAN TRENCH #2-CF



N TRENCH #2-CROSS SECTION



Later, probably in response to increased glacial activity farther west, mass wasting processes intensified as periglacial climatic conditions in the valley returned. This activity continued during the late Woodfordian and buried the Farndalian surface. Upon deterioration of the glacial/periglacial climatic regime, stabilization occurred on the footslopes and soil development progressed. The extremely well developed subsurface Bt horizon seen in trench #1 suggests stability for perhaps the entire duration of the Holocene. It is likely that many of the footslopes developed in this manner and have remained stable during most of the Holocene. During the end of the Woodfordian the intermediate terrace was the active floodplain and reworked the valley floor. The radiocarbon date of 10,090BP indicates that the main channel was reworking the northern margin of the Hawkeye. After channel abandonment soil development occurred on the vertical accretion deposits of the intermediate terrace.

The time increment between the beginning of soil development on the terrace and burial by the first fan deposit is unknown. This is particularly difficult to tell because soil development on the terrace apparently progressed after fan burial. However, based upon the development seen on the overlying truncated soil, the first episode of fan deposition probably occurred early in the Holocene. Hence, the soil developed on the terrace probably developed over a period of around a thousand years and was buried by about 8500 or 9000BP.

Stabilization occurred and pedogenic development progressed on the fan while the intermediate terrace remained the active floodplain during the early and mid Holocene. As an apparent climatic change occurred perhaps around 5000BP, the fluvial response caused vertical incision and floodplain abandonment, establishing the intermediate terrace. Then active lateral channel migration began to rework the valley floor sediments and an episode of lateral incision occurred along the north valley wall. A portion of the fan capped intermediate terrace was reworked with subsequent channel abandonment around 4300BP.

About this time it is thought that the steeper Co.Rd.E fan #1 buried the low terrace and stabilized soon thereafter. This is based upon the relative degree of soil development seen in the profile and that the fan overlies the low terrace which was the floodplain under construction around 4000-5000BP.

Then an episode of rill erosion occurred on the fan which buries the intermediate terrace (trench 2, Figure 15). Prior to this episode, soil profile development on the fan apparently progressed for several thousands of years evidenced by the morphologic characteristics of argillans and silt caps. The indication is that this particular fan probably developed prior to 8500 or 9000, and then remained stable until 4000 or 4500 years ago. Erosion on the fan probably occurred in response to the lowered base level created by the low terrace abandoned channel, and perhaps by

the increased precipitation which occurred in response to a more moist late Holocene climate.

Erosion of the fan produced an erosional lag seen as an irregular and discontinuous pebble band. The lag could be seen in the upper third of the trench. The eroded sediments including some organic material filled the abandoned low terrace channel, and produced the radiocarbon date of 5120BP. The older date overlying the younger date seen in the abandoned channel fill suggests that the first fan deposit overlying the intermediate terrace was probably stable at least until 5120BP. It was actually after 4300BP that the fan surface became unstable. This instability reworked the highly mobile low bulk density organic material and additional fan sediments into the abandoned channel.

Soon after fan incision, another upslope erosional episode produced fan sediments covering the surface and completely filling the abandoned channel. This valley fill deposit has probably remained stable for the last 3 to 4 thousand years, and has escaped the more recent episode of valley reworking.

It is thought that the 2 fans and 1 footslope studied fairly represent the erosional and depositional episodes occurring along the north end of the Hawkeye. Farther to the west, the Saylorville reservoir study reported that alluvial fans developed between about 11,000 and 4000 years ago (Benn and Bettis 1985:8). In the Hawkeye the evidence to date suggests that fans developed prior to 8500 and after about 4000 years ago. Further studies here may demonstrate that fans developed throughout much of the Holocene. However, due to the extremely complex series of geomorphic events occurring along the north valley wall, additional generalizations will require more evidence.

Summary Of The Hawkeye Wildlife Area:

The following summary deals with the proposed natural history in the Hawkeye based upon the current information. Both direct and indirect evidence, obtained throughout the study period, is used in this reconstruction. The depositional record begins along the north valley wall where pre-Farmdalian (before ca. 30,000BP) colluvial deposits are found. Stability occurred in the valley and organic matter began to accumulate around 28,000 years ago. It is not known how long this stability lasted but renewed mass wasting occurred during the Woodfordian and seems to have terminated prior to the last increment of loess fall in the valley ca. 14,000 years ago. The elevation of this Farmdalian organic enriched unit is 218 meters.

Perhaps modest valley alluviation occurred culminated by loess deposition and landscape stability. A period of glacial wastage appears to have existed between 20,000 and 16,000 years ago (Wright, 1976b). Stability can be seen from a soil developing around 17,000 years ago which was later buried beneath a dune at 220 meters. This relatively thin fine textured loessal soil may represent a deposit originating from a more distant source. The fact that soil

development progressed indicates a period of climatic moderation which presumably occurred prior to the advance of the Des Moines Lobe. Underlying the loess are older fluvial laminae of sand and silt.

Apparently after 17,000 but prior to 14,000 years ago a more periglacial climate persisted which likely produced additional footslope development along the north valley wall. In addition, an episode of sand dune development followed by modest incision seems to have occurred along the south end of the valley. The incision lowered the valley a few meters to about 218 meters. Subsequently, valley alluviation produced a fine grained fill component. This gleyed unit was stratigraphically traced over a one-half mile distance and probably relates to a periods of frequent inundation by low energy fluvial fine grained vertical accretion.

This fill component was subsequently buried by a coarse loess, in some cases calcareous, composed of fine sand and coarse silt. The origin of the loess was probably local based upon the relatively coarse nature of the deposit. The final increments of this deposit probably occurred between 14,000 and 15,000 years ago. Shortly after 14,000BP valley incision occurred about 5 meters from 218 to 213 meters.

The late Woodfordian high terrace was the active floodplain beginning around 14,000. It probably remained active until about 11,000 years ago when the Des Moines Lobe retreated north ending glaciation in Iowa. Another episode of entrenchment occurred lowering the valley 2 meters to 211 meters.

This lower surface (intermediate terrace) was the floodplain throughout the early and middle Holocene. While this floodplain was active, the valley experienced considerable climatic change which affected vegetation and, consequently, landscape stability. The change to a more westerly upper atmospheric component produced a dominance of warm dry Pacific derived air masses. The desiccating effects of the warm dry air masses destabilized hillslopes in the valley and mobilized upslope sediments. Valley fill components in the form of alluvial fans were developed along the north half of the valley. On the south margin dunes were destabilized, affected by both slopewash and eolian erosion. In addition, the high Woodfordian terrace was destabilized and subjected to erosion and deposition through surficial reworking and deflation.

The surfaces on the Wisconsin terrace, which retained a thick loess cap such as that documented at trench 4, apparently were more stable throughout the Holocene. All of the other sites studied on this terrace provided evidence of instability. Currently, the reason is not known why some areas on the Wisconsin terrace escaped surface erosion and/or deflation. On the late Woodfordian terrace the surface was repeatedly being mixed by soil fauna, while eolian reworking produced small scale dunes and scoured depressions. The indication is that this terrace has been repeatedly reworked throughout the Holocene.

Whether the floodplain had aggraded during the early and middle Holocene has yet to be confirmed or denied. Farther to the west in Saylorville reservoir, floodplain aggradation was reported, evidenced by paleosols and interfingering between floodplain and fan sediments (Benn and Bettis 1985, Bettis, 1985). With the exception of being buried by fan sediments along the north valley wall, the exposed portions of the intermediate terrace to the south did not reveal any surfaces buried by early or mid Holocene floodplain aggradation.

With an increase in precipitation and deterioration of the persistent zonal circulation pattern, the fluvial response was vertical incision of 2 meters (to 209 meters) and floodplain abandonment. This apparently occurred prior to 4300BP and probably occurred closer to 5000 years ago. The beginning of the late Holocene brought about meridional circulation patterns which favored an increase in the frequency and magnitude of storms and floods. The fluvial response was incision with subsequent active lateral reworking of the valley fill sediments.

The surface of the intermediate terrace meanwhile was periodically destabilized, but probably not to the extent seen on the high terrace. Also during the late Holocene, a period of incision on alluvial fans occurred. After incision, another episode of upland erosion and fan development affected the valley. The apparent destabilization of the intermediate terrace may be chronologically related to the last upland erosion sequence. It is likely that elements of the middle Holocene persisted until after the intermediate terrace was abandoned. Further to the west in central Iowa, a pollen sequence from Pilot Mound shows that prairie elements persisted until about 3200BP (Baker and Kim, 1985).

A small change in climate may have been responsible for initiating another episode of lateral stream erosion and floods, around 2800 years ago. The intermediate terrace was actively being eroded along the south side of the Hawkeye, but many of the north valley components escaped reworking. Occasionally, flood episodes were of sufficient magnitude to reactivate an abandoned paleochannel located on the intermediate terrace depositing laminae of fine sand and silt. Meanwhile, the alluvial fans along the north end of the valley and the dunes and interdunal depressions probably became stabilized by about 3000-4000 years ago.

Around 1500BP alluviation of the valley floor began and progressed until after 500 BP. Meanwhile during this late period, an apparent episode of surficial instability was recorded after 1300 years ago on the late Woodfordian high terrace. Likewise, surface instability probably affected portions of the Wisconsinan and intermediate terrace as well. This geomorphic response probably derived from an overall warming trend between 1000 and 1200 A.D. in Northern Hemisphere (La Marche, 1974).

The late Holocene floodplain consisting of the low terrace probably was not abandoned until the beginning of this century. Historical evidence shows that a more sinuous

stream course apparent before A.D. 1897 had been naturally straightened by 1937. The straightening and incision was probably in response to an increase in the frequency and magnitude of floods associated with historical land use and vegetation changes. As a result, floodplain abandonment and creation of the low terrace probably occurred between 1897 and 1937.

Since historical settlement, erosion and sedimentation processes have been accelerated across the valley. Truncation of the former presettlement surface horizon and deposition from historical alluvium is widespread. On the intermediate and high terraces, much of the former surface A horizon is missing from the profile. This is a result of oxidation and erosion of the formerly organic rich Mollisols which occupy the surface.

More recently, the reservoir impoundment has aggraded the active floodplain to an elevation approximating the low terrace and has created a prominent natural levee composed of PSA adjacent to the current river course. Most of the other surfaces in the valley have sustained a relatively thin layer of PSA. The larger sediment volumes have concentrated in the numerous abandoned channels and depressions found mainly on the low terrace.

THE IOWA RIVER GORGE:

Introduction:

The Iowa river southeast of the Hawkeye Wildlife area is confined to a narrow bedrock gorge. Coralville Dam is located in this reach of the river and has impounded the main valley Holocene aged terraces. A brief study focussed upon the area surrounding the main valley that has experienced recent erosion. This erosion has resulted from anomalous high magnitude precipitation events, when pool levels were at or near capacity for sufficient duration to promote considerable hillslope erosion along the main valley margins.

Erosion and Sedimentation:

A survey was conducted in an area of the main valley where reservoir erosion was pronounced. The purpose of the survey was to accurately delineate the elevations where "slight, moderate and severe" erosion would be expected along the main valley margin. The results of this survey are as follows:

- 1) Floating flood debris was recorded at a maximum elevation of 712.02'. This is the upper limit where the high water effects can be observed.
- 2) SLIGHT EROSION: This occurred just below 712' to 708.15'. Slight erosion of the surface A horizon is seen under this category.
- 3) MODERATE EROSION: This is observed between 708.15' and 704.18'. The duration of impoundment inundation increases resulting in truncation of the A horizon.
- 4) SEVERE EROSION: This occurs below 704.18' and is marked by a prominent scarp. Erosion into subsurface horizons and parent material(s) are observed. Tree roots are undercut and exposed.

Additional evidence from archaeological sites along the main valley margin show considerable erosion of the solum and parent materials. This was particularly evident at 13JH482 and 13JH492 where erosion into pre-Illinoian deposits and bedrock were observed (Overstreet et al., 1985: 68-70).

Sedimentation in the Iowa River gorge margin has in many cases been a post erosional process. In other words, as impoundment levels rise, sediments along the margin are eroded and slump into the pool. As impoundment levels subside, sediments eroded from farther upslope are deposited downslope as laminae often overlying truncated Pleistocene sediments.

Associated with high reservoir levels is attenuation of easily erodible silty surficial sediments through wave action, particularly in the main Iowa River gorge valley. This action tends to dislodge and liquify valley sideslope sediments which facilitates downslope transport. Unlike the main valley, erosion and sedimentation processes in the tributaries have generally been less severe.

RIDGEWOOD CEMETERY TRANSECTS:

This small 4th order tributary to the Iowa river drains both the Iowan and pre-Illinoian surfaces (Fig. 16), and is located in the Iowa river gorge. Reservoir erosion and sedimentation has had a localized impact upon this tributary valley, especially in the study area. The relatively minor reservoir impact is one reason for choosing this site for study. Another reason is that this site is more remote and has apparently experienced less historical disturbance compared to the other gorge tributaries. The 1937 air photos show that much of the tributary was not cultivated and has remained in either pasture or woodland. This is probably due to the relative inaccessibility of the site and steep side slopes which were probably not suitable for cultivation. Today, the watershed is populated by a mature stand of oak/hickory, while the interfluvium is primarily in pasture.

The headwater reach is located on the Iowan surface, while below the more dissected pre-Illinoian landscape is drained. Upvalley from transect 1, the drainage area of the tributary is approximately 1/2 sq. mile, and the local relief is about 150' (Fig. 17). Base flow discharge along transect 1 is hardly measurable and is estimated at a small fraction of 1.0 cfs. Base flow channel width is 0.9 meters while depth in the thalweg is 0.05 meters. Baseflow discharge nearly ceased during the early summer drought of 1985, but by the end of August ground water recharge was sufficient to increase discharge. The channel along this reach is sinuous and is generally of suspended to mixed load composition.

In contrast, upvalley from transect 1 but below the Iowan drainage, the channel is confined to a narrow steep sided bedrock controlled valley about 30 - 40 meters wide. Contained in the valley are limestone benches overlain by alluvial, colluvial and slope wash sediments. The present channel has incised into bedrock or is actively cutting alluvial fills, particularly in the vicinity of transects 2 and 3. About 50 meters upstream from transect 3 an apparently young alluvial fan is actively being cut. Thin weakly developed Alfisols or Inceptisols have developed in the sediments overlying the benches with depth to bedrock generally 1 meter or less.

Below transect 2 and near transect 1, the valley abruptly widens, increasing to about 85 meters. Alluvial fills of considerable age and unknown depth are observed in this reach of the valley. Hence, the basin morphology significantly changes in this reach of the valley along with the longitudinal stream profile. Stream and valley gradient significantly drop in this reach. As a result, this lower reach promotes short term (Holocene time scale) net storage of sediments while upstream where the valley constricts, net erosion of sediments has occurred. Therefore, the lower reach is characterized by multiple geomorphic fill components which include alluvial point bar sequences, flood laminae, vertical accretion deposits, slope wash laminae, and

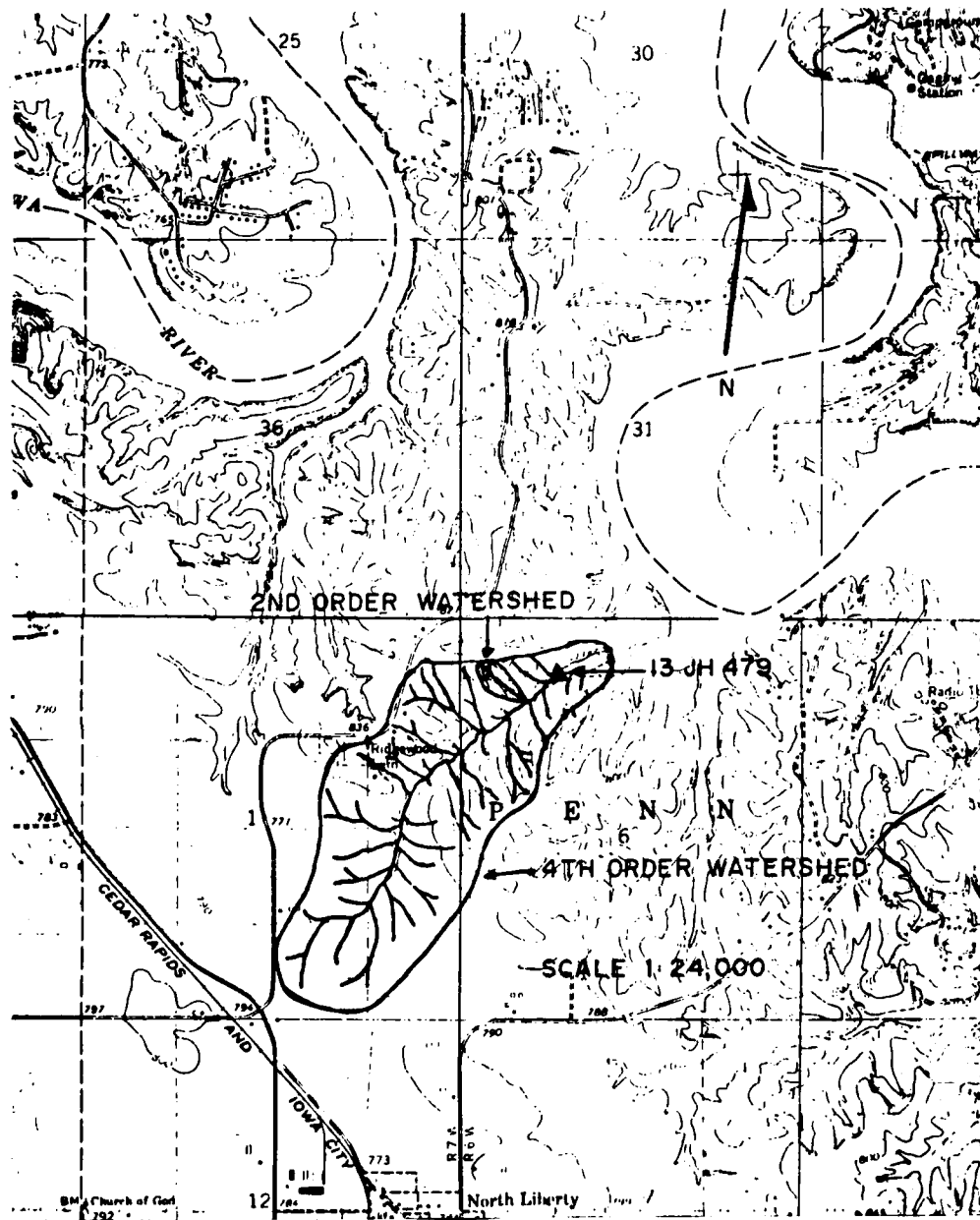
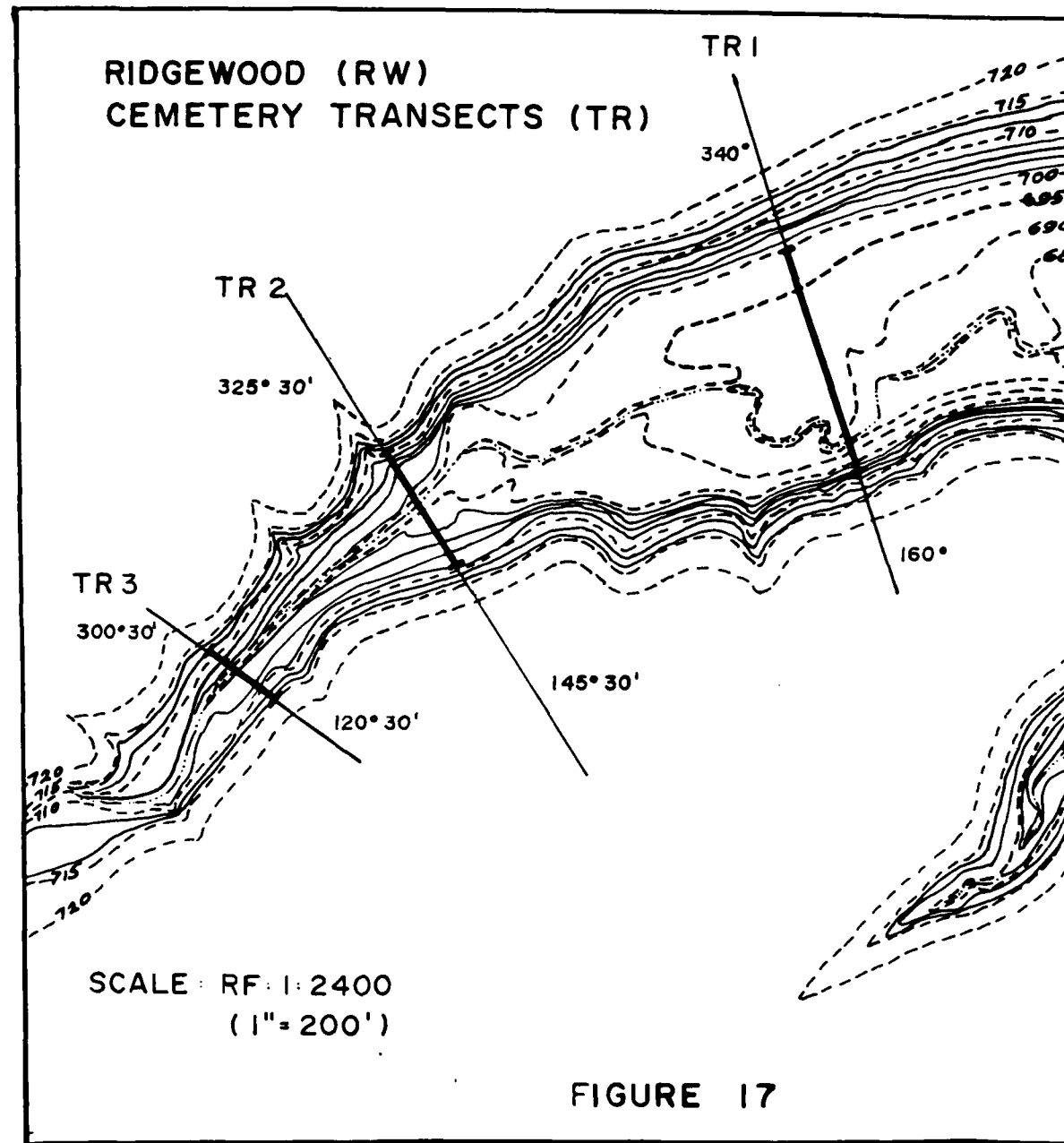
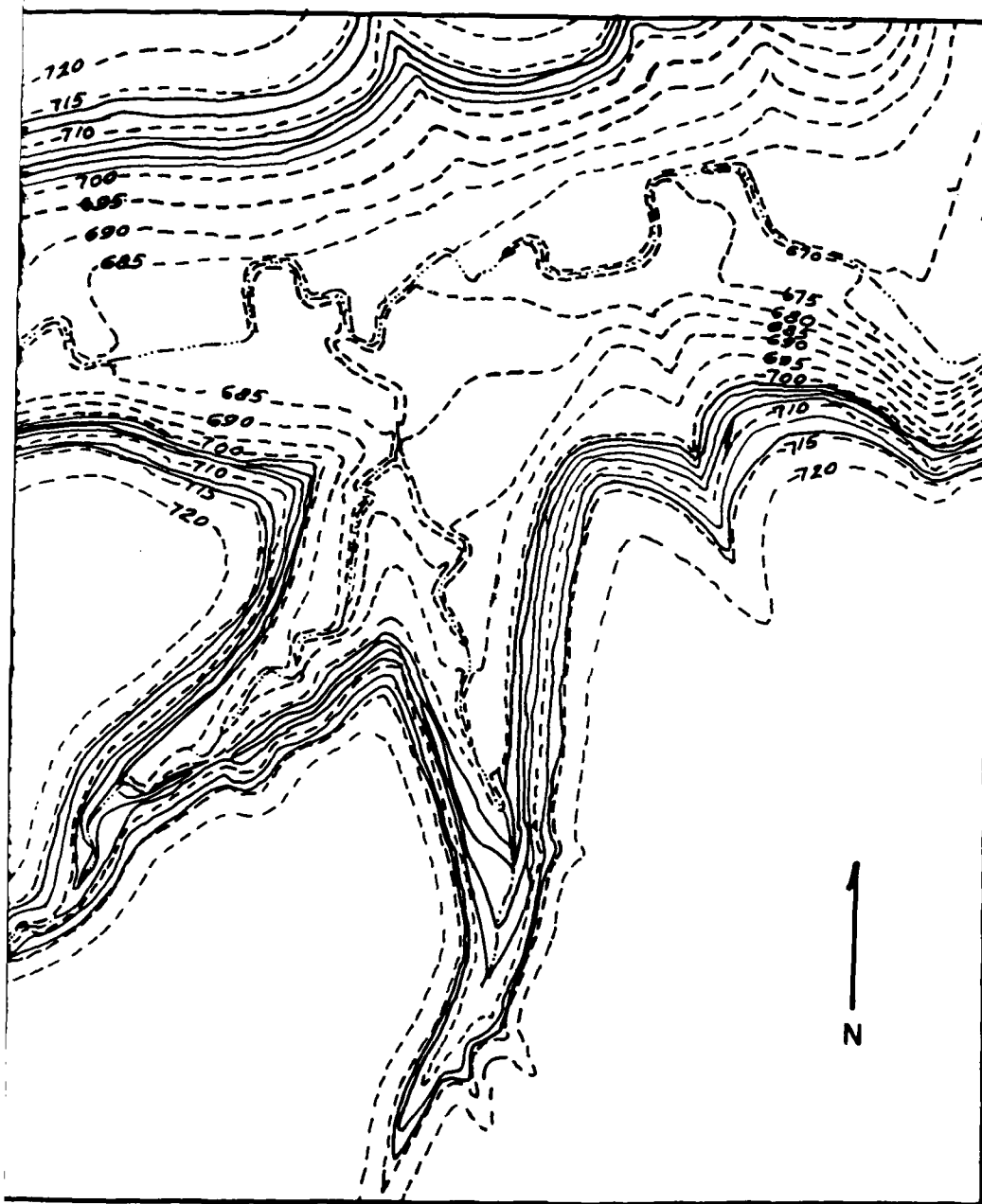


FIGURE 16: Fourth order watershed containing Ridgewood cemetery transects 1, 2, and 3 (the watershed drains Iowan and pre-Illinoian provinces).





colluvium. In addition, evidence of periodic sediment flushing is observed in the alluvial record.

Transect 1:

This transect which crosses the downstream reach of the tributary valley, exposes a very complicated geomorphic history (Fig. 18). The basal valley fill component is characterized by a primarily mass wasted unleached Farmdalian or earlier deposit. A radiocarbon date of 28,590+-700BP, was recorded from this unit. This poorly sorted gleyed unit comprises the basal component traced along the valley floor and underlies much younger valley fill material. Along the valley margin it grades into an oxidized or deoxidized cobbly colluvium.

It is unknown when incision of the basal Farmdalian component occurred or even how many episodes of incision took place. However, it is suspected that major erosion occurred in the tributary, probably in response to the final stages of glaciation in Iowa. Major incision into the fill deposits likely occurred during the late Woodfordian in response to a lowered base level both upstream and downstream in the main Iowa river valley.

Upstream, floodplain abandonment and incision produced the late Woodfordian high terrace. Downstream in the lower Iowa River valley, recent work has demonstrated that terrace development presumably occurred (Roosa et al., 1984). The product of these fluvial events is the lowering of local base levels associated with the trunk stream and initiation of headward tributary degradation (Leopold and Bull, 1979).

It is thought that after this episode of late Woodfordian erosion, valley fill sediments probably began to accumulate. The earliest Holocene deposits are found along the north valley wall. This is a lateral accretion deposit found at sites 5 and 6 immediately overlying the much older Farmdalian valley fill. The age of this deposit is unknown, however, it is older than the radiocarbon date of 5140BP seen from a sample at site 5. The point bar deposit is probably a middle or early late Holocene unit.

Additional evidence in support of this interpretation is the alluvial flood laminae directly overlying the point bar, particularly at site 6. The point bar grades into laminae that are well represented at site 6 and comprise a unit approximately 2 meters thick. At site 5 the laminae are also observed. But unlike site 6, they have been truncated by an episode of late Holocene lateral erosion presumably around 4000 years ago. Comparing the reworked silt units seen at sites 5 and 6, pedogenic development has progressed further at site 6. This is demonstrated in the textural evidence which shows stronger subsurface B horizon development at site 6 in comparison to site 5.

The morphologic characteristics of this unit composed of the flood laminae are considerably different than the younger late Holocene mixed lateral and vertical accretion deposits. Abrupt textural contacts of silt, fine and medium sand characterize this laminated deposit. This is in

RIDGEWOOD CEMETERY (RW)

TRANSECT #1 CROSS SECTION

SOUTH

NORTH

ELEVATION IN METERS

DISTANCE IN METERS

VE = 4.0X

FIGURE 18

FIGURE 18

contrast to the lateral accretion point bar deposits which illustrate a characteristic fining upward sequence beginning with coarse cobbles and gravels at the base and grading upward through finer particle size fractions.

A different set of environmental parameters were probably responsible for the development of the laminated overbank deposits. These high magnitude flood events may be in response to mid Holocene convective storms. The preferred zonal circulation patterns during the mid-Holocene may have produced large floods in the tributaries (Knox, et al., 1981). The desiccating effects of long term drought likely reduced vegetation to the point where surface runoff significantly increased. As a result, during intense convective storms flash flooding conditions probably occurred. High sediment concentrations mobilized from higher in the basin would be attenuated as valley width rapidly increased downstream. This would result in reduced stream competency and sediment deposition.

In a similar manner, the laminae may have been deposited as climatic patterns first began to change favoring a more meridional component. This transition probably occurred around 6000BP and may have produced a lag in the response by vegetation to the increased precipitation associated with meridional air mass circulation. In either case, these events predate the 5140BP radiocarbon date.

The flood laminae were buried by oxidized slopewash silt with a few random erratic well rounded pebbles, and apparently burial occurred quickly since pedogenic development in the laminated unit did not occur. However, at the contact between the upper reworked silt and lower alluvial laminae, some charcoal flecks were observed at site 6. Charcoal flecks were again observed closer to the contemporary surface at 34cm.

The drier mid Holocene conditions may have increased the frequency of forest fires, therefore thinning vegetation and accelerating hillslope sediment yield (McDowell, 1983). In addition, the presumably dry summers likely terminated base flow discharge along this reach of the valley. Erosion of the steep valley side slopes during convection storms was probably responsible for the downslope reworking and subsequent footslope deposition seen in the profile at site 6.

Incision into the reworked hillslope and alluvial components along the north valley margin occurred around 4000BP based upon the radiocarbon date seen at site 5. Incision may have been produced by an increase in vegetal density which reduced hillslope erosion and lowered sediment concentration in proportion to discharge (Huntington, 1914). In contrast, main Iowa River valley incision that occurred in the Hawkeye around 4500BP may have lowered base levels and initiated entrenchment in the tributaries. Base level changes affecting the stability of channel systems have their greatest impact after geomorphic thresholds have been exceeded, and often result from climatic change (Knox, 1975). It is thought that degradation in the main valley caused lower local base levels and promoted upvalley

entrenchment in the tributaries, because hillslope erosion continued after 4000BP.

This episode of lateral erosion reworked the valley which was subsequently buried by additional hillslope sediments. The date of 5140BP on top of the vertical accretion deposits probably represents reworked organic materials from upslope. After this episode of lateral reworking of the north valley wall, the channel migrated further to the south margin for the remainder of the Holocene. Apparently after about 4000 years ago the channel abandoned the north end of the valley. After abandonment, this portion of the floodplain apparently began to fill with additional hillslope sediments.

Along the south end of the valley, the profile at site 1.3 shows an older lateral accretion unit which probably corresponds to the episode of lateral reworking around 4000BP. The overlying colluvial materials presumably became unstable and entered the floodplain after lateral reworking. Soil development in the colluvium is relatively weak. Later, another episode of lateral erosion reworked the valley truncating the older colluvial and alluvial material inset at site 1.3. Valley alluviation in the form of floodplain aggradation continued along the south end of the valley while along the north end reworking of upslope surficial sediments progressively filled the valley. From the evidence provided by soil profile development, stabilization along the north end has probably occurred for at least a few thousand years.

Within the last 2000 years floodplain construction progressed which is particularly evident along the south valley margin and is supported by the radiocarbon dates recovered from site 2. However, difficulty exists in explaining this series of radiocarbon dates seen at this site. The date which appears to be younger overlies the much older colluvium but is subjacent to an older flood deposit containing wood. The overlying wood was dated at 1950BP+-120 while below, the date in organic enriched point bar deposits was 1350BP+-60BP. The wood was part of a major flood episode and was in association with numerous other approximately 3cm thick pieces of decomposing wood and sand. It would be difficult to imagine a quantity of wood this large stored up valley in a point bar deposit for hundreds of years. The alternative is that the organic material comprising the lower younger date has been contaminated from more contemporaneous organic materials.

More recently, floodplain abandonment and vertical incision occurred which is evidenced in the profile at site 4. This is likely an early historical event. However, currently floodplain aggradation is progressing. While this can be seen at sites 4 and 3 (not shown in the cross section), additional observations have shown that the historical deposits are concentrated near the current channel. Site 3, located in the active floodplain, was found to contain over 1 meter of PSA. This recent episode of historical aggradation is probably in response to a raised base level associated with Iowa river impoundment.

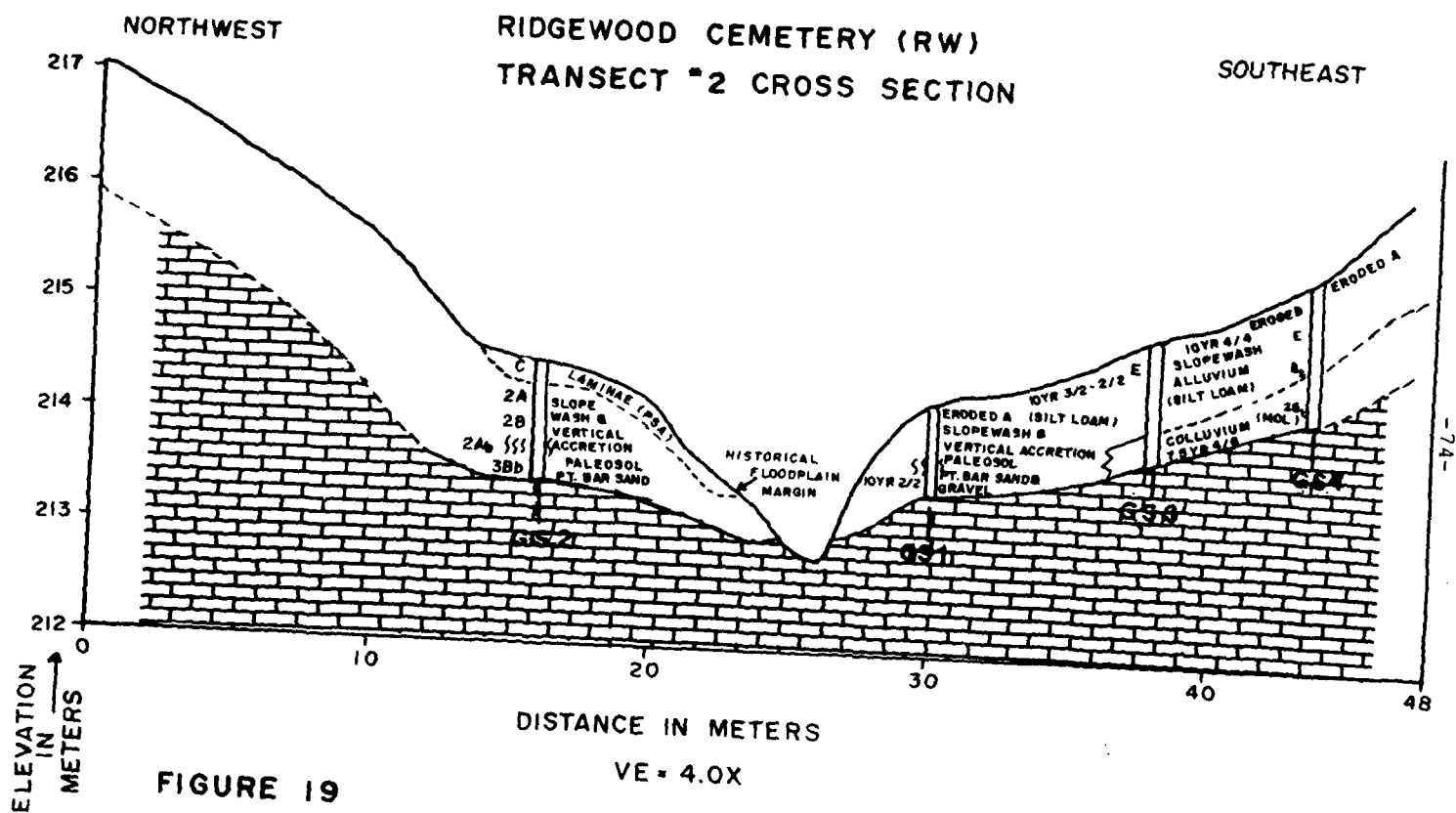
Transects 2 and 3:

Transects 2 and 3 are located upvalley from transect 1 in a narrow reach of the tributary valley (Figs. 19&20). The valley constricts along this portion of the watershed and is characterized by thin silty soils which overly bedrock. In the narrow valley limestone benches are covered by a mixture of slopewash and channel alluvium. Along the valley margin colluvial materials are found. Apparently, this reach of the valley is characterized by net sediment erosion. Sediments are frequently scoured from this portion of the watershed after relatively short term storage.

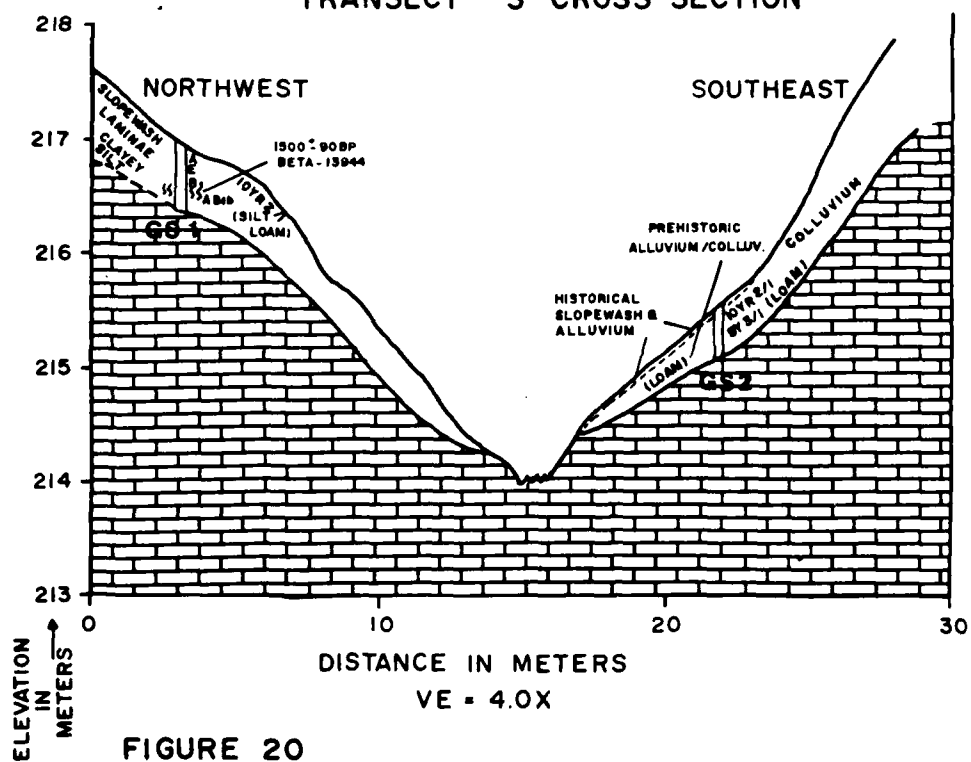
Considerable evidence supports this contention. Valley width is sharply less than what can be observed immediately downstream. The narrow constriction identified in this reach is also in association with a steep valley gradient. Limestone benches which are relict erosional remnants were developed during periods of incision and are mantled by thin somewhat poorly developed soil profiles. A radiocarbon date from a sample taken near the base of the slopewash unit immediately overlying bedrock is 1500 BP. Gullying is observed in the second order tributaries which enter the valley, while the current channel along both transects has incised to bedrock.

Transect 2 shows soil profiles which overlay limestone benches. These profiles are developed in a combination of alluvial stream deposits and slopewash alluvium. Overlying the bench at sites 1 and 2, is a coarse channel lag with a thin cap of finer grained vertical accretion deposits. These deposits are organic enriched and may represent a brief period of stability. Slopewash sediments have buried the organic component. At site 2 a thin unit of historical flood deposits mantles the surface burying the presettlement A horizon, while at sites 1, 3, and 4, erosion of the A horizon has occurred. At site 4 very weak argillans were observed which suggests that at this footslope subsurface stability may represent a few thousand years. However, the remainder of the profiles reflected a lesser degree of soil development.

Valley width continues to constrict upvalley which is indicated by transect 3. Like transect 2, the channel has incised to bedrock. But the unlithified sediments overlying limestone are thinner in this reach. Depth to bedrock is less than 60cm. At site 1 the soil profile shows a significant drop in pH in the eluvial horizon and a few argillans were observed in the subjacent B horizon. Near the base of the profile a radiocarbon date of 1500BP was recorded. It is unclear if this really represents a buried soil. Although, the date indicates that prior to 1500 years ago the valley had probably experienced an episode of scour. Unlike site 1, the profile at site 2 is considerably less pedogenically developed and may represent only a few hundred years of stability.



RIDGEWOOD CEMETERY (RW)
TRANSECT "3" CROSS SECTION



Summary:

The apparent effects of basin morphology are evident in the erosional and depositional history of the Ridgewood Cemetery tributary. After Pleistocene mass wasting conditions filled the lower reach of the valley, organic matter production began during the Farmdalian. At least one, and probably several, episodes of valley incision likely characterized the Woodfordian. It is thought that the lower reach of the tributary seen along transect 1 was closely affected by the events occurring immediately downstream in the Iowa River. Due to impoundment, correlation with terrace components in the Iowa River gorge is not possible. Late Woodfordian entrenchment which is observed in the Hawkeye likely occurred in the gorge, and was probably responsible for lowering local base levels and initiating a tributary response of degradation. However, as climate became considerably warmer and drier when circulation patterns changed toward a more westerly component, hillslope erosion, fire, and flash flooding appear to have filled the lower tributary valley.

As the mid-Holocene came to an end, the increased precipitation initiated an episode of entrenchment which was documented in the Hawkeye and likely produced a similar response in the tributaries. Lateral reworking evacuated a considerable portion of the fill in the lower tributary valley.

Later, within the last two thousand years, an episode of scour, possibly initiated by a major fire, mobilized sediments out of the upper tributary reach for deposition downvalley. This is evidenced by the upvalley radiocarbon date of 1500BP which overlies bedrock, and downvalley by the apparently large flood episode which included considerable wood debris dated at 1900 years ago. At least a portion of the upvalley hillslopes have been relatively stable during the last several hundred years. Downvalley, a very late episode of erosion, probably historical, has reworked a small portion of the valley. More recently, the impoundment has promoted aggradation of the historical floodplain.

MAN-LANDSCAPE CORRELATIONS:

Introduction:

Investigations of the surficial geology of Coralville Lake project areas, supplemented by laboratory analyses, have yielded a model of landscape evolution. This model identifies various landscape units or clusters, presents a discussion of the geological and geomorphic processes to which the landforms owe their genesis and morphology, and provides, through radiocarbon assay and indirect means, a regional chronology. In turn, the model of landscape evolution is employed to develop a working model of archaeological site distributions. The focus is placed on where we can expect to encounter archaeological sites, what ages or cultures are predictably represented, and, the contexts in which archaeological remains can reasonably be expected to be found. Further interpretation is based on integration of the landscape model with what we already have learned from various survey and excavation endeavors at Coralville Lake. The application of the predictive-interpretive model is to enhance management of Coralville Lake cultural resources. At this juncture we are confident that the efforts reflected in the seven volume study: "The Archaeology of Coralville Lake" provide many significant improvements for management. More importantly, the data base, as it now exists, will be a useful guide to more focused and more effective investigations for purposes of both management and research in the future.

The landscape model encompasses eleven specific units. These include: (1) the contemporary floodplain of the Iowa River; (2) the late Holocene low terrace; (3) the early and mid-Holocene intermediate terrace; (4) the late Woodfordian high terrace; (5) the mid-Woodfordian Wisconsinan terrace; (6) the dissected uplands composed of pre-Illinoian and Iowan surfaces; (7) alluvial fans; (8) dunes and dune fields; (9) colluvial footslopes; (10) secondary/tertiary drainage systems; and (11) the Iowa River gorge.

Correlations of these eleven units with so-called "archaeological potential" are provided in the following narrative. In some instances the correlations are comprehensive, while in others, owing to limitations either in the geomorphic and/or archaeological data bases, are quite limited. In any event, by no means is the following presentation to be viewed as a static tool. The predictions are based on current knowledge. Thus, we can expect, without reservation, to be in error in certain instances. Further, the model is theoretical and hypothetical. To be accepted, revised, rejected, or modified in other ways will of course be dependent on the rigor with which future tests area applied.

The Iowa River floodplain:

As indicated in an earlier discussion in this report, the Iowa River floodplain is defined as the recognizable

remnants of recent river courses. This would include such features as chutes, cutoffs, abandoned channels, and depressions located mainly on the low terrace. In addition, these features are characterized by annual inundation. Currently, these elements of the floodplain are rapidly aggrading and thick units of post-settlement alluvium have been recorded in such features. Given their very recent development, those units designated as "F" in Figure 1 and in the CADD Atlas (Volume VI) have very low archaeological potential.

The Late Holocene Low Terrace:

In Volume I (Overstreet 1986: 69-70) it was noted that archaeological components that could be associated with historic Indian and/or EuroAmerican occupation were grossly underrepresented in the Coralville Lake site sample. Geomorphic investigations in the late Holocene low terrace provide a possible resolution of this cultural void.

The low terrace was subjected to two late Holocene episodes of reworking. The first of these was initiated about 4500 BP shortly after intermediate terrace abandonment. The second episode occurred about 2800 BP. With the latter episode, activity was focused along the southern margin of the valley. Further, the channel pattern of the Iowa River has been altered as a response to historic land-use patterns. Prior to 1937, but sometime after 1897, the Iowa River manifested a channel pattern significantly more sinuous than at present. Increase in the frequency and magnitude of floods fostered channel straightening leaving a series of ox-bow lakes and meander scars. Finally, these low terrace features have served as sediment traps with significant accumulations of post-settlement alluvium. Anderson has noted his investigations reveal a natural levee along the current course of the Iowa River along outside meanders composed of up to 1.50 meters of PSA.

Taken together, these phenomena are useful for evaluating the potential for encountering archaeological sites which may be buried on the low terrace. In various localities there is evidence of stable presettlement surfaces, now buried by the variable mantle of PSA, that have escaped destruction by lateral channel migration. We suspect that older remnants (those as old as 4300 BP) cluster on the north valley margin and may be buried by alluvial fans, while younger remnants of once stable landscapes (ca. 2800 BP) are concentrated on the south margin of the valley.

The question remains as to whether this alluvial unit was occupied by historic or prehistoric occupants because no vestiges or remains are known to exist. Benn has noted the very limited number of low terrace sites (1) at Saylorville reservoir (1985: 107). This is at least partially due to the relatively young (750 BP) age of the surface. However, it is interesting to note that the single recorded occurrence is an historic component. It is also conceivable that localities on the low terrace may have been utilized as

seasonal resource extraction camps by Iowa River valley Late Woodland residents. We would expect such sites to occur if other regional reconstructions of Late Woodland settlement-subsistence patterns apply to the Coralville Lake locality.

One way this problem could be resolved would be to conduct biased survey of shoreline exposures during low-water periods in the reservoir. Shellfish collection and processing stations and/or other seasonal functionally specific encampments (e.g., fishing camps or waterfowling stations) should be readily revealed in cut-bank exposures. Until such biased surveys are implemented we are left with the uncomfortable assumption that late prehistoric populations did not utilize the low terrace and that historic period settlements are absent in this reach of the Iowa River.

The Early and Middle Holocene Intermediate Terrace:

The intermediate terrace at Coralville Lake is designated on Figure 4 and on the CADD atlas by the symbol: "IT." The terrace was active sometime prior to 10,900 BP and was abandoned prior to 4300 BP. The radiocarbon chronology thus indicates that early-middle Holocene settlements, ranging from Paleo-Indian times through Middle Archaic, as well as subsequent cultural evidence, could be expected to be encountered on the intermediate terrace. While this chronology is a very positive note, optimism for encountering intact archaeological sites is limited. Extensive archaeological survey and geomorphic investigations on/in this landform has served to identify significant reworking of the surface of the terrace. As a result, most archaeological sites are badly disturbed. The available evidence indicates many episodes of eolian scour. Some of these episodes clearly were stimulated by climatic events during the early-middle Holocene, and, the distress was exacerbated by intensive agricultural practices of the 20th century. Virtually all of the archaeological sites recorded and investigated during this study can be characterized as lag deposits on deflated surfaces.

However, particularly in the north margins of the Hawkeye Wildlife Area, several localities have been delineated where alluvial fans have buried the intermediate terrace and associated paleosols. These localities are considered to be extremely high potential for encountering preserved landscapes and associated archaeological sites. Of additional considerable significance is the age of the buried landscapes established by radiocarbon assay which indicates the probability for encountering Paleo-Indian through Middle Archaic components.

Of additional potential significance for both archaeological and paleo-climate reconstruction are the small intermediate terrace outliers that are situated in close proximity to the contemporary channel of the Iowa River. While these areas have not yet been subjected to testing, their proximity to the river and analysis of

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THE ARCHAEOLOGY OF CORALVILLE LAKE IOWA VOLUME 2

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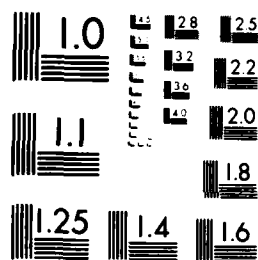
EVOLUTION OF HOLOCENE LA. (U) GREAT LAKES

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historical records holds forth the prospect that portions of these outlier landforms have not been degraded by recent agricultural practices. This means that two important potentials can be evaluated. First, these landforms may contain undisturbed prehistoric sites. Second, assuming that they have not been cultivated, intermediate terrace outliers can serve as a baseline to measure the effects of Holocene landscape degradation in contrast to destruction associated with historic agricultural practices.

In summary, the early and middle Holocene intermediate terrace likely contains the greatest concentration of prehistoric archaeological sites at Coralville Lake. However, future investigations on the intermediate terrace should be biased to localities that have been protected (i.e., alluvial fans) by burial, or, that have escaped the characteristic deflation on the terrace (i.e., terrace outliers).

The Late Woodfordian High Terrace:

This terrace was abandoned with renewed down-cutting of the Iowa River sometime after 14,000 BP. The surface of this unit, illustrated in Figure 4 and the CADD Atlas by the symbol "HT," consists for the most part of reworked silty sand. Many archaeological sites have been recorded on the high terrace, particularly at or near the scarp that serves to differentiate the high and intermediate terraces. None of the sites thus far recorded and investigated as a result of the current investigations can be demonstrated to contain intact archaeological deposits. The destruction of stratigraphic records on the high terrace derive in part from climatic events during the Holocene and to an unknown degree from 19th and 20th century agricultural practices.

It should be noted that several small dune-like features may cap buried surfaces. In turn, these surfaces could incorporate archaeological materials of considerable age. Unfortunately, we are unable to precisely document the chronology of these landforms. However, based on limited stratigraphic and radiocarbon evidence we assume that these features appeared on the landscape between 16,000 and 10,000 years BP.

The Wisconsinan Terrace:

Delineated on Figure 4 and on the CADD maps by the symbol "W," the Wisconsinan terrace is of Mid-Woodfordian Age. Virtually all archaeological sites known on the Wisconsinan terrace have been identified as lag deposits on or near the present surface. Sub-surface materials have been translocated as a by-product ofolian reworking of surface materials. The areas of deposition identified on the Wisconsinan terrace include inter-dune depressions. At these locations, clustered in the east one-half of the south margin of the Hawkeye Wildlife Area, potentials for encountering buried surfaces for various times during the Holocene are high. It has not been determined, however, if

these localities were occupied or utilized by the residents of this reach of the Iowa river Valley. Thus, prior to disturbance or destruction of localities associated with inter-dune depressions, field investigations should be conducted to determine the presence or absence of archaeological materials within the depressions.

Dissected Uplands:

Site densities, as one would expect, are low in the dissected uplands along the northern valley margin. These surfaces are the oldest identified at Coralville Lake and consist either of pre-Illinoian or Iowan landscapes. For the most part, any archaeological deposits would be encountered at or near the surface. Added to this factor, the practices of land clearing and cultivation, followed by erosion, has effectively served to destroy the context of archaeological sites situated on this landscape.

Alluvial Fans:

Alluvial fans, depicted by the symbol "AF" on Figure 4 and on the CADD Atlas maps undoubtedly have the highest potential for harboring intact archaeological deposits at Coralville Lake. These features are clustered along the northern valley wall and incorporate numerous paleosols within their matrix. Fans of both low and steep angles mask once-stable surfaces that have been dated by radiocarbon assay to as early as 10,090 years BP. Thus, the greatest opportunity to provide a comprehensive cultural history, a necessary component for interpretation now lacking, for Coralville Lake can be found in further investigation of these features.

Colluvial Footslopes:

These landscape features at Coralville Lake appear to be associated with mass-wasting episodes of considerable antiquity. From radiocarbon assay at Coralville Lake, correlated with similar occurrences in other regions, we suspect that steep slope mass wasting occurred approximately 20,000 years ago. Colluvial footslopes are considered, for purposes of cultural resources identification and management, to have very low potentials.

The Iowa River Gorge:

The number of archaeological sites identified at Coralville Lake from within the river gorge is inordinately high. Simply stated, this is a biased sample associated with ease of discovery. Shoreline collections of erosional surfaces have yielded large numbers of cultural materials and has resulted in the identification of many sites. Unfortunately, the sites investigated have been demonstrated to represent lag deposits, in several cases were likely redeposited, and possess very significant research

limitations. In a previous narrative, and, as illustrated on the CADD Atlas, relative degrees of erosion are correlated with specific elevation brackets. It is unlikely that we will ever be able to reconstruct site functions and types from the river gorge sites. Finally, an important consideration to keep in mind is that post-erosion sediments are now being deposited atop archaeological materials, many of which had their origins upslope from their present position. The gorge, like colluvial footslopes, represent an area of low archaeological research potential. A notable exception to this generalization may be at the confluence of tributary drainages within the gorge. These localities have not been sufficiently investigated to provide generalizations regarding site preservation disturbance.

Tributary Valleys:

A single tributary valley (the fourth order drainage near Ridgewood Cemetery) has been subjected to combined archaeological and geomorphic investigations. It has not been demonstrated to be representative of other tributary valleys, however, some generalizations can be made. First, valley heads are characterized by severe erosion. Sediments have been transported down-valley and deposited where changes in stream gradient and widening of the valley floor occur. This of course varies from one instance to the next and the conformation and morphology of each valley must be considered for its own unique characteristics. However, we believe that, within certain broad limits, middle and lower reaches of tributary valleys contain buried surfaces of significant age. These localities are considered to have moderate to high potential for archaeological research. Up-valley benches where a very thin mantle of earth covers the bedrock have much less potential. However, the presence of rockshelters, several of which have been identified at Coralville Lake, undoubtedly can be found in the tributary valleys.

Summary and Conclusions:

Presently no archaeological sites recorded at Coralville Reservoir can be demonstrated to be eligible for The National Register of Historic Places. The analyses of landscapes and site distributions provides convincing evidence that such significant sites do, in fact, exist. Future investigations, by focusing on landscape positions where disturbance has been minimal or where sediments have been deposited on older surfaces, will be much more efficient in identifying, evaluating, preserving, and interpreting the cultural resources of the Coralville Lake project locality.

CONCLUSIONS AND RECOMMENDATIONS:

The landscape surrounding Coralville Reservoir reflects an assemblage of landforms which have evolved from erosional and depositional events occurring throughout the Quaternary. This diversity of natural landscapes has essentially been produced by fluvial, eolian and gravitational processes of varying intensities. Episodes of landscape stability are evidenced by soil profile development, whereas geomorphic events are evidenced by terrace formation, valley fill components, dunes and fan development and infer instability.

It is believed that in the Hawkeye Wildlife Area and in the Iowa River gorge, events during the Wisconsin and Holocene have had a profound impact upon landscape development. The periglacial climate characterizing a considerable portion of the Wisconsin produced mass wasting conditions in both the main valley and the tributaries prior to 28,000 years ago. Evidence of this earlier Wisconsin episode can only be observed along the northern valley wall of the Hawkeye and in some of the relatively wide tributary valley fills. Apparently, major erosion occurred during the Wisconsin and particularly during the Woodfordian. Major deep valley incision during the Wisconsin has also been reported in nearby northeastern Iowa (Hallberg *et al.*, 1984)

Evidence suggests that between increments of loess fall during the Woodfordian, dune development occurred along the southern margin of the Hawkeye. Dune development may have occurred while the Iowan surface was being cut, and later during the Holocene. However, additional stratigraphic and field studies, combined with further radiometric dating, are required to develop a more accurate chronology on this extremely complex Wisconsin terrace.

After loess deposition ceased, major valley incision occurred in the Hawkeye and probably produced headward erosion into the tributaries. Another episode of valley incision occurred around 11,000BP. The causes behind this episode of valley incision are unclear, but may be related to glacial events farther up in the Iowa system or downstream associated with terrace development in the lower Iowa River valley. Further directed work should address these questions.

The intermediate terrace was active floodplain throughout the early and mid-Holocene. During this period, hillslope erosion has been documented on the dunes and in the tributaries. Alluvial fan development was also active along the north end of the Hawkeye. However, unlike what was reported to the west in the Des Moines River Bettis (1985), no evidence has been recovered supporting floodplain aggradation on the intermediate terrace. Additional stratigraphic studies, including deep coring along the north end of the Hawkeye, are recommended where intermediate terrace and fan components are buried. Research in these areas may recover preserved archaeological sites, as well as produce evidence confirming or refuting floodplain aggradation.

As upper atmospheric circulation shifted from a persistent zonal to a prevailing meridional pattern, the fluvial response was floodplain abandonment and rapid lateral reworking around 3800 to 4500BP in the Hawkeye. Somewhat later, around 4000BP, lateral reworking advanced in the tributaries evacuating sediments from the lower reaches. However, elements of the mid-Holocene persisted into the late Holocene evidenced by continued alluvial fan development in the Hawkeye, and hillslope erosion in the tributaries.

During the last 3000 years, another episode of lateral stream migration and floods occurred in the Hawkeye, although it appears that the low terrace along the north valley wall escaped this more recent event. After 2000 years ago, floodplain aggradation occurred in the main valley burying earlier low terrace components. In the tributary, the upstream reaches were apparently scoured while flood deposits were recognized downstream. The abundance of wood, organic flood debris and sand observed in this tributary terrace suggests that a large fire may have been the event that destabilized this valley.

Other evidence for destabilization was recovered in the Hawkeye particularly on the two highest terraces. Sometime after 1330 BP an episode of eolian reworking occurred and was probably associated with large scale warming around 1100-1300 A.D. The warming may have reduced vegetation cover sufficiently to produce surficial instability.

More recently, the results of historical settlement and associated land use practices has increased the frequency and magnitude of floods in the main valley. The fluvial response has been channel straightening and meander cut off in the Hawkeye, while in the tributary, channel entrenchment has occurred.

Since historical occupation, alluvial sediments have begun to fill the numerous cut offs and meander scars located in the Hawkeye. However, the impoundment has accelerated this process evidenced by large volumes of PSA concentrated in the depressions on the low terrace. In addition, a natural levee abutting the main rivercourse is composed of about 1.5 meters of the historical deposit. These large concentrations of PSA appear highly localized, with many areas in the Hawkeye capped by relatively minor amounts. Meanwhile, in the tributary, the raised base level caused by impoundment has produced aggradation in the lower tributary floodplains.

This study has attempted to produce a comprehensive landscape model based on empirical field and laboratory evidence. Typically, field and lab investigations produce more questions than answers. The model of landscape evolution presented here represents considerable refinement. At the same time, many of the hypothesis stated herein will be verified or rejected only through future studies.

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APPENDIX A
SCOPE OF WORK

PART I - Section C, Description/Specification

I. PURPOSE

1.1 The purpose of this scope of work is to obtain an intensive geomorphological/stratigraphic study of the Coralville Lake Project, Iowa. The objective of this investigation will be to construct a model of landscape development from the Late Wisconsinan (approximately 12,000 B.P.) to present, emphasizing Holocene (10,500 B.P. to present) stratigraphy and fluvial history. The required landscape model should consist of a detailed chronology of the evolution of the Iowa River Valley in the Coralville Lake locality and adjoining tributary valleys. The investigation should be sufficiently detailed to 1) describe and map the magnitude of landform development during discrete time intervals and 2) allow for correlations of deposits of similar age and origin between locations of detailed investigations, including that portion of the area within the permanent/conservation pool which is presently inaccessible. The results of this study will be articulated with the Overview/Management Plan for Cultural Resources at Coralville Lake prepared by archeologists working under a separate contract.

1.2 This action is in accordance with the National Historic Preservation Act of 1966 (as amended), Executive Order 11593, the Archaeological and Historic Preservation Act of 1974, and Title 36 of the Code of Federal Regulations (Parts 60-66 and 800, as appropriate). Additional references include the guideline entitled Treatment of Archeological Properties (Advisory Council on Historic Preservation 1980) and guidelines recently set forth by the National Park Service, Department of the Interior (Federal Register Vol. 48, No. 190, Thursday, September 29, 1983) entitled Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines.

II. BACKGROUND

2.1 The land acquired for the Coralville Lake project comprises a total of 33,685 acres. A total of 16,478 acres of fee land is outgranted, 13,600 of that for wildlife management. The Rock Island District, Corps of Engineers, is responsible for cultural resource management for the 33,685 acres, albeit some of this land is permanently inundated under the conservation pool.

2.2 There are 198 recorded archeological sites on Federal land at Coralville Lake. Of that total, 66 presently have assigned cultural affiliations, leaving 132 of indeterminate temporal classification. Approximately 50 percent of the 66 sites are multicomponent.

2.3 Prospective Offerors are advised to utilize the following recently developed documents when formulating proposals:

1. Coralville Reservoir Shoreline Survey (Schermer 1983).
2. Implementation of the Resource Planning Protection Process in Iowa (E. Henning 1982).
3. Planning in Context. Draft guidelines formulated by Dr. Thomas King from the Advisory Council on Historic Preservation, 1982.
4. Problem Orientation and Allocation Strategies for Prehistoric Cultural Resources on the New Mexico National Forest, Cultural Resources Management Report No. 3 (Green and F. Plog 1983).
5. The Cultural Resources and Geomorphology of Coralville Lake, Johnson County, Iowa (Impact Services, Inc., Emerson 1983).
6. An Archaeological and Geomorphological Survey in the Central Des Moines River Valley, Iowa (Bettis and Benn). In Plains Anthropologist 29-105, 1984:211-227.
7. Interrelations of Cultural and Fluvial Deposits in Northwest Iowa. Guidebook and short papers prepared for a field trip to Plymouth County, and the spring meeting of the Association of Iowa archeologists (Bettis and Thompson 1982).

2.4 The first report deals with a 20 percent sample of two large stretches of the Coralville Lake shoreline. The second reference delineates Iowa's RP3 study units which apply to the project. The 'Planning in Context' or PIC approach as described by King (1982) is generally consistent with the RP3 approach defined by Aten (1980). Offerors must formulate the overall cultural resources management plan based upon these two documents. Prospective Offerors are also encouraged to consider the utility of the allocation strategy (AS) process per item 4 above. In terms of defining preservation, conservation, and adaptive use criteria, the situation at Coralville Lake is very similar to that for the New Mexico National Forests. Finally, item 5 above represents the latest published cultural resources study for Coralville Lake, Iowa. Consideration of this cultural resources synthesis overview is imperative for understanding RP3/PIC development. This report also provides an up-to-date preliminary geomorphological evaluation. Dr. David P. Overstreet, Great Lakes Archaeological Research Center (GLARC) (414-259-6020), currently is under contract with this District to prepare a Cultural Resource Overview and Management Plan (CRMP). Some survey and testing are included under this contract. Prospective Offerors are encouraged to contact Dr. Overstreet to ensure that proposals are compatible with the CRMP and that work/research items can be articulated with the CRMP narrative and CADD mapping for Coralville Lake.

2.5 Copies of items 1 through 7 listed in paragraph 2.3 are available for on-site review at the Rock Island District Office, Rock Island, Illinois. The Iowa State Historic Preservation Officer (Dr. Adrian D. Anderson) and the Iowa State Archeologist (Dr. Duane Anderson) have copies of items 1, 2, and 5 for review at their offices. Copies of items 3 and 4 should be requested from the authors or their agencies.

III. PROPOSALS

3.1 The Contractor shall conduct this investigation in a manner that ensures the greatest contribution to an understanding of Midwestern geoarcheology. In an effort to ensure this, prospective principal investigators shall submit a technical research proposal and a separate cost proposal to the Contracting Officer for evaluation. The technical proposal shall include sufficient discussion to document how Scope of Work needs will be met. Key personnel will be identified and manpower efforts (by hours) shall be included but without costs. The cost proposal will be a detailed, itemized quotation for personnel, goods, and services required to accomplish the technical proposal. Overhead and wage rate figures shall be clearly presented, as well as any costs for equipment, transportation, per diems, lodging, and consultant services. The cost proposal shall be sealed in a separate envelope to ensure that the technical evaluation can be accomplished without prejudice prior to evaluating cost proposals.

3.2 Prospective Offerors must adhere to the minimum professional qualifications set forth in the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation (Federal Register 48:190:44716-44742). For the most part, these guidelines are compatible with standards set forth by the Society of Professional Archeologists (SOPA) and standards recommended by the Iowa State Historic Preservation Officer. It is the responsibility of the Contractor to ensure that the designated principal investigator(s) and key personnel are in compliance with this requirement and that their qualifications are clearly set forth by vita and/or other documents. The Contractor shall identify, by name, the principal investigator and key personnel in the proposal and document experience in work of this type in the Midwest, and preferably in the Iowa River Valley. The principal investigator must be able to document involvement in the project, and will be held responsible for the technical quality of the work.

3.3 Proposals will be evaluated as specified in Part IV, Section M. The technical evaluation team will evaluate the technical proposals first without prior knowledge or review of concurrently submitted price proposals. Therefore, it is in the best interest of the Offeror to include the data necessary to evaluate the merits of technical proposals, independent of cost considerations. Proposals must demonstrate that the Offeror is knowledgeable of previous work in the region, current research objectives, and state-of-the-art methodologies and techniques. Proposals that simply restate the Scope of Work or offer "canned" approaches may be judged technically inadequate.

3.4 Particular emphasis in proposal evaluation will be given to proposals offering a high quality product which will best identify and evaluate geomorphic contexts in accordance with local and regional research objectives and management concerns.

3.5 Offerors should submit a comprehensive scheduling plan to document anticipated levels of effort.

3.6 Contract award will not necessarily be based upon low estimated price, but on the most advantageous combination of method, price, and schedule that best meets the Government's needs. This will be a firm-fixed-price negotiated contract.

3.7 Offerors are invited in their proposals to suggest improvements on the Scope of Work so long as the State minimum requirements are met. Any substantive changes will be dealt with during the negotiation (best and final) process for those within the competitive range. Offerors are encouraged to provide alternative approaches in addition to approaches solicited under this RFP. The objective is to obtain the maximum amount of useful information in the most cost efficient manner. Note that award may be made without negotiation if a proposal is received that can be awarded as is.

3.8 Laboratory procedures shall be described for special studies such as soils and C-14 analyses. Prospective Contractors shall include in proposals a discussion of the capabilities and facilities to adequately perform required laboratory analyses proposed. C-14 dating will be a critical element for interpreting geomorphological/stratigraphic contexts.

3.9 Laboratory procedures shall be described for special studies such as soils and C-14 analyses. Prospective Contractors shall include in proposals a discussion of the capabilities and facilities to adequately perform required laboratory analyses and for curation upon completion of the project. Curation standards shall be those set forth by the National Park Service, Department of the Interior (Federal Register, Thursday, September 29, 1983:48:190:44737) entitled Archeology and Historic Preservation Standards; Secretary of the Interior's Guidelines.

3.10 Remote sensing applications should be described, if proposed, particularly in terms of the data sought and the efficiency or interpretive capabilities in relation of traditional collection/analysis procedures. Use of CADD mapping systems, particularly for integration with the computerized data base developed by Dr. Overstreet for the Management Plan, also should be described.

IV. Related Study for Consideration: Saylorville Lake, Iowa

4.1 Cultural resource investigations conducted to date have provided a substantial body of site-specific locational data for some 450 sites in the Saylorville Lake area. It was likely, however, that many sites were not yet found, being buried sites or sites not identified by earlier surface surveys because of heavy vegetation. For this reason, the District contracted a similar geomorphological/stratigraphic study with the Iowa State Geological Survey (Bettis and Hoyer) to refine our understanding of Holocene landscape evolution. This study was initiated based upon preliminary information developed under archeological contracts with Southwest Missouri State University (Dr. David W. Benn). Since the Iowa State Geological Survey report will not be due until after award of this contract, a summary of the results generated by Benn is provided below under item 4.2.

4.2 Geomorphological investigations were conducted in the Saylorville Downstream Corridor beginning in 1980 (Benn and Bettis 1981). As part of this study, Benn and Bettis developed a general geomorphological sequence for the Des Moines River Valley: (1) high terrace development, 8,500 B.P. before the present B.P. to 4,000 B.P., (2) alluvial fan development, 8,000 B.P. to 2,000 B.P., (3) intermediate terrace development, 4,000 B.P. to 1,000 B.P., and (4) low terrace development, A.D. 1,000 to present. As a result of this study, it was clear that river valley development (including meanders and terraces) affected the way in which prehistoric groups utilized the landscape. Benn and Bettis were able to determine relationships between site locations (and their functions and cultural affiliations) and various landforms in the Des Moines River Valley. Historic materials are scarce on low terraces, but occur in relatively dense concentrations on intermediate and high terraces. Paleo-Indian sites and Early through Middle Archaic sites would be most common on high terraces where erosion and historic disturbances also have been most severe. Woodland and Late Archaic sites occur most frequently on intermediate terraces (habitation and campsites), but these sites are buried by alluvium. Woodland Period mortuary sites are expected on the bluffs at the edge of the valley. Therefore, the majority of recorded sites within the reservoir area tend to be small lithic scatters from the Paleo-Indian and Early through Middle Archaic Periods which are often exposed on remnant high terraces. This may mean that in spite of extensive survey and mitigation, a major portion of the prehistoric and historic record for the reservoir area has been lost, primarily because the problem of site burial was not fully considered, and that the extractive camps that remain upstream of the dam are in areas where erosion and recent historic disturbances have been the greatest.

In general, the downstream corridor studies have established that significant periods of real time are not represented by flood plain surfaces or contexts. Therefore, only limited segments of real time, or cultural time, have been dealt with by previous surface surveys elsewhere in the Des Moines River valley. Consequently, the existing site data base is biased. The downstream studies indicate that 1) certain time periods are under-represented (or over-presented), 2) site contexts of the same age are skewed (e.g., Woodland sites on old low terraces but not in the lower landscape positions), and 3) certain data classes and physical data contexts are absent (e.g., fragile botanical or faunal remains which would be preserved in buried contexts but not in sola or plowzones or easily separated site components). Of greatest importance, however, is that both the quality and quantity of existing data from the alluvial landscape in Saylorville can be evaluated with information available from the downstream study.

4.3 For the present project, a major goal will be to determine the kinds and degrees of landscape change which preserved or destroyed archeological evidence in various depositional contexts. In this definition, sites are deposits. Site meaning is ascribed; site content and size are purely physical. Since site deposits are preserved on or within alluvial deposits, it is necessary to understand the larger, encompassing landscape system to determine the degree and context of site preservation. The central task of the planned study will be to describe and map alluvial deposits with detail needed to guide subsequent archeological studies and for application to the CRMP being developed by GLARC. To do this effectively, a familiarity with archeology is essential.

V. SPECIFICATIONS

5.1 The area of investigation in the fluvial landscape should include the Iowa River Valley (as defined by the Corps of Engineers) and tributary valleys which enter therein. These tributary valleys are essential for investigation of alluvial fans which are thought to be potential contexts of Early to Mid-Holocene archeological sites (buried). Similarly, consistency of fan formation would indicate significantly different potentials for the preservation of archeological deposits in tributary valleys. Colluvial slopes also should be investigated.

5.2 Assembled information and interpretations should conform to standards and conventions in fields of pedology, stratigraphy, and fluvial geomorphology, and also conform to current usage of time and rock stratigraphic terminology in Iowa.

5.3 Every effort should be made to correlate stratigraphic studies with those defined for Saylorville Lake (Benn and Bettis 1981; Iowa State Geological Survey:in preparation), conforming whenever possible with previously defined nomenclature and terminology applied to late Wisconsinan and Holocene fluvial deposits.

5.4 Detailed field studies should be undertaken in sample areas for purposes of describing differentiating and correlating significant fluvial deposits. All appropriate survey controls should be used. The sample areas should not be interpreted as valley cross sections. Rather, blocks ("archeological quadrants") should be investigated. Sampling areas should represent conditions encountered throughout the reach of the total survey area, and include situations where tributaries enter the main valley. In addition, tributary valleys should be investigated in order to interrelate depositional histories of tributary and main valleys and therefore similarities or differences in archeological potentials.

5.5 The Contractor should visit downstream and tributary valley areas at Coralville Lake and investigate as needed to correlate deposits. This will be very important to reconstruct the distribution of significant deposits within the conservation pool.

5.6 The Contractor should gather sufficient information to identify any significant gaps in the stratigraphic record which would account for absences of archeological sites of specific ages.

5.7 The Contractor shall provide maps and cross sections depicting:

- a. principal alluvial fills and their distributions
- b. the lithologic and sedimentologic characteristics of the fills
- c. their depositional histories and radiocarbon age, specifically including the approximate age of their surfaces
- d. correlation with modern landforms and soil associations

5.8 The Contractor should collect information pertaining to soil environments which are, or are not, conducive to preservation of fragile plant and animal remains associated with archeological deposits in the identifiable fill/stratigraphic units.

5.9 The Contractor will be required to estimate (perhaps based on existing data) the potential for preservation of data classes in sites found on the surface of surrounding uplands. Erosion classes or phases, and influences of agriculture could be related to the likelihood of encountering undisturbed components or fragile environmental or subsistence data in components (this would tie to review of previously tested/salvaged sites).

5.10 Reporting should consist of data pertaining to analysis and geomorphic interpretation and stratigraphic correlations. Maps should include: 1) plan and section views of the sampling area, 2) generalized stratigraphic sections of significant deposits, and 3) maps showing correlations of deposits throughout the survey reach. Complete descriptions of borings or profiles should be provided in formats established by the U.S. Department of Agriculture (soils) and the Iowa Geological Survey (for Quaternary deposits--e.g., Hallberg, Fenton and Miller 1978 for weathering zones, and recent publications on the Des Moines Lobe published by the IGS).

5.11 The Contractor will be required to provide for recovery of continuous undisturbed soil cores. He should avoid use of flight augers for primary stratigraphic studies. The Contractor also should use backhoes where it is necessary to examine details of fill units or their sedimentary characteristics.

5.12 The Contractor will obtain relevant information from the District or the archeological contractor preparing the Coralville Lake Overview/Management Plan. The exchange of data between the two contractors is considered an essential aspect of the District's Cultural Resource Management Program.

5.13 An explicit research design will be required that provides the rationales, goals, and methods for field investigations including but not necessarily limited to:

a. The scientific and geomorphological reasons for pursuing the proposed investigations.

b. How proposed investigations will contribute to the Cultural Resources Management Plan and how anticipated results will help clarify our understanding of cultural contexts at Coralville Lake.

c. The explicit manner in which data will be collected and analyzed, and how these relate to research and management objectives.

d. A detailed discussion of geomorphic strategies to be applied, including sampling fractions, sample unit size, configuration, placement of tests, and equipment to be used and its appropriateness.

e. Quantitative techniques to be used to interpret geomorphological data.

f. What collection and evaluation procedures will be utilized to identify required data classes and to interpret them.

5.14 The Contractor shall make use of known archeological sites to improve the integration of cultural and geomorphological data. While this procurement is for a geomorphological/stratigraphic study, it is recognized that an archeological testing component may be necessary to generate the required overall results. Archeological work shall be performed by professionals meeting current standards in terms of both qualifications and performance (see 3.2 above). Any new archeological sites discovered shall be immediately reported to the Rock Island District and the SHPO. Office of State Archaeologist (OSA) site forms will be prepared and submitted to the District, the SHPO and OSA. The Contractor shall identify in advance, in proposals if possible, any recorded sites intended for investigation. Because the District anticipates having several archeological Contractors working in the area concurrently with this contract, the District will have to monitor site selection after coordinating with the SHPO to avoid conflicts, duplication of effort, and to see that any site testing is in the best interest of the Government and the data base.

5.15 Site locations (for new sites) are to be defined in four quarter section descriptions and UTM coordinates; these will be plotted on USGS topographic maps and sketch maps in a separately bound appendix not for public distribution. The following information is to be obtained for each site tested under this contract:

- a. Horizontal and vertical extent.
- b. Number of cultural components and stratigraphic positions of site and components.
- c. Overall geomorphic setting (basin-wide).
- d. Type or types of activities represented by the data.
- e. Previous investigation/collection activities.
- f. Date of work at the site.
- g. Locations of collections.
- h. Current status of the site in terms of burial, erosion, ground cover, inundation, vandalism, other disturbances.
- i. Relationships between the site, environment, physical setting, surrounding sites, and preliminary models.
- j. How site relates to RP3/PIC/AS objectives.
- k. Assessment of research potentials, application of endemic National Register criteria.

1. Recommendations for preservation, stabilization, conservation, immediate mitigation (data recovery).

The need for site testing and the generation of this level of detail should be minimal relative to the overall contract effort.

VI. REPORT

6.1 The principal investigator shall be responsible for preparing a comprehensive technical report based upon the results of the work under Sections I through V. A report format is attached as Exhibit 2 for guidance. Any detailed maps of individual sampling units and stratigraphic overviews will be included in the main report. Basic data description, including provenience in metrics, will be provided for use both in support of the author's arguments and conclusions and as a source of basic information that may find wider use by other cultural resource professionals. Drawings and photographs are also required. The Contractor will conduct an evaluation of geomorphological changes as they impact and affect cultural resources within the specified recreation areas.

6.2 Six copies of the draft report shall be submitted to the Contracting Officer for review 210 days after work begins on the contract (20 days after award). Draft reports shall be complete when submitted, unless other arrangements are made with the Contracting Officer, no less than 30 days prior to the due date. Changes directed by the Contracting Officer based upon draft review shall be made prior to submission of a final report. In the event that major revisions are required, the Contracting Officer may request, and the Contractor will supply, a revised draft report for review at no additional cost to the Government. In the event that a revised draft is required, it will be due 30 days after notice of the Contracting Officer. The final version will be due 30 days after the Contracting Officer approves the draft.

6.3 The draft review period may be as long as 60 days. The intervening time is necessary to obtain reviews from the State Historic Preservation Officers, the Rock Island District, and the National Park Service (Interagency Archeological Services).

6.4 Any materials (documents, samples, artifacts, or notes) collected under this contract shall be evaluated, analyzed, and referenced according to current professional standards for presentation in the report. These procedures must be specified in proposals. An inventory of these materials shall be supplied to the Contracting Officer with the final bill as they remain Government property and are subject to review or recall at any time. Artifacts shall be sent to the Contractor performing the separate cultural work.

6.5 The Contractor shall furnish the Contracting Officer with fifty (50) copies of the final document, including all photographs and appendixes. A master copy of the final report in reproduction format will be furnished to the Contracting Officer with the final bill.

6.6 The Contractor will prepare an informational report on this work suitable for presentation to the lay public. This report should focus on the general geomorphology and fluvial history of the area, the work done under the contract, and what has been contributed to our understanding of the area. Appropriate photographs, maps, or drawings shall be included to illustrate the project. A set of 35mm color slides shall be provided to complement the text.

6.7 Prior to acceptance of the final reports by the Government, neither the Contractor nor their representatives shall release any information or materials of any nature obtained or prepared under contract without prior approval of the Contracting Officer. After acceptance of the final reports, their reproduction and use shall not be restricted by either party. Appendixes not intended for public release are identified in Exhibit 2.

VII. RECOMMENDATIONS

7.1 The Contractor shall make recommendations in the technical report for each site based upon the kinds of data that are present; expected to be present, or absent. Data gaps will be discussed and statements on future research objectives will be provided. The Contractor will also provide a detailed discussion on how information generated under this contract applies to the CRMP and overview being produced by GLARC.

VIII. CURATION

8.1 Any materials collected and any notes, photographs, or other data generated during the performance of contract services shall be curated with the Principal Investigator for preservation at the discretion of the Rock Island District and the Iowa State Historic Preservation Officer. Successful Contractors outside of the State of Iowa may be required to move these materials to an approved curation facility within Iowa. All of these materials remain the property of the Government and shall be made available upon request by the District for interpretive programs, additional research purposes, or any other reason approved by Rock Island District. All data generated under this contract will be curated in one place. It is the Contractor's responsibility to safeguard all of this material and to provide an inventory or catalogue system to facilitate access. Copies of any inventories shall be submitted to the Contracting Officer with the final bill.

8.2 Any cultural materials generated under this contract shall be curated in accordance with professional standards (see Federal Register 48:190:44716-44742) by the principal investigator at the discretion of Rock Island District, the State Historic Preservation Officer, and the State Archeologist. Contractors from outside of the State of Iowa may be asked to move collections to a repository within Iowa upon completion of the Contract. This is to ensure that the materials are available within the State and region from which they were collected for research purposes. An inventory of these materials shall be submitted with the final bill. All materials generated under this contract shall remain the property of the Government.

IX. COORDINATION

9.1 Continuous coordination will be maintained with the Iowa State Historic Preservation Officer, the Rock Island District staff archeologist, and the U.S. Fish and Wildlife Service. Evidence of this coordination will be documented in the draft and final reports. Furthermore, coordination with the archeological contractor preparing the Coralville Lake Overview/Management Plan must be documented.

9.2 Monthly Progress Reports shall be submitted to the Contracting Officer by the 10th day of each month. This report will indicate specific activities and accomplishments during the preceding month and show any scheduled tasks for the following month. These reports will be used by this District to keep abreast of contract progress and serve as a vehicle for identifying problems with performance of the contract or with significant cultural resources.

X. SCHEDULE

10.1 The overall contract period is 300 days. The Contractor will have up to 20 days after award to initiate the contract work. A schedule is provided below for guidance:

Startup	day 0-20
Literature Search/Fieldwork	day 21-120
Analysis & Draft Report Preparation	day 121-210
Draft Review	day 211-270
Final Report Preparation	day 271-300

This information is provided to guide Offerors in proposal preparation. Prospective Offerors may alter the fieldwork and analysis days, as appropriate, to carry out their proposals, as long as the overall contract period does not change. Earlier startup times are encouraged.

XI. GENERAL

11.1 Any arrangements for ingress or egress over non-Federal lands shall be the responsibility of the Contractor. The Contractor is responsible for obtaining permission from any landowners prior to trespass. The Contractor shall inform District staff of any lands to be investigated which are leased for wildlife management or agricultural purposes well in advance so that lessees can be notified.

11.2 The Contractor will keep District staff informed as to where the work is being conducted and supply names of all field personnel. This contract will be managed by staff Archeologist C. R. Smith, Environmental Analysis Branch, Planning Division, Rock Island District, Corps of Engineers. The phone number

is 309/788-6361, Extension 349. The Contracting Officer's Representative shall be J. Paul VanHoorebeke. While routine informational matters will be handled by Mr. Smith, all bills or contracting matters should be sent in writing to J. P. VanHoorebeke.

XII. PAYMENTS

12.1 Payments shall be made through receipt of Contractor's billing invoices. Each payment request will be audited by District staff to ensure that sufficient progress has been made in support of the bill. As a guideline, the payment schedule listed below shall be used. Recognizing that there is great variability in billing procedures, fractional amounts will be accepted; however, adherence to the schedule is preferred.

Completion of Documentary Work	20% of contract amount
Completion of Fieldwork	40% of contract amount
Completion of Analysis	60% of contract amount
Receipt of Acceptable Draft Report	70% of contract amount
Approval of Draft Report	80% of contract amount
Receipt of Final Reports	90% of contract amount
Receipt of Final Bill, Inventory Sheets, Reproduction Format Master	100% of contract amount

The Contracting Officer may approve payment for higher percentages than those shown in the above schedule if an appropriate amount of work can be identified as having been accomplished.

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APPENDIX B
REVIEW CORRESPONDENCE

DAVID CROSSON, EXECUTIVE DIRECTOR

STATE HISTORIC PRESERVATION OFFICER

RE: DRAFT REPORT, THE ARCHEOLOGY OF CORALVILLE LAKE, IOWA:
EVOLUTION OF HOLOCENE LANDSCAPES.

Thank you for the opportunity to review the above referenced report. It appears to meet the requirements of the SOW. We have only a few comments.

There should be a chart of geological periods in the natural history section.

The section on man-landscape correlations would be improved by having a map of Corralville with the 11 units marked. Though the information exists in Vol.VI, it is very inconvenient to refer to it.

Another useful map in this same section would be one marking archeological potential. This could be quite schematic in nature. It also would be useful to have a map correlating archeological potential with high and low impact areas within the reservoir.

We look forward to reviewing the final report.

Sincerely,

ly,
Ray Simpson, for

Dr. Lowell J. Soike, Director
Deputy State Historic Preservation Officer

LJS/ks

cc: David Overstreet

Project Review Comments

Type:
Concept: ☐
Final: ☐
Other: ☐

Page 1 of ____

Date: 13 Feb 86

Project: Evolution of Holocene Landscape
Location: Coralville Lake, Iowa

Reviewer:

Name: Charles R. Smith

Organization: USAED, Rock Island

Comment Number	Drawing/Page/ Number Space		Comment	Action
	Number	Space		
1	p.6		It is difficult to imagine what the Iowan Surface looked like and how it was formed. Excluding the larger watercourses with topographic relief, this portion of Iowa is essentially, a fairly flat plain. Are you suggesting voluminous yet even sheet wash or outwash, or was the area a large mosaic of multibraided shallow water courses? Was the erosion primarily wind directed?	
2	p.14		Consider enlarging and redrawing Figure 3 for increased clarity	
3	p.26		Could the transects on Figure 5-8 be added to Figure 4 for general locational purposes?	
4	p.25		Figure 4 needs a scale and north arrow. Also, a major landmark or two would be helpful (i.e., Wisniewski and Matson Ponds, County Road O, Knapp Creek, Plum Creek, Dupont Cemetery)	
5	p.46		The inconsistent use of "loess fall" and	
	p.47		"loessfall" should be corrected.	
6	Gen		A summary table would be very helpful including topics like: landform, radiocarbon or relative age, preservation potentials, defining characteristics, cultural associations, elevation, etc.	
7	Gen		A table summarizing landform developments and erosional/depositional episodes would be helpful	

Project Review Comments

Type: ☐
 Concept: ☐
 Final: ☐
 Other: DRAFT ☒

Page 2 of 2

Date: 24 May 86

Project: CORALVILLE LAKE
 Location: IOWA

Reviewer:
 Name: A. BRUEZEWICZ
 Organization: USACE-NCR

Comment Number	Drawing/Page/		Comment	Action
	Number	Space		
1	6		Ka - A notation which will probably not be familiar to many corps readers of this document.	
2	24		Aren't these renditions <u>maps</u> ?	
3	Fig 6		No identifier under the core under the word "south".	
4	32		Tend vs tending. I vote for tend.	
5	35		Under "The Wisconsinan" 1st sentence is ambiguous - Is this the highest terrace of this age or does the highest terrace present have this age?	
6	48		Underlined passage paragraph 2 meaning is unclear.	
7	56		Line 4, I don't think that parameter is the right word.	
8	61		The low terrace: - (209 meters) should follow the low terrace of the intermediate terrace.	
9	71		The last sentence needs clarification.	
10	110		Sentence 4 unclear.	
11	114		* Soil development is arguably a geomorphic event also (i.e., stability is geomorphic).	
12	123		Nature - upper case.	

Project Review Comments

Type:
Concept: ☐
Final: ☐
Other: DRAFT ☒

Page 1 of 2

Date: 24 Mar 86

Project: CORALVILLE LAKE

Location: IOWA

Reviewer:

Name: A. BRUZEWICZ

Organization: USACE-NCR

[illegible]

State of Iowa

Iowa Geological Survey

123 North Capital Street • Iowa City, Iowa 52242 • (319) 338-1173

April 10, 1986

Terry E. Branstad
Governor of Iowa



Donald J. Koch
State Geologist and Director

Bernard E. Hoyer
Associate State Geologist

Mr. Charles Smith
U. S. Army Engineer District, Rock Island
Clock Tower Building - P.O. Box 2004
Rock Island, IL 61204-2004

Dear Mr. Smith:

This letter is to present my review comments on the report by Mr. Jeff Anderson entitled "The Archaeology of Coralville Lake, Iowa Volume II: Evolution of Holocene Landscapes. My review is composed of two parts; first, a narrative of general comments followed by specific comments referenced to various portions of the report's text.

Overall, I think the report is good and fulfills the requirements set forth in the scope of work. I especially liked the detailed investigation of several different geomorphic situations typical of the project area as a whole. I applaud the attempt to thoroughly date the observed depositional sequence. The availability of the field descriptions and laboratory are also greatly appreciated.

Although I feel that a good job has been done, several aspects of the project and report bother me. The discussion of the pre-Holocene history and bedrock of the area is based on outdated references and is inadequate. I've included a few newer references which should be consulted. I also think that the dramatic differences in valley morphology between the Hawkeye area and the gorge have been downplayed. Why do these differences exist?

I also think that quite a bit of stretching of the data has been done in order to squeeze it into the geomorphic-climatic model proposed by Knox. This is a matter of personal preference but I think the climatic forcing argument should be toned down.

I'm also disappointed that deep borings were not taken. I am not convinced that the sandy "lateral accretion" deposits are indeed the bottom of the sequence.

Finally, the writing style is somewhat cumbersome. Numerous typos and instances of improper sentence structure are present. These distract from the report. The specific comments are attached. Thank you for an opportunity to review this report.

Sincerely,

E. A. Bettis, III
Research Geologist

EAB/leh

Enclosure

p. 2. guide to where intact archaeological deposits can be predicted to occur -- aren't you really talking about potential for occurrence.

p. 4. Cedar Valley is also Middle Devonian.
Shell Rock is not present in Coralville area.
whole bedrock terminology is antiquated.
see Witzke (ed), 1984 and Bunker and Hallberg (ed) 1984.

Last sentence strike "early".

p. 5. Last sentence of 1st paragraph should read - during the early and middle Pleistocene.

2nd paragraph--your idea of the old Iowan concept is incorrect. The pebble band was not considered the Iowan till -- it was the upper till in the Iowan area (see Kay and Graham, 1943; Leverett, 1939). This till was calcareous at the surface and the landscape was not as deeply dissected as the adjacent "Kansan" areas. In other words, the Iowan till of Alden and Leighton is eroded "Kansan" till (see Ruhe et al, 1968). This is a very complex issue with several different opinions concerning the age and origin of the Iowan area. You have not done it justice.

Last complete paragraph. I think you would be hard pressed to find anyone in the know to agree that the pahas contain a complete Pleistocene record.

p. 6. 2nd paragraph. You have fallen into the same trap that Knox has. Wolf Creek is not equivalent to Kansan, and Alburnett is not equivalent to Nebraskan. In many areas tills formerly called Kansan are included in the Wolf Creek Fm. while in others formerly "Kansan" tills are Alburnett Fm. and vice versa. The whole problem is that what was formerly thought to be a two till sequence (Kansan/Nebraskan) is a 7-12 till sequence. Erode varying portions of the sequence away and you have the problem. I would urge you to reread Hallberg (1980) and Hallberg, ed (1980). What you have presented is incorrect and misleading.

Next paragraph. In the same vein see p. 10 of Hallberg, ed (1980). There are numerous paleosols in the Pre-Illinoian sequence (3 formally named). The formally named ones are not necessarily more well expressed than others, its just that they occur in a known stratigraphic position and can therefore qualify as pedostratigraphic units.

Last sentence - using the old terminology (Aftonian paleosol) is not acceptable. Simply state that the erosion surface truncates the upper two tills at the site.

p.10. Several additional refs. have directly addressed the timing and nature of fan development in the Upper Midwest (Hoyer 1980 a & b; Bettis et al, 1984).

p.11. 3rd paragraph, 1st sentence. What is post-Kansan?
(p.s. - Kansan is an invalid time concept).

- p. 11. 3rd paragraph, 3rd sentence. Cedar Valley and Wapsipinicon.

Last paragraph, 2nd sentence. The buried valley is not preglacial -- no preglacial valleys occupied by the modern drainage system exist in eastern Iowa (see Hallberg and Bettis, 1985).

- p. 15. 2nd paragraph. Early on you talked about not using jargon -- I think Aquept, Ochrept, etc. are jargon -- you could clarify these terms.

Fig. 4

- p. Pre-Illinoian...these surfaces are not Pre-Illinoian they are developed in loess-mantled Pre-Illinoian till.
Typo under LT vertical.

- p. 27. 2nd paragraph - your dates would indicate to me that the Intermediate terrace would interfinger with fans as well as being buried by them in some areas.

3rd paragraph, 1st sentence, you didn't describe the sedimentological profile of the Intermediate Terrace. How do we know it is different from the Low Terrace?

- p. 34. 1st paragraph under 3) there is more to sedimentology than texture.

- p. 36. 1st paragraph under Trench #3, 4th sentence, paleosols are not lithostratigraphic units, they are modifications of units and can be developed across several units.

- p. 38. This discussion is somewhat confusing. What are the relationships among the various lamellae? Do they overlap? Are there crosscutting relationships? These sorts of observations will tell you about the chronology of the lamellae.

1st paragraph - are you sure the lamellae were originally present on this part of the dune? Maybe another possible interpretation is that the environment favoring their development was not present there.

- p. 40. Last paragraph, we don't see the episodes in the deposits, we see the product of the episodes.

- p. 41. 1st paragraph, how do you know the stratigraphic relationships between the surface dated 6230 BP and the "higher" paleosol? elevation & stratigraphy. Look at the modern surface - equivalent surface soils are at different elevations.

1st sentence of last paragraph, why not call the "reworked loessal unit" local alluvium?

- p. 42. 2nd paragraph, second to last sentence...stratigraphically above...elevation does not equal stratigraphy (see previous comments).

- p. 45. 2nd paragraph, 2nd sentence...is overlain by the soil dated 17,150 B.P. - soils are not depositional units - they do not overlie units they are developed into units.
- p. 47. Last paragraph - why are you so willing to dismiss your date as contaminated in order to fit it into your global climate model? Do all parts of the system respond in synchrony?
- p. 48. 1st paragraph, second to last paragraph...active during Cary glaciation... - Cary has been dropped as a time unit (see William and Frye 1970 p. 127). Use Des Moines Lobe instead.
- p. 54. 1st paragraph, 1st sentence, what is a weak paleosol? Do you mean weakly expressed?
- p. 55. 1st paragraph, 1st sentence - how do you know these geomorphic events have occurred in response to climatic and subsequent vegetation changes? You have no climate proxy data from the area!
- p. 60. 1st paragraph under discussion, Cary Substage - see previous comments - you could use Woodfordian.
- p. 64. 1st paragraph - I would be more cautious about using these few C-14 dates to identify episodes of fluvial activity. Clusters of dates are necessary to talk about episodes of fluvial activity (see the numerous Knox works you cite).
- p. 72. 3rd paragraph, last sentence - elevation is not stratigraphy - see previous comments.

1st paragraph, last sentence, the valley wall here is not Pre-Illinoian.
- p. 73. 2nd paragraph under Discussion. Instead of two or more "episodes" isn't it more likely that the river has just been migrating southward across the flood plain during the Late Holocene?
- p. 85. 1st paragraph, last sentence. Just because you don't find organic remains in a deposit doesn't mean that vegetation didn't occupy it during accumulation!

2nd paragraph, last sentence. The valley didn't incise, the river did.
- p. 96. 1st paragraph reference to Lake Calvin - recent work has demonstrated that a Pleistocene Lake Calvin did not exist. The "Lake bed" is a series of fluvial terraces. See Esling, 1984 or Koosa et al., 1984.
- p. 103. 1st complete paragraph, 3rd sentence unconsolidated is a bad choice of words, it has a very specific meaning to engineers - you should use unlithified.

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University of Northern Iowa
Department of Geography

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May 1, 1986

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

Dear Mr. Hanson:

Enclosed are my general comments and a list of specific revisions needed to make the report, The Archeology of Corallville Lake Iowa: Evolution of Holocene Landscapes, an exceptionally good report.

The report represents a tremendous effort. The Corps of Engineers has certainly received their money's worth on this phase of research at Corallville Lake. What sets this report apart from so many similar reports is the intense effort extended in the field. The investigator has documented very well the variety of landforms and more importantly, the stratigraphy of sediments and soils comprising each. The interpretations are generally very good and scientifically sound.

I hope the enclosed comments are useful.

Sincerely,

David May
Assistant Professor

s
Enc.

General Comments

1. While texture is an excellent way to discriminate soil horizons, structure and color changes are likely equally diagnostic in the field. If other features were used, then paragraph 4 page 20 is misleading.
2. The investigation of landscape elements was very thorough. I am impressed with the mapping and especially coring of alluvial fans and colluvial footslopes.
3. How are vertical and lateral accretion deposits discriminated? Perhaps origin (or process) should not be attributed to deposits until the morphology of the landform and the physical and chemical properties of the sediments comprising it are discussed. The reader is asked simply to believe that the investigator can discriminate floodplain deposits in the field. Perhaps he can, but what structural or sedimentological clues are used?
4. The investigator has a good grasp of rates of valley alluviation.
5. The investigator very convincingly discriminated historical sediments from older alluvium.
6. The word "component" is used frequently. Perhaps it is my bias, but I feel that the word adds little to the description. Furthermore, the report should be easily understood by archeologists, and archeologists ascribe a very different meaning to the word.
7. The descriptions and interpretations on pages 30 and 85 are confusing and should probably be entirely rewritten.
8. Many more references to figures are needed to aid the reader!
9. The interpretations of weathering, erosion, and redeposition from pH are excellent.
10. The designations of oxidized, leached, etc., on the diagrams should not be abbreviated, or, if they are, they should be explained in a key.
11. Loess is defined by particles in the range of 10-50 microns, yet "fine sandy loess" is referred to on page 44.
12. A very good explanation of process in the second paragraph on p. 58.
13. The results of this investigation should be more explicitly compared to the work done at the Cherokee Fan in western Iowa and to the work done by Knox and his students in southwest Wisconsin.

Specific Revisions Needed

<u>Page</u>	<u>Par.</u>	<u>Line</u>	<u>Content</u>
5	1	last 4	Reference needed
5	3	17	"they" refers to what? pebble bands?
7	3	7	"destabilized vegetation" - Is vegetation inherently stable or unstable? Most plat geographers and botanists would not like such a description of natural vegetation.
8	4	1-3	Reference needed
9	2	10	"alluvial floodplains" - are there any floodplains that are <u>not</u> alluvial?
16	2	10	A "flood event" is <u>not</u> part of a floodplain. The deposited <u>alluvium</u> becomes part of the floodplain.
18	2	5	"Empirical" misspelled
19	2	4	"No sign of many [<u>of</u>] these relict ..."
19	2	9-12	What does "This" refer to?
20	5	1	"Periodically" implies repeatedly, but I doubt that the transects were repeatedly surveyed at regular intervals.
21	2	5	What are "non-sampled descriptions"? This makes no sense.
22	2	1	"Dried" misspelled "dried"
24	2	3	Define "mid-woodfordian"
24	3	2	Figure 5 - needs elevation of river or reservoir indicated
24	3	7	Are "dune features" dunes? or are they other eolian landforms?
27	2	2	What does "terrace that was active" mean? I presume it means it was the floodplain under construction, but this is a poor way to express it.
27	3	1	Has the "low terrace" really been "active since about 4500 BP"?
27	3	4	"Active lateral . . ." should read "Rapid lateral" or "Slow lateral . . ."
30	Figure	8	All of the information is on the valley margin. Why not enlarge this portion of the diagram?
32	1	243	"Mississippi Valley <u>began with</u> . . ." replace "began with" with "was."

32	3	8	Give the <u>range</u> of thickness of historic deposits.
33	1	2	<u>How</u> do the "sedimentology and morphology" of the historical unit differ from those of older units?
33	2	1	"along" should be "alone"
33	2	2	"information" misspelled
34	1	2&3	rewrite 2) the color . . .
34	1	6	"negating sedimentology" -- express more clearly
34	2	10	delete "were"
35	1	3	replace "distributed" with "deposited"
35	2	8	What is the <u>evidence</u> that dunes developed rapidly?
36	3	10	The comma after map should be a period.
38	1	4-6	This sentence is very confusing.
40	4	3	"is" should be "are"
44	4	3,7,10	"came in contact with" should be "reached"
45	2	8	"development" should be "sediments"
46	1	1-3	rewrite
46	3	3	"correlative" with what?
47	2	entire	rewrite - very confusing. Middle Holocene should be defined, and the definition should be based on stratigraphy, <u>not</u> inferred climate.
48	1	5&6	"active" is not a good choice of words. Perhaps "constructed" would be better.
48	2	entire	It is not explicitly stated that the high terrace was reworked during the Holocene.
50	5	3	"reworked" - does this mean eroded or deposited?
51	1	2	"has" should be "have"
51	1	6	"dried" misspelled
51	1	13-15	rewrite
51	3	6	"profile stability" should be "landscape stability"
52	3	9-11	rewrite. Could channel sands have been deposited by an incising channel?

52	2	13	What is the meaning of "weak degraded paleosol?"
54	1	3	darker <u>color</u> , but not "organic-rich color"
54	3	11-12	one comma should be a period
56	3	5	"active" should be "rapid"
57	1	1	But is there any <u>evidence in Iowa</u> of lateral channel migration between 6000 and 4500 BP?
57	1	1-3	Incomplete sentence
58	1	2&3	A radiocarbon date is <u>not</u> taken from a unit. A <u>sample</u> from a unit is dated.
59	3	3	"flood events can be <u>seen</u> ". They cannot be <u>seen</u> , but flooding can be <u>inferred</u> from the stratigraphy.
60	1	2&3	Same comment as 58-1-2&3
61	2	8	"reworked through surface instability" is a poor way to express what happened
61	4	5-7	rewrite last sentence
62	2	1-3	What is meant by "the low terrace has multiple components that include the present active floodplain?"
64	3	1&3	Avoid the use of "active". It adds nothing.
67	3	5	"of fining upward" should read "that fines upward"
67	4	1-3	commas needed
70	1	7	same comment as 58-1-2&3
72			Need references to figures and to data in appendices.
73	2	2	"surfaces" should be "deposits"
73	3&4		Do cutoffs <u>necessarily</u> occur during times of greatest channel migration?
74	3	3	"components" are these remnants of fills?
75	3	3	"episodes" should be "deposits"
76	2		compare results to Cherokee Fan alluviation in western Iowa
77			Are Bt21 d Bt22 proper horizon designations according to the new nomenclature?
78	2	8-10	Refer to data in appendix.
79	2	6-8	Very awkward sentence

79	4	1	Where are the profiles mentioned? Need figure reference.
81	3	3	"an abandoned low terrace channel" What ??? does this mean?
81	3	8-11	Good interpretation, but awkward sentence
82	1	1	"persisted" - do you mean "returned"
82	1	11	"terrace was actively reworking the valley" - What does this mean?
82	3	4-7	Is the late Holocene being defined by climatic change?
83	1	5	See comment 82-1-11
84	1	2-5	Only a few pages before fans were <u>stable</u> between 8500 and 4000 BP!
84	2	1-4	Awkward sentence
84	3	1-2	Awkward sentence
84	3	4-6	The soil did not <u>develop</u> beneath the dune.
85			Many awkward sentences. Terrace names should be used to aid the reader.
86	3	6	"In contrast" to what?
86	4	4-5	Is this based on hard evidence, or correlation?
87	1	4-7	Awkward sentence
87	2	11	I though the depressions had been stable for longer than 3000 years.
87	3	5	"instability probably reworked" - rewrite!
90	2		Unintelligible paragraph
97	2	1-3	It should be explicitly stated that these are considered overbank deposits.
98	2	6	Why not cite Langbein & Schumm 1958 rather than Huntington 1914?
99	2	17	"more contemporaneous" young?
101			Horizon designations are incorrect in Fig. 19.
112	2	4	"s" in shoreline should be capitalized
115	2	1&4	avoid using "active"
115	2	13	"denying" should be "refuting?"

115 344

Again, is climate or stratigraphy the basis for subdividing
the Holocene?

116 5 2

empirical misspelled

Review: The Archaeology of Coralville Lake, Iowa. Volume II: Evolution of Holocene Landscapes
By Jeffrey D. Anderson & David F. Overstreet

Reviewed by: J. Schuldenrein, Gilbert/Commonwealth, Jackson, MI 49201

This draft report was prepared by the Principal Investigators in fulfillment of terms under contract no. DACW25-85-R-0028 for the U.S. Army Corps of Engineers, Rock Island District. The objective of the study was to clarify relationships between geomorphological processes and contexts in terms of archeological site locations and states of preservation. This is the second of three geomorphological studies, sponsored by the Rock Island Corps, that seek to explore the nature of archeological site locations and preservation conditions with respect to dynamic environmental changes that selectively seal in and erode archeological manifestations. Identifying patterning in geomorphological processes and preservation will guide the Corps in developing a sound and efficient management strategy for cultural resources.

One geo-archeological study has already been submitted (Bettis & Hoyer 1985) and a second is nearing completion (Schuldenrein, i.p.). These latter studies both concern geo-archeological developments along the Des Moines River. The Anderson & Overstreet work examines a portion of the Iowa River system, located two major drainage nets north and east of the Des Moines, and it is not directly applicable geographically to the other investigations. Still, it should be possible to merge geo-archeological results of all three studies to outline regional patterns in the prehistoric and geomorphic records. The present review therefore stresses the comprehensive nature of the Coralville study and its relevance for a synthetic geo-archeological perspective on the cultural resources of central Iowa.

The general focus of the report is on the reconstruction of Holocene geomorphic landscapes. Major attention is accorded to the development of landform systems from a temporal and paleoclimatic perspective. Less attention is devoted to soils and soil development and the big-picture approach is emphasized. For regional synthesis purposes this is the most advantageous way to handle the data. The field observations and laboratory results are meticulously described in the appendix volume, though it might have been beneficial to incorporate key field and analysis findings in tables that correspond to the various profiles illustrated in the text. It is somewhat cumbersome to refer back to the graphs and form sheets.

The methodological approach that was taken was the most appropriate for the study area, specifically sampling and description of localities that are most diagnostic of the late Quaternary landscape developments. This biases the overall treatment of the Reservoir since the magnitude of geomorphic changes in the diagnostic sectors may not actually be most representative but precisely the opposite, i.e. the most dynamic and unique. Still, there really is no alternative (because of access and sampling problems) and the comprehensive treatment of the Hawkeye Wildlife Area presents a rigorous evaluation of the key landform properties and structures their chronological relationships. The Hawkeye localities received the most attention, presumably since they contain the most complete chrono-stratigraphic and geomorphic records. Both the Iowa River Gorge and Ridgewood Cemetery localities were perhaps "under-reported". To extrapolate for the Reservoir in general on the basis of the Hawkeye sections and landforms does appear to be legitimate, however, given the size of the area and the variety of landscapes sampled.

The major strength of the report lies in its comprehensive synthesis of the geomorphology of the

study area. It is less informative in addressing the issues of preservation and man-landscape correlations. The last chapter presents a case for applying a landscape model to evaluate the nature of prehistoric utilization. The use of a landscape model divided into specific landform units is innovative and very relevant to the study area. But while this is a most appropriate strategy, for most of the eleven landscape categories identified there is no quantitative data presented for the archeological distributions. The isolated archeological sites referred to are not described in any meaningful detail. This deficiency is not necessarily a shortcoming on the part of the authors, but is apparently a result of the minimal data base. Clearly, it will be necessary to plot the set of site-landform correlations on a master map when the locational data are available. At this juncture, the authors should state explicitly that predictive modeling is at an early stage and mapping out site expectations is premature.

The report itself is very well documented and referenced, but I would recommend several changes in presentation. The graphics and line drawings are generally adequate and provide either requisite or even excessive levels of detail in most cases. The geomorphic map (Figure 4) is difficult to read since there are no patterns offsetting the identified surfaces. For the complex and extensive stratigraphic profiles (i.e. Figures 5, 8, 9, 15 and 19 among others) it might be beneficial to subdivide the primary depositional units and soil horizons into numbered stratigraphic units in accordance with both soil stratigraphic designations (Seventh Approximation) and the guidelines of North American Stratigraphic Nomenclature. That type of presentation would enable the reader to follow the geological cycles (deposition, soil formation, and erosion) more clearly. As they stand now, many of the graphics are "cluttered" with text. Additionally, the absence of photographs is unfortunate. We need to see examples of the paleosols, some of which are striking and some not so, to gain a feel for the range of pedogenic expression across the study area. Similarly, sedimentary structures, till formations and loess caps are all features that should be illustrated since they are discussed in varying levels of detail.

The geomorphological map of Coralville is extremely useful, as mentioned, but there might be a master project location map that links the study area with the rest of the landform regions defined for Iowa (Prior 1976), especially the Des Moines Valley where the other studies are based. A base map could show larger scale physiographic and geographic features including the changing width of the valley and the variability in channel shape and flow direction (Figures 1 and 2 don't really convey much in this regard).

Given the high levels of effort placed in the report and quality of data presented it would be advantageous to collapse much of it in tabular form. A table should be able to synthesize the Late Quaternary chronology with reference to the principal exposures that produced the discussed reconstructions. It might be helpful to synthesize the reconstruction of the Holocene landscape around the morphology of the terraces and fans and incorporating the following headings: Terrace Complex, Relief, Terrace Expression (by stretch), Principal Sedimentary Mode, Principal Paleosols, Chronology, Archeological Potential. Many of these issues are addressed in the report but it would be convenient for readers, especially non-specialists, to turn to a single table and extract the key data. The synthesis could also incorporate all the radiometric data and utilize it to identify, if possible, rates of sedimentation, relative stability of landforms, duration of soil forming episodes, and paleo-climatic breaks. Such a synthesis would also be an effective lead in to the comprehensive discussion on Man-Landscape Correlations (last chapter).

Several minor points that might be addressed:

1- It might be advantageous to relate the Coralville geomorphic observations to other landscape and Quaternary stratigraphic models advanced for the Midwest (ie. work in the lower Illinois and Mississippi Valleys). The Bettis and Hoyer (1985) study should be referenced in greater detail.

2- The discussion on Field Investigations (p. 20-21) is a bit scant, especially when compared to the detailed account of grain-size analysis procedures that follows (pp. 21-23).

3- How do you illustrate micromorphologic features in the field even with close-up shots (p.21)? Micromorphological identifications implicitly utilize microscopic examination for identifications.

4- The discussion of the Settlement Alluvium (PSA) is very meaningful and calls attention to a much neglected aspect of stratigraphic investigation. Geomorphologists and stratigraphers remain blind to the significance of historic sedimentation accelerated by the land destructive activities of the past 200 years. I would highlight this discussion in the concluding portion of the report.

5- The landscape units specified for the man-landscape correlation model are inconsistent (pp. 105-106). The first nine units are system-wide landforms, while the tenth (secondary and tertiary drainage systems) is a hydrographic feature and the eleventh (Iowa River Gorge) is a specific location. To avoid confusion I would stick to the system-wide landforms as classificatory units.

In summary, the Anderson & Overstreet report provides an excellent comparative study area for synthesizing the regional geomorphic constructions for Central Iowa. It provides a major contribution for framing hypotheses on Holocene landscape developments. It is hoped that a follow-up study will fix the archeological date to the comprehensive geomorphic and stratigraphic model provided.

END

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