SOIL CHARACTERIZATION AND HYDROLOGICAL MONITORING PROJECT, BRAZORIA COUNTY, TEXAS, BOTTOMLAND HARDWOOD VERTISOLS

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Cover caption: **Site 3 ponded in an area previously mapped as Pledger clay. As a result of this study, the proposed soil series, Churnabog, will be mapped here and in similar areas.**

ABSTRACT

SOIL CHARACTERIZATION AND HYDROLOGICAL MONITORING PROJECT, BRAZORIA COUNTY, TEXAS, BOTTOMLAND HARDWOOD VERTISOLS

Wesley L. Miller and Amanda L. Bragg

The Interagency Soil Characterization and Hydrological Monitoring Project, Brazoria County, Texas, Bottomland Hardwood Vertisols Study (bottomland hardwood study) in the Texas Gulf Coast Prairie was initiated to study soil temperature, morphology, hydrology, reducing conditions, and plant communities to better understand and characterize wet Vertisols (mainly the Pledger soils) and jurisdictional wetland areas in the Columbia Bottomlands in Brazoria and Matagorda Counties, Texas. Soil reducing conditions were measured in nonponded, transitional, and ponded landscapes, with Eh meters and alpha, alpha dipyridyl dye (AADP). A soil characterization study was conducted in 1998 and thirteen soil profiles were described and sampled in nonponded, transition, and ponded areas for chemical and physical analysis by the USDA-NRCS National Soil Survey Laboratory. Field data was collected from 1996 to 2002.

Soil temperature was measured as part of the USDA-NRCS National Soil Survey Center investigation of soil temperature regimes in the southern United States. January was the coldest soil temperature month at the bottomland hardwood study, and average soil temperatures 50 cm for nonponded and ponded sites were 14.1°C. The results of this and other recent soil temperature studies indicated that soil temperatures at 50 cm seldom reach 10°C, and that the growing season, as currently defined, is for a full 12 months each year. Current regulatory guidance for estimating growing season in these regions based on frost dates is technically incorrect, and should be changed to reflect the findings of these studies.

Sites 1 and 5 nonponded microlows ponded during most months with above-normal precipitation and usually ponded for less than 2 weeks. The microlows may meet the current NRCS hydric soil standard of 7 days ponding during normal precipitation months and years. During normal precipitation months and years Sites 1 and 5 nonponded microlows would not meet the USACOE 87 Manual minimum time of 5% of the growing season (14 days), nor 5% of the total year (18 days).

Ponding at Site 1 ponded was mostly during months and years with normal precipitation. Durations were mainly less than 2-continuous-weeks, with one event of 6-continuous-weeks. Site 1 ponded may meet the current NRCS hydric soil standard of 7 days ponding during normal precipitation months and years. During normal precipitation months and years, the site would not meet the USACOE 87 Manual minimum time of 5% of the growing season (14 days), nor 5% of the total year (18 days).

Ponding at Sites 3 ponded edge, 3 ponded middle, and 4 ponded occurred during most months and years with normal precipitation. Ponding durations were mainly for at least 4-continuous-weeks. Sites 3 ponded edge, 3 ponded middle, and 4 ponded met the current NRCS hydric soil standard of 7 days ponding during normal precipitation months and years. During normal precipitation months and years the ponded sites met the USACOE 87 Manual minimum time of 5% of the growing season (14 days), and 5% of the total year (18 days).

The trends in soil gravimetric water content indicated that the soils at the monitoring sites wet from the surface downward, and were episaturated. Most soil water changes were in the upper 50 cm. During ponded conditions, soils were wet satiated (≥50% gravimetric soil water and soil glistened) in ped

interiors to depths of 30 cm within about 2 weeks. During continued ponding the soils were wet satiated in ped interiors to depths of 50 cm within about 3 weeks.

Strong reducing conditions based on Eh readings were observed at 10, 30, and 50 cm at Sites 3 ponded edge, 3 ponded middle, and 4 ponded within 3 to 8 days from the start of four major storm events. AADP dye reaction was 100% very positive in the upper 10 cm within 7 to 8 days from the start of two of the storm events. A positive AADP dye reaction was observed in the surface of the soil immediately below flowing runoff water, and also in the soil at the soil-water interface at ponded sites. Ponded water was always oxygenated based on the observed activity of small animals and insects at all depths. At Sites 1 and 5 nonponded microlows, Eh readings were very similar to the ponded sites. During the length of the study, a few positive reactions to AADP dye (less than about 40% of the soil matrix) were observed in the upper 5-cm of the soil during prolonged periods of above normal wet conditions.

Sites 1 and 5 nonponded, and Site 1 ponded did not have common, easily identifiable redoximorphic features. Sites 3 ponded edge and 3 ponded middle had common to many, easily identifiable redoximorphic features in the upper part in the form of brownish masses of oxidized iron on faces of peds and along root channels. The soils at these two sites had enough redoximorphic features to meet current standards for hydric soils, and met the 2005 NRCS-NTCHS Field Indicator F18 (Reduced Vertic). At Site 4 ponded, easily observable redoximorphic features were less well defined or in many cases were absent. Redoximorphic features at Site 4 ponded in most cases did not meet current standards for hydric soils. However, AADP dye reactions observed at Site 4 during the study met 2005 NRCS-NTCHS Field Indicator F18 (Reduced Vertic).

Pledger soils classify as very-fine, smectitic, hyperthermic Typic Hapluderts. The Pledger series concept is of a nonponded, moderately well drained, dark mollic colored, slightly acid to moderately alkaline Vertisol with distinct gilgai microrelief on bottomland hardwood flood plains. Microlows make up about 10% of the microrelief. Redoximorphic features in the upper 50 cm of Pledger soils (microlow) are typically limited to few 2 to 3 mm iron-manganese nodules. Ponding in microlows is for brief periods during normal precipitation events. Overbank flooding occurs during prolonged periods of above normal precipitation events.

Ponded areas of soils previously mapped as Pledger classify as very-fine, smectitic, hyperthermic Typic Epiaquerts (proposed new series, Churnabog). The Churnabog series concept is of a poorly drained, dark mollic colored, slightly acid to moderately alkaline Vertisol on bottomland hardwood flood plains in abandoned channels and flats. Churnabog soils seasonally pond for long to very long durations from runoff during normal precipitation events, and overbank flooding occurs during prolonged periods of above normal precipitation events. Redoximorphic features in the upper 50 cm of Churnabog soils are common to many masses of oxidized iron on faces of peds and on surfaces along root channels and pores, and few 2 to 3 mm in diameter iron-manganese nodules. Some Churnabog soils lack redoximorphic features in the upper part.

Landscape position is the major key to understanding and documenting hydrology in these bottomland hardwoods. Soils that have wetland hydrology occur in landscape positions that receive run on water from surrounding landscapes to cause wetness over and above normal precipitation. In the Columbia Bottomland Hardwoods, these landscapes are abandoned channels, backswamps, and flats. Digital orthophoto tonal patterns can be used to identify many of these areas.

Soil redoximorphic features that best identify mollic colored hydric and wetland Vertisols in the Columbia Bottomland Hardwoods are common to many masses of oxidized iron on faces of peds and on surfaces along root channels and pores in ponded landscapes. Soils with near neutral reaction, or that are also calcareous, may have very few of these redoximorphic features or not exhibit these features at all, even though they pond and reduce for long to very long periods during normal months and years.

ACKNOWLEDGMENTS

The Soil Characterization and Hydrological Monitoring Project, Brazoria County, Texas, Bottomland Hardwood Vertisols Interagency Study (bottomland hardwood study) was a very long and complicated field study compared to almost all other field studies that USDA-NRCS has conducted as part of the USDA-NRCS National Wet Soil Study program, and especially any similar wet soil studies conducted in Texas. The scope and magnitude of the study would not have occurred except for the importance of wildlife habitat in the bottomland hardwoods, land use changes in the area, and the time frame that the study was initiated during the USDA-NRCS National Wet Soil Study program. The support and participation of key personnel in EPA, USACOE, USFWS, USDA-NRCS soil staff, and university staff at both the local and national level, contributed to the overall success of the long-term bottomland hardwood study.

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select the sites, and for helping install all of the automated equipment. Glen is a very knowledgeable soil scientist and our discussions over the years helped work through many soil classification and interpretation projects. Other Texas NRCS soil staff that helped with the study were Jamey Douglass, Jon Wiedenfeld, Conrad Neitsch, Amanda Bragg, Laurie Kiniry, and Pat Weber. Jamey and especially Amanda helped do the analysis of the field data and prepared the figures and tables used in the report.

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SOIL CHARACTERIZATION AND HYDROLOGICAL MONITORING PROJECT, BRAZORIA COUNTY, TEXAS, BOTTOMLAND HARDWOOD VERTISOLS

Wesley L. Miller and Amanda L. Bragg

1. INTRODUCTION

Background

Over the past 30 years there has been a growing awareness of the importance and unique functions performed by wetlands, particularly bottomland hardwood forests. These forest habitats are known for high biological productivity. The bottomland forests of the Brazos, San Bernard, and Colorado Rivers in Brazoria, Fort Bend, Matagorda, and Wharton Counties, Texas, designated as the Columbia Bottomlands Project Area by U.S. Fish and Wildlife Service (USFWS), have all the biological values of other bottomland hardwood areas, along with the additional importance for neotropical migratory birds (Ault et al., 1995).

At the beginning of the 20th century the hardwood forests of the Columbia Bottomlands occupied nearly 283,000 ha (Ault et al., 1995; U.S. Fish and Wildlife Service, 1997). Due to clearing for agriculture, logging, and commercial and residential development, only about 71,600 ha of bottomland hardwoods remain in the area. In recent times about 3,645 ha per year are lost to similar anthropogenic activities.

Interagency Field Investigation, Brazoria County Bottomland Hardwoods

On May 14-16, 1996, at the request of the Regulatory Branch of the U.S. Army Corps of Engineers (USACOE) Galveston District (CESWG-CO-RC), a meeting and field investigation of wetlands in bottomland hardwoods in Brazoria County, Texas, was conducted involving personnel from the U.S. Environmental Protection Agency (USEPA), USDA-Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), National Biological Service (NBC), and Texas Parks and Wildlife Department (TPWD). The USACOE Galveston District also requested that Dr. James S. Wakeley, representative of the U.S. Army Engineer Waterways Experiment Station (WES), participate in the interagency forum. Dr. Wakeley would provide an opinion as to whether the USCOE Galveston District was interpreting and applying the 1987 Corps of Engineers Wetlands Delineation Manual (87 Manual) (Environmental Laboratory, 1987), and subsequent guidance memoranda from USCOE Headquarters, correctly in this environment.

The meeting was convened by USEPA to address concerns of USFWS that the USACOE Galveston District was not identifying critical forested wetland habitats as jurisdictional under Section 404 of the Clean Water Act (Public Law 92-500, 33 U.S. Congress 1251), thereby contributing to the inexorable destruction of the remaining bottomland hardwood (BLH) resource of the Columbia Bottomlands in Texas. The interagency group discussed the issues involved and visited typical field sites in Brazoria County. Standard wetland delineation data were collected at five sites in two BLH tracts at Peach Point and Dance Bayou Wildlife Areas, and a number of other forest sites were examined without data collection (Wakeley, 1996).

The key points in the Memorandum for Record (Wakeley, 1996) that Dr. Wakeley prepared for the Commander, USACOE Galveston District, following this interagency meeting and field study (Appendix A) are as follows:

Basic Findings

- USACOE Galveston District personnel were well trained and exhibited a thorough understanding of the 87 Manual and its proper use. However, environmental conditions in this region make wetland identification and delineation unusually difficult, particularly with regard to soils and hydrology. In his opinion, areas meeting jurisdictional wetland criteria could be potentially overlooked because of the difficulty of identifying hydric soils and wetland hydrology in these systems.

- Future efforts to improve the accuracy of jurisdictional delineations in bottomland hardwood (BLH) forests of coastal Texas should focus on the difficult problem of identifying areas that are frequently ponded or flooded for long duration during the growing season and that may, nonetheless, lack easily recognizable indicators of hydric soils or wetland hydrology. Because USACOE wetland determinations must be defendable in a court of law, development and use of new or modified methods for identifying wetlands in the region must be supported by rigorous scientific study and testing.

Hydrophytic Vegetation Determinations

- Hydrophytic vegetation determinations are relatively straightforward in coastal Texas BLH and do not present a problem for wetland delineations. However, communities meeting hydrophytic vegetation criteria appeared to extend well above any recognizable wetland boundaries. Therefore, during the field investigations, wetland boundaries were identified mainly on the basis of hydric soils and/or wetland hydrology indicators.

Hydric Soil Determinations

- Soils in the area are mainly Vertisols and many of the problem sites visited were mapped as Pledger clay (very-fine, smectitic, hyperthermic Typic Hapludert). Vertisols crack to considerable depths during dry periods. They absorb water quickly through macropores (cracks) after rainfall events, causing clays to swell and cracks and soil surfaces to seal. Subsequently, additional rainfall moves as runoff to low areas in the landscap, where water may pond for long periods. The soil matrix may never fully saturate and, therefore, may not exhibit typical hydric soil indicators. However, the USACOE recognizes soils as hydric if they meet criteria for flooding and ponding, whether or not hydric soil indicators are present.

- Another soil property affecting the presence of hydric soil indicators in these soils is the relatively high pH (above pH 7). Alkaline pH inhibits the formation of redoximorphic features by lowering the threshold redox potential required to reduce and mobilize iron and manganese. Furthermore, these Vertisols have thick, dark surfaces (value/chroma of 3/2 or less). This soil characteristic was recognized as a problem in the 87 Manual due to the potential for organic matter to mask the presence of redoximorphic features near the soil surface.

- Soils in the wettest landscape positions in the BLH are black (2/1or N 2/), and yet may not exhibit redoximorphic features. Some of the soils examined contained ferromanganese concretions with (for the most part) hard, smooth boundaries consistent with relict features and lacked the diffuse corona that would indicate contemporary features. Short of long-term monitoring studies that may help to identify new hydric soil indicators for these problem soils, perhaps the only way to identify many

hydric Vertisols in this region is to demonstrate that the soils in question meet hydric soil criteria for ponding or flooding.

Wetland Hydrology

- The interagency group generally agreed that most of the BLH areas in question were not subject to overbank flooding from rivers and streams frequently enough or for long enough duration to meet wetland hydrology criteria due to flooding. The main source of wetland hydrology apparently is ponding in low landscape positions after heavy rains.

- Wetland hydrology indicators were present, but not strongly expressed at most of the sites that were visited. Observed indicators included water marks on trees (salt lines, dark staining or abrupt moss lines), drifted leaf litter and debris, occasional water-stained leaves, one instance of oxidized rhizospheres, and a plant community that passed the FAC-neutral test. Indicators of ponding that could not be tied clearly to those listed in the 87 Manual included matted leaves on the soil surface, very sparse cover of ground-layer plants, and low landscape position.

- For the aforementioned reasons, identification of areas in coastal Texas that pond water for long periods during the growing season may be the key to wetland identification and delineation. Unfortunately, presence of wetland hydrology indicators listed in the 87 Manual (e.g., water marks, debris lines, sediment deposits) provide very little support for wetland hydrology criteria, including timing, frequency, and duration. The USACOE has always accepted *documented* direct evidence of inundation (e.g., gauge data; aerial photographs showing repeated long-duration ponding or flooding; systemically recorded observations by reliable observers) as strong evidence for wetland hydrology. However, anecdotal observations and undocumented impressions could not be defended in court and are unacceptable evidence of wetland hydrology. NRCS has also used satellite data to identify areas meeting the required inundation criteria for farmed wetlands. Such data are acceptable if they lead to a strong likelihood that the site is inundated or saturated continuously for at least 5% of the growing season in most years (50% probability of recurrence). The growing season is usually approximated as the period between the average date of last occurrence of 28° F air temperatures in spring and the average first occurrence of 28° F temperature in fall, based on local weather station data.

Recommendations

- There are no easy solutions to the problem of wetland identification in the Texas coastal region. Some technical steps that can be taken include the following:

- Attempt to identify more reliable indicators of hydric soils by initiating long-term studies of soil hydrology and morphology within important problem soil units, such as Pledger clay. Studies should use methods similar to those developed in Texas and Louisiana during the 1980's for aquic soil moisture regimes in relation to soil taxonomic classification (Soil Survey Staff, 1999). Studies should focus on soil catenas or gradients to provide information useful in delineating hydric soil boundaries. At a minimum, soil monitoring data might include ferrous iron tests, redox potentials, and tensiometer data.

- Identify reliable indicators of frequent, long-duration ponding by monitoring depth and extent of surface water at selected sites, and correlating with observed environmental features such as types of water marks, leaf litter color or distribution, or soil surface characteristics.

- Develop methods for direct identification and mapping of areas subject to long-duration ponding, such as use of aerial photography or satellite multispectral data.

Interagency Memorandum of Agreement Objectives

Vertisols in Brazoria County bottomland hardwoods, typically mapped as Pledger clay, were identified as *problem soils* (Environmental Laboratory, 1987) during the interagency field study in 1996 because of the thick dark surfaces and the potential for organic matter to mask the presence of redoximorphic features near the surface (Wakeley, 1996) (Appendix A) (Appendix B). Based on the May 1996 meeting and field study, the federal and state agencies involved in the study jointly decided to initiate a long term monitoring study of representative landscapes to document soil morphology, hydrology, and plant communities to address the issues discussed in Dr. Wakeley's memorandum. In October 1997, a Memorandum of Agreement (MOA) to initiate such a study was signed by representatives of the USEPA (Region 6), USACOE (Galveston District), USFWS (Region 2), USDA-NRCS (Temple, TX), and TPWD (Austin, TX) (Appendix A).

The objective of the MOA for the Soil Characterization and Hydrological Monitoring Project, Brazoria County, Texas, Bottomland Hardwood Vertisols Study (bottomland hardwood study) was to establish an agreement among the signatory federal and state agencies on procedures to identify and develop reliable field indicators for delineating wetlands in the forested bottomlands in the lower Brazos and San Bernard River basins in Brazoria, Fort Bend, Wharton, and Matagorda Counties, Texas. These field indicators will be based on the soil, hydrology, and vegetation parameters as described in the USACOE Wetland Delineation Manual, which is used to determine the geographic extent of the waters of the United States with respect to Section 404 of the Clean Water Act.

As presented in the MOA, the outline of the proposed study was as follows;

- Conduct hydrological monitoring study to determine actual frequency and duration of soil saturation and inundation, and presence of reducing conditions.
- Measure soil temperature to establish true growing season of native wetland vegetation.
- Conduct field studies of vegetative communities to correlate vegetation with soil hydrology and morphological features.
- Update soil survey of area and establish new soil series as needed.

As presented in the MOA, the following parameters will be measured:

- Water tables.
- Ponding depth and duration.
- Soil and air temperature, precipitation.
- Soil reduction.
- Soil characterization (redoximorphic features, etc.).
- Vegetation (correlate with soil and hydrology).

Sites were selected jointly by participating agencies based on landscape position, vegetation, and soils. Five sites were proposed for the study, one site that represented the Pledger series concept, three sites across a

relatively short distanced hydrologic catena (one relatively dry, nonponded; one intermediate in a transition zone; and one in a ponded, wet landscape position), and one site at another intermediate position.

The study required specialized equipment such as piezometers, platinum electrodes, and automated data recorders. It was agreed that the participating agencies would, according to their abilities, contribute financial, technical, and human resources, as resources allowed, ensuring a successful project.

NRCS provided technical leadership in obtaining and installing monitoring equipment, as well as financial support for the project. NRCS will purchase initial equipment and maintain the equipment throughout the study.

Previous Wet Soil Studies in the Texas Gulf Coast Prairie Major Land Resource Area

Wet soil studies were initiated in Texas and Louisiana in 1988 for the purpose of providing study sites for the International Committee on Aquic Moisture Regimes (ICOMAQ), as part of the VIII International Soil Correlation Meeting, Management and Classification of Wet Soils, (VIII ISCOM, 1990) (Kimble, 1992). NRCS (with continued funding from their Global Warming Project) sponsored these studies (Wakeley, 2002). ICOMAQ was one of several international committees formed at the time to work on designated topics related to improving and revising *Soil Taxonomy* (Soil Survey Staff, 1975).

The ICOMAQ studies were directed by Dr. Wayne Hudnall at Louisiana State University and Dr. Larry Wilding at Texas A&M University, in collaboration with NRCS soil scientists. Fourteen sites representing nine different soil series were selected within the Texas Gulf Coast Prairie Major Land Resource Area (MLRA). Six sites were located in Jefferson County, two in Harris County, and six in Victoria County. The ICOMAQ study was one of the first national wet soil studies to develop standard methods for observing and measuring wet soil field conditions (Kimble, 1992). Typical wet soils were selected in different representative landscape positions. The field studies involved detailed description, instrumentation, characterization, and analysis of a number of different soils. At each site, depth, duration, and frequency of soil saturation were monitored at 2-week intervals with replicated piezometers and tensiometers installed at different depths in the soil profile. Soil reducing conditions were determined every 2 weeks by measuring redox potential with platinum electrodes at each depth and by a chemical test for ferrous iron in the soil using alpha, alpha dipyridyl dye (AADP dye).

Before the VIII ISCOM meeting a contingent of approximately100 international, university, and government soil scientists conducted a 2-week field tour of the study sites in Louisiana and Texas. During the tour, soil profiles and soil morphology were observed at the study sites and results of the field studies were discussed. During the VIII ISCOM meeting, members of various sub-committees drafted proposals for revisions to *Soil Taxonomy* (Soil Survey Staff, 1975) concerning wet soils and the development of the concept of aquic soil conditions (Soil Survey Staff, 1999).

In response to the ICOMAQ study and the start of the Global Change Initiative, NRCS decided in 1991 to initiate additional projects in other wet soil landscapes and climates (Wakeley, 2002). The National Wet Soil Monitoring Project was a coordinated effort among investigators from NRCS and Land Grant universities in eight states.

Coincidentally the USACOE initiated its Wetlands Research Program, which, among its other objectives, sought to strengthen the technical foundations of the 87 Manual and refine methods for field investigation of hydric soils (Wakeley, 2002). At the invitation of NRCS, representatives of the U.S Army Engineer Waterways Experiment Station (Dr. Steve Sprecher and Dr. Jim Wakeley) attended a coordination meeting for NRCS and university project leaders. Participants discussed the relevance of the project to hydric soil issues,

offered suggestions for research design to help address regulatory issues, and provided funds for the additional projects.

The main purpose of the NRCS-sponsored wet soil studies was to document wet soil morphology, hydrology, chemical processes, and reducing conditions (Kimble, 1992). This information would then be used to improve both soil classification criteria in *Soil Taxonomy* (Soil Survey Staff, 1999) and soil classification and interpretations as part of the National Cooperative Soil Survey. The USDA-NRCS National Technical Committee for Hydric Soils (NTCHS), after reviewing the field data and in most cases visiting the field sites, also used the information to develop technical standards for hydric soils in the Field Indicators of Hydric Soils in the United States (USDA-NRCS, 2002a).

Geology and Soils of the Columbia Bottomland Hardwoods

Geology

The Holocene age fluviatile sediments of the Columbia Bottomland Hardwoods, specifically in Brazoria and Matagorda Counties, were deposited by the Brazos, San Bernard, and Colorado Rivers and several minor streams that meandered across sediments originally deposited by these major rivers (Aronow, 1978). The area is labeled as the Modern/Holocene Brazos and Colorado River Fluvial-Deltaic geologic unit as mapped by Fisher et al. (1972) and McGowen et al. (1976). The bottomland hardwoods fluvial sediments and their major associated soils can be divided into two groups of landforms, including the clayey Pledger and Brazoria soils in backswamps and abandoned channels, and the loamy Norwood and Asa soils on meander belts, point bars and natural levees (Crenwelge, 1981).

Meander belts are described as the landscape within which migration of a meandering stream channel occurs. Landforms within a meanderbelt include backswamps, point bars, abandoned meanders, meander scrolls, oxbow lakes, natural levees, and flood-plain splays (USDA-NRCS, 2005b).

Backswamp deposits are usually flat, poorly drained areas (flats) bounded by uplands and/or other features such as natural levees. Surface deposits are fine-grained sediments that were slowly deposited in slack-water conditions. Backswamps characteristically have substrates of massive clays and are incompletely drained by small, anastomosing, streams. They may include areas that do not fully drain through the channel systems but remain ponded well into the growing season (Smith and Klimas, 2002).

Abandoned channel deposits are the result of cutoffs, where a steam abandons a channel segment either because flood flows scoured out a point bar swale and created a new main channel (chute cutoff) or because migrating bendways intersect and channel flow moves through the neck (neck cutoff). Chute cutoffs tend to be relatively small, fill rapidly with sediment and persist as large depressions, while the upper and lower ends of neck cutoffs quickly fill with sediment, and form open oxbow lakes (Smith and Klimas, 2002). Abandoned channels often become depressions with heavy (clayey) soils as the filling process is dramatically slowed, and they may persist as open lakes or depressions of various depths and dimensions.

Point bar deposits generally consist of relatively coarse-grained materials (silts and sands) laid down on the inside (convex) bend of a migrating stream channel (Smith and Klimas, 2002). The migration and progradation of point bars varies with sediment supply, flood stage, and other factors. The result is a characteristic topography of low arcuate ridges separated by swales.

Natural levees form when overbank flows result in deposition of relatively coarse sediments (sand and silt) in a broad low ridge or embankment adjacent to the stream channel when water overflowing the normal stream bank is forced to deposit the coarsest part of its load. The material is deposited as a continuous sheet

that thins with distance from the stream, resulting in a relatively high ridge along the bankline and a gradual backslope that becomes progressively more fine-grained with distance from the channel.

Surface substrates within a meanderbelt generally grade from relatively coarse-textured, well-drained, higher elevation soils on natural levees near the river and stream channels, through progressively finer-textured and less well drained materials on levee backslopes and point bar deposits, to very heavy clays in closed basins within large swales and abandoned channels. Backswamp deposits between meander belts are also heavy clays (Smith and Klimas, 2002). The gradient of increasingly fine textures from high-energy to low-energy environments of deposition (natural levees to abandoned channels and backswamps) implies increasing soil organic matter content, increasing cation exchange capacity, and decreasing permeability. However, all of these patterns are generalizations, and deposits can be highly variable.

Soils

The Holocene deposits of the Brazos and Colorado Rivers have a characteristic reddish-brown or yellowish-red color, as can be seen in the lower part of the profiles of the Pledger-Brazoria and Asa-Norwood map units on the General Soil Map of Brazoria County (Aronow, 1978; Crenwelge, 1981). The reddish ferric-oxide pigment is traditionally thought to be derived from the Permian red beds into which the drainage basins of these streams penetrate several hundred miles to the north and west. The reddish colors are also occasionally seen in deep excavations in the Pleistocene deposits of these streams. A stratigraphic marker of Pleistocene paleo-Colorado River sediments, consisting of an accumulation of biotite, was found during soil survey fieldwork in Jackson County, Texas (Miller, 1986). This stratigraphic marker was also found in Holocene and Pleistocene deposits of the Colorado River in Brazoria and Matagorda Counties (Jacob et al., 1986).

The predominant soils of the Columbia Bottomland Hardwoods are Pledger, Brazoria, Asa, and Norwood soils (Crenwelge, 1981). Pledger and Brazoria soils are clayey soils on bottomlands in backswamps and abandoned channels. Pledger soils have plane, nearly level slopes. Typically Pledger soils are black clays about 64 cm thick over reddish brown silty clay and clay to a depth of 164 cm. Brazoria soils have slightly concave, nearly level slopes and are slightly lower in elevation than the Pledger soils. Typically, Brazoria soils are dark reddish brown clay to a depth of 170 cm.

Asa and Norwood soils are loamy soils on bottomlands in meander belts, point bars and natural levees. Asa and Norwood soils have nearly level, convex slopes. Typically, Asa soils are brown silty clay loam about 36 cm thick over reddish brown silty clay loam to a depth of 154 cm. Typically, Norwood soils are reddish brown silt loam about 53 cm thick. Below that to a depth of 167 cm is yellowish red very fine sandy loam in the upper part and reddish brown silt loam in the lower part.

Vertisol Morphology and Hydrology

Morphology

Vertisols are a group of soils distinguished by high amounts of shrink-swell clays; minimal horizon differentiation due to pedoturbation; pronounced changes in volume with changes in water content resulting in deep, wide cracks in the dry seasons; very plastic and sticky soil consistency when wet; and unique subsurface structure features called slickensides (Mermut et al., 1996b). The shrink-swell process (volume change) due to wetting and drying of the smectitic clay minerals associated with Vertisols can generate swelling pressures in the order of 1 to 5 kg per square cm (Ahmad, 1983). Associated with the swelling and volume change characteristic is surface vertical movement (heave) in the order of 10 to 20 cm to an extreme of 45 to 90 cm based on laboratory analysis and case studies of building foundation failures (Fredlund, 1996).

The physical behavior of Vertisols commonly results in surface microrelief called gilgai. Gilgai is an Australian aborigine term meaning "little water hole" and consists of slight depressions and mounds (Ahmad, 1996) (Paton, 1974). Normal (circular) gilgai is a term usually used to describe gilgai with slight depressions and mounds in an irregular pattern on nearly level landscapes. Melon hole gilgai is a term also used in Australian literature for gilgai areas on nearly level landscapes where the microlows are very distinct isolated depressions surrounded by microhighs. Linear gilgai occurs on sloping land and is orientated with the slope gradient.

Distinct gilgai surface mound and depression features (well defined and easily discernable) are further subdivided into microhigh, microslope, and microlow (Fig. 1) (Miller et al., 2005; Soil Survey Staff, 1993). The microhigh is convex and occurs along the top part of the mound. The microlow is concave and occurs along the bottom part of the depression. The gently sloping area between the lower part of the microhigh and the upper part of the microlow is the microslope. Distance between microhighs and adjacent microlows is commonly in the range of 2 to 5 m. Measured elevation differences between the top of microhighs and bottom of microlows range from about 20 to 50 cm in the Texas Gulf Coast Prairie (W. L. Miller, unpublished data, 2002).

Associated subsurface features to microlow, microslope, and microhigh are denoted respectively as bowl, intermediate, and chimney (Fig. 1) (Miller et al., 2005; Soil Survey Staff, 1993). The bowl position is a cup or trough shaped subsurface feature under the microlow, and bounded along its base by master slickensides. The intermediate position is a transition zone between the chimney and bowl, and is under the microslope surface feature. The chimney position is composed of substratum material that appears to upwell and reach close to the surface under the microhigh or upper part of the microslope surface features. In some Vertisol landscapes the chimney material is exposed at the surface and is called a puff (Paton, 1974). Chimney material (microhigh) is usually lighter in color, more alkaline, and has less organic matter content than the associated bowl material (microlow). In many cases the chimney material is also calcareous and contains pedogenic carbonates in the form of calcium carbonate nodules.

Pedogenic carbonates in the Texas Gulf Coast Prairie Vertisols form by leaching of detrital carbonate in the fine earth fraction of the sediments to just below the effective meteoric infiltration (Stiles, 2001). Isotopic profile shapes are similar for microhigh and microlow calcium carbonate nodules that are less than about 1 cm in diameter (Nordt et al., 1998; Stiles, 2001) (Claudia Mora, personal communication, 2001). Larger calcium carbonate nodules tend to be isotopically zoned, indicating that they started deep in the bowl (microlow) and were pushed up toward the surface along major slickensides in the intermediate (microslope) and chimney (microhigh) material with time.

NRCS and university staff formal soil characterization studies of many Vertisols in the Texas Gulf Coast Prairie have documented the physical and chemical spatial variability among soils in the microhigh, microslope, and microlow. This same trend has also been documented in many other national and worldwide Vertisol studies (Coulombe et al., 1996; Mermut et al., 1996a; Wilding et al., 1990).

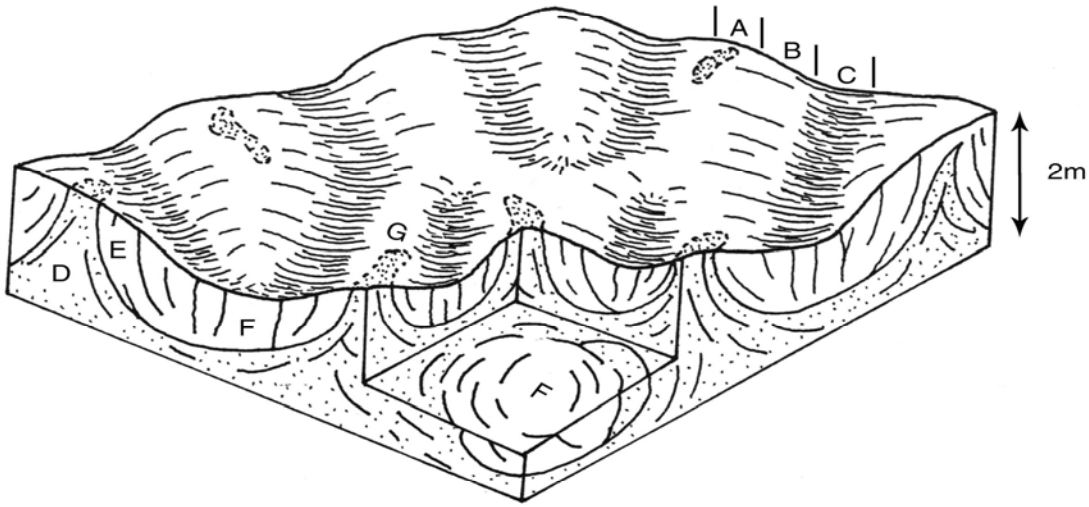


Fig. 1. Schematic block diagram showing microvariability of a Texas Gulf Coast Prairie Vertisol, gilgai microrelief, and surface and subsurface features. Surface features are microhigh (A), microslope (B), and microlow (C). Subsurface features bounded by major slickensides are chimney (D), intermediate (E), and bowl (F). A surface exposure of the chimney is called a puff (G).

Hydrology

Due to the fine texture and predominant smectitic mineralogy of the clay fraction, Vertisols are capable of absorbing considerable amounts of water on wetting and retaining much of it on desiccation (Ahmad, 1983). Using NSSL bulk density values of clay samples from the upper 30 cm of Vertisols in the Texas Gulf Coast Prairie, pore space of the clay ranges from about 50 to 60% (Appendix C). Precipitation amounts needed to saturate the clay on a theoretical basis range from about 5 to 6 cm for the upper 10 cm, 7 to 8 cm for the upper 15 cm, and 13 to 15 cm for the upper 30 cm (Cristine Morgan, personnel communication, 2006; Larry Wilding, personnel communication, 2004).

Infiltration into Vertisols ranges from very slow to relatively fast depending on soil-water content and chemical status under normal field conditions. Measured infiltration rates range from 2.4 to 6.7 cm per day depending on initial soil-water content and exchangeable sodium content of the clay. These studies also showed that by using water tagged with fluorescein, flow of water was active only around structural units (peds) and that the rate of movement through the soil decreased markedly with time (Ahmad, 1983).

Vertisols have bimodal pore distribution because of the cracks (macropores) and the high clay content (micropores). The large cracks that are characteristic of Vertisols when dry act as large conduits for unimpeded downward water flow (bypass flow). This is in contrast to the very fine pores of the soil matrix where water flow is always very slow (Jacob et al., 1997). Studies by Griffin et al. (1992) show that during above normal precipitation events when Vertisols are dry and cracks are open, free water quickly reaches depths of 50 to 100 cm due to bypass flow. After periods of 2 to 3 months of very wet conditions, free water

from bypass flow can reach depths of 200 cm based on piezometer measurements. The soil matrix at 200 cm is not saturated based on field observations (W.L. Miller, unpublished data, 1992). The bimodal pore distribution greatly complicates characterizing water movement in Vertisols and increases the complexity of measuring and understanding field measurements because water movement is dynamic in both time and space.

The other implication of bimodal pore distribution is that there usually is a long lag time for hydrologic equilibrium between the macropores (cracks, slickensides, and inter-ped spaces) and the soil matrix (ped interiors) (Jacob et al., 1997). Free water may be on ped exteriors but ped interiors may not be saturated. For Vertisols that wet from the top down (episaturation and ponding), during the wetting phase free water and saturation first occurs in the macropores and ped exteriors. With time and continued wet conditions the micropores and ped interiors saturate. During the drying phase, macropores dry first and ped interiors dry last.

Field measurement of free water and saturated conditions in Vertisols is problematic due to the bimodal pore distribution and bypass flow. Standard methods agreed to by most soil researchers to measure free water and saturated conditions in Vertisols include piezometers (Griffin et al., 1992; Richardson et al. 1997; U.S. Army Corps of Engineers, 2005) and gravimetric soil water samples (USDA-NRCS, 2004).

2. MATERIALS AND METHODS

Monitoring Site Selection and Description

Five monitoring sites within the Texas Gulf Coast Prairie Major Land Resource Area (MLRA) were initially selected in 1996 to conduct a wet soil study of Vertisols in bottomland hardwoods in Brazoria and Matagorda Counties (Fig. 2). Extensive review of aerial photography and soil survey maps and ground reconnaissance of the areas were conducted prior to site selection. Representatives from each of the federal and state agencies involved in the study met in the field and selected the exact location of each monitoring site (Sprecher, 1996; Theriot and Sprecher, 1998).

Four monitoring sites were selected at the USFWS Dance Bayou Unit of the San Bernard National Wildlife Refuge in the vicinity of Dance Bayou in Brazoria County (Fig. 3) and one monitoring site was selected at the Phillips Unit of the San Bernard National Wildlife Refuge in Matagorda County near Linnville Bayou. Monitoring site placement intended to characterize a toposequence that represented a nonponded area, a transition between nonponded and ponded areas, and a ponded area. Vegetation changes and elevation differences were used to make these determinations. Monitoring sites were also selected with good surface expression of gilgai microrelief, a typical microfeature of Vertisols and the Pledger series concept (very-fine, smectitic, superactive, hyperthermic Typic Hapluderts). Following the August 1998 Soil Characterization Study, two additional monitoring sites at the Dance Bayou Unit were recommended by national level NRCS and USACOE soil scientists. As a result, a total of seven monitoring sites were selected for this study with multiple monitoring locations at Sites 1 and 3 (Table 1).

Soil Characterization Study and Field Soil Transects

A soil characterization study was conducted near each of the monitoring sites in 1998. The purpose of the soil characterization study was to select and describe representative soil profiles near the monitoring sites, and obtain samples of each horizon of the soil profiles for complete physical, chemical, and mineralogical analyses by the NRCS National Soil Survey Laboratory (NSSL) in Lincoln, NE.

In the initial phase of this soil characterization study, NRCS soil scientists, university staff, and university graduate students ran transects across nonponded and ponded areas near each of the monitoring sites. NRCS

vehicles with power steel probes measuring 1.25 m in length and 4.5 cm or 2 cm internal diameter, were used for these transects. Soil profiles were generally described to a depth of 1 meter. In each transect, several soil profiles were described to depths of 4 to 5 m using several probe extensions measuring 1.5 m in length. In addition, numerous small pits were dug to 50 cm in selected areas to describe soil features in more detail.

In August 1998, trenches approximately 1 m wide and 1 to 1.5 m deep were excavated by a backhoe. At the nonponded and adjacent ponded sites, one end of the trench started in a known nonponded area and traversed into the middle of the adjacent ponded area. At Sites 1 the trench was about 30 m long. At Sites 2 and 3 the trench was about 60 m long. At Site 4 the trench was about 10 m long and was only in a ponded area. At Site 5 the trench was about 10 m long and was only in a nonponded area.

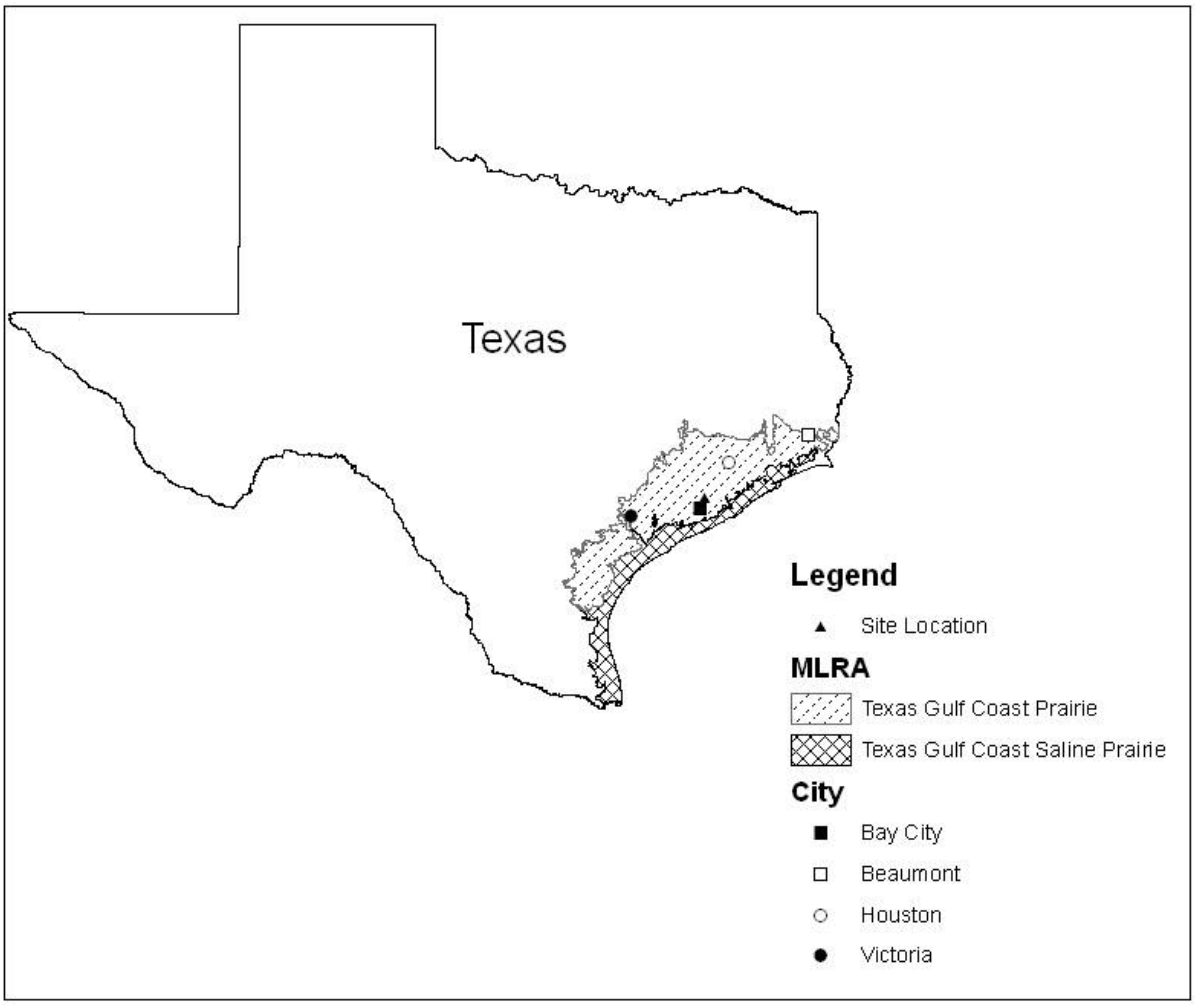


Fig. 2. Map of the Texas Gulf Coast Prairie and Texas Gulf Coast Saline Prairie showing bottomland hardwood study site location (Site location), and the locations of Bay City, Beaumont, Houston, and Victoria, Texas.

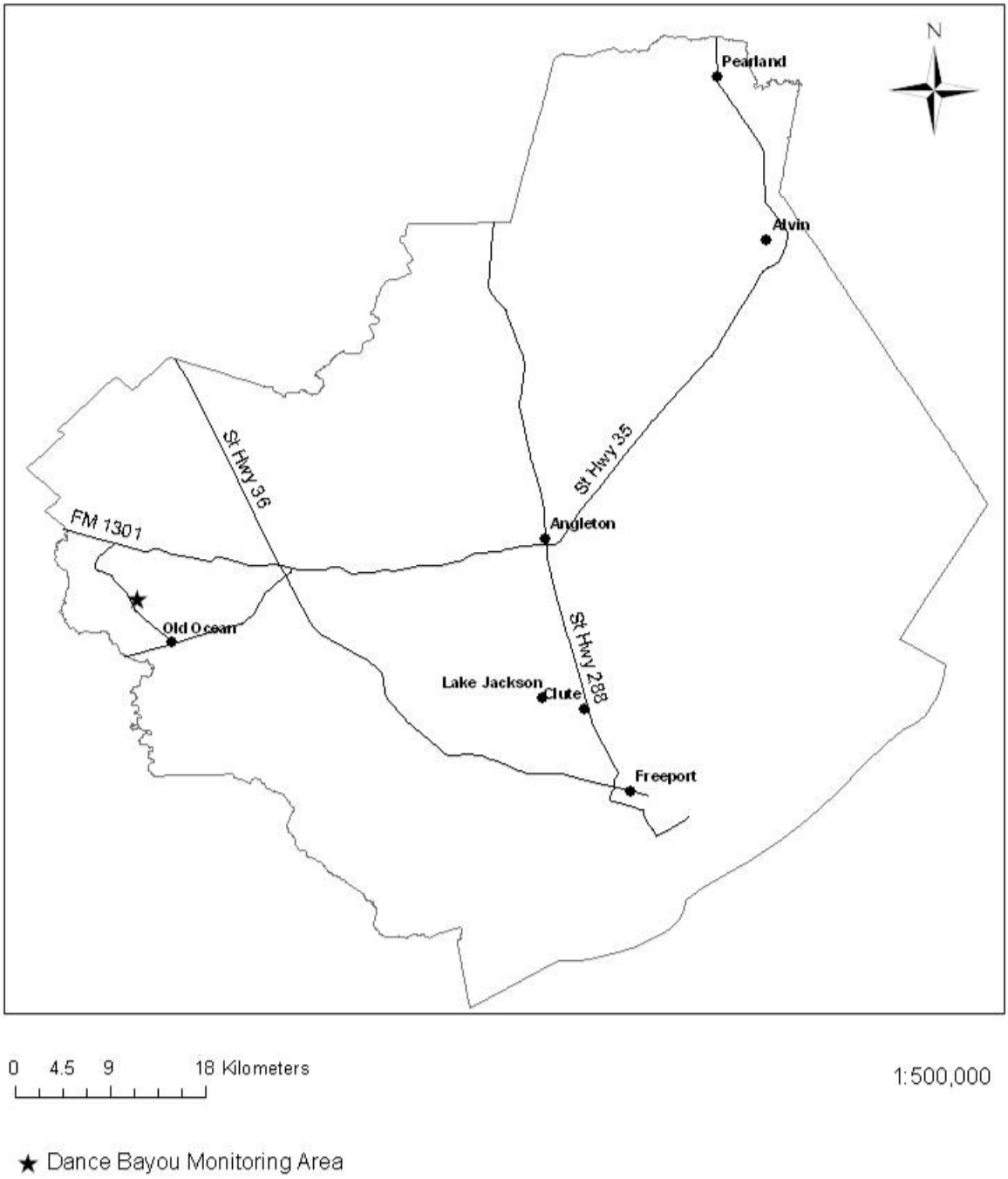


Fig. 3: Map of Brazoria County and location of the Dance Bayou monitoring area.

Soil morphology was carefully observed along the trench face to select pedons that were representative of the particular landscape (nonponded, transition, and ponded). Previous documentation on ponding levels was also referenced for soil pedon selection. University staff, and NRCS and USACOE soil scientists agreed on the location of each soil pedon for sampling. Where subsurface chimneys and bowls were exposed in the trench (all sites except Site 4), sampled pedons were selected both in the bowl position under the microlow and in the intermediate position under the microhigh or upper microslope and slightly to one side of the chimney. A total of 13 pedons were selected for sampling. About 20 representatives from academia, NRCS, USACOE, USFWS, and TPWD participated in the week-long field soil characterization study. An electric generator and four large floor fans were provided for safety purposes during the five day field study due to the high temperatures, humidity, and the resultant high heat index.

Profiles were excavated to a depth of over 2 m and soil properties were described using standard terminology (Schoeneberger et al., 2002; Soil Survey Staff 1993; USDA-NRCS, 2002a; Vepraskas, 1995). Percentages of observed redox features in the soil profiles were determined by the point intercept method (number of observed features along a 50 or 100 cm distance) and by comparing the redox features in a soil sample to standard pages showing quantity (percent) of area covered (Schoeneberger et al., 2002). Bulk soil samples were collected from each horizon for routine physical, chemical, and mineralogical analysis by the NSSL. A total of 13 soil pedons were selected for sampling and NSSL analysis. Descriptions for each soil profile are listed in Appendix B, and physical and chemical data for each soil horizon are listed in Appendix C. Monitoring site designations, landscape descriptions, and NSSL pedon identification (ID) numbers are shown in Table 1. Monitoring Sites 1 through 4 were at the Dance Bayou Unit in Brazoria County, and Site 5 was at the Phillips Plant Unit in Matagorda County.

Table 1. Monitoring site designations, landscape descriptions, and NSSL user pedon ID numbers (S98TX 039-001) and corresponding report reference numbers (TX39-1).

1. Site 1 nonponded, (flood plain with distinct gilgai microrelief)
   microlow - S98TX 039-001 (TX39-1)
   microhigh - S98TX-039-001A (TX39-1A)
2. Site 1 ponded (abandoned channel without distinct gilgai microrelief)
   microlow - S98TX-039-002 (TX39-2)
   microhigh - S98TX-039-002A (TX39-2A)
3. Site 2 nonponded (flood plain with distinct gilgai microrelief)
   microlow - S98TX-039-003 (TX39-3)
   microhigh - S98TX-039-003A (TX39-3A)
4. Site 3 ponded edge (outer ponding edge and transition zone of abandoned channel with distinct gilgai microrelief above ponding edge)
   microlow - S98TX-039-004 (TX39-4)
   microhigh - S98TX-039-004A (TX39-4A)
5. Site 3 ponded middle (near center of abandoned channel without distinct gilgai microrelief)
   microlow - S98TX0-039-005 (TX39-5)
   microhigh - S98TX-039-005A (TX39-5A)
6. Site 4 ponded (flat or backswamp depression without distinct gilgai microrelief)
   small depression - S98TX-039-006 (TX39-6)
7. Site 5 nonponded (flood plain with distinct gilgai microrelief)
   microlow - S98TX-039-007 (TX39-7)
   microhigh - S98TX-039-007A (TX39-7A)

At the Dance Bayou Unit, Sites 1 nonponded and 1 ponded were within about 30 m of each other (Figs. 4 and 5). Sites 2 nonponded, 3 ponded edge and 3 ponded middle were about 210 m south of Site 1 (Fig. 5). About 30 to 40 m separated Sites 2 nonponded, 3 ponded edge, and 3 ponded middle. Site 4 was about 630 m south of Sites 2 and 3 (Fig. 5). At the Phillips Unit Site 5 was about 7 km south of the Dance Bayou Unit monitoring sites (Figs. 4 and 6).

Soil scientists described three, 150-m soil transects near the monitoring sites in August, 2000. The purpose of the transects was to obtain detailed descriptions of soil colors and redox features in the upper 50 cm of nonponded, transition and ponded locations. One transect was near Sites 1 nonponded and 1 ponded; one transect was near Sites 2 nonponded, 3 ponded edge, and 3 ponded middle; and one transect was near Site 4 ponded.

Soil pedons were selected every 5 m along the 150-m transect to include 15 pedons in nonponded areas and 15 pedons in adjacent ponded areas. As much as possible, the 15 nonponded pedons were on either side of the ponded areas (7 or 8 pedons on either side of the ponded area). Where distinct gilgai occurred, both microhighs and microlows were described every 5 m. At each 5-m interval a soil pit was dug to slightly deeper than 50 cm, and a soil slice was taken from one side of the pit. Description procedures of soil color and redox features in these transects were similar to those used on the soil characterization pedons.

Soil scientists plotted four additional transects in areas with distinct gilgai microrelief to document percent composition and size of microlows, and elevation differences between tops of microhighs and bottoms of microlows. Two 50-m transects were conducted near Site 1 nonponded, one 40-m transect in an area near Site 2 nonponded, and one 40-m transect in an area near Site 5 nonponded.

For the gilgai microrelief transects, the microlow areas were recognized and delineated when the bottom, concave area, which was covered by blackened leaves, was crossed by the transect line. At each microlow the approximate distance of the microlow along the transect line was recorded as well as the length and width of the microlow.

The elevation difference between tops of microhighs and bottoms of microlows was determined by placing one end of a carpenter's level (122 cm in length) on top of a microhigh and placing the other end over the bottom of the adjacent microlow at its deepest point. After achieving a level position, the distance from the end of the carpenter's level over the microlow to the bottom of the microlow was measured. A similar method was used to measure the depth of the blackened leaf area at the bottom of the microlow.

During the course of the study, PVC pipes were used as bench marks to mark points along soil transects; the middle, transitional, and outer edges of ponding; observed points of vegetation changes; monitoring sites; and other points of field data collection interest. These points and relative elevation differences were marked and recorded by NRCS employees with an Ashtech Z Surveyor (RTK Sub centimeter GPS Unit), a TopCon Total Station GTS3B, and a Garmin GPSMAP 76 unit (GPS unit) (mention of equipment used is not an endorsement for the equipment or the manufacturing company). Relative elevation points were determined from nearby USGS bench marks and also from accurate measurements of ponded water depths during the study period.

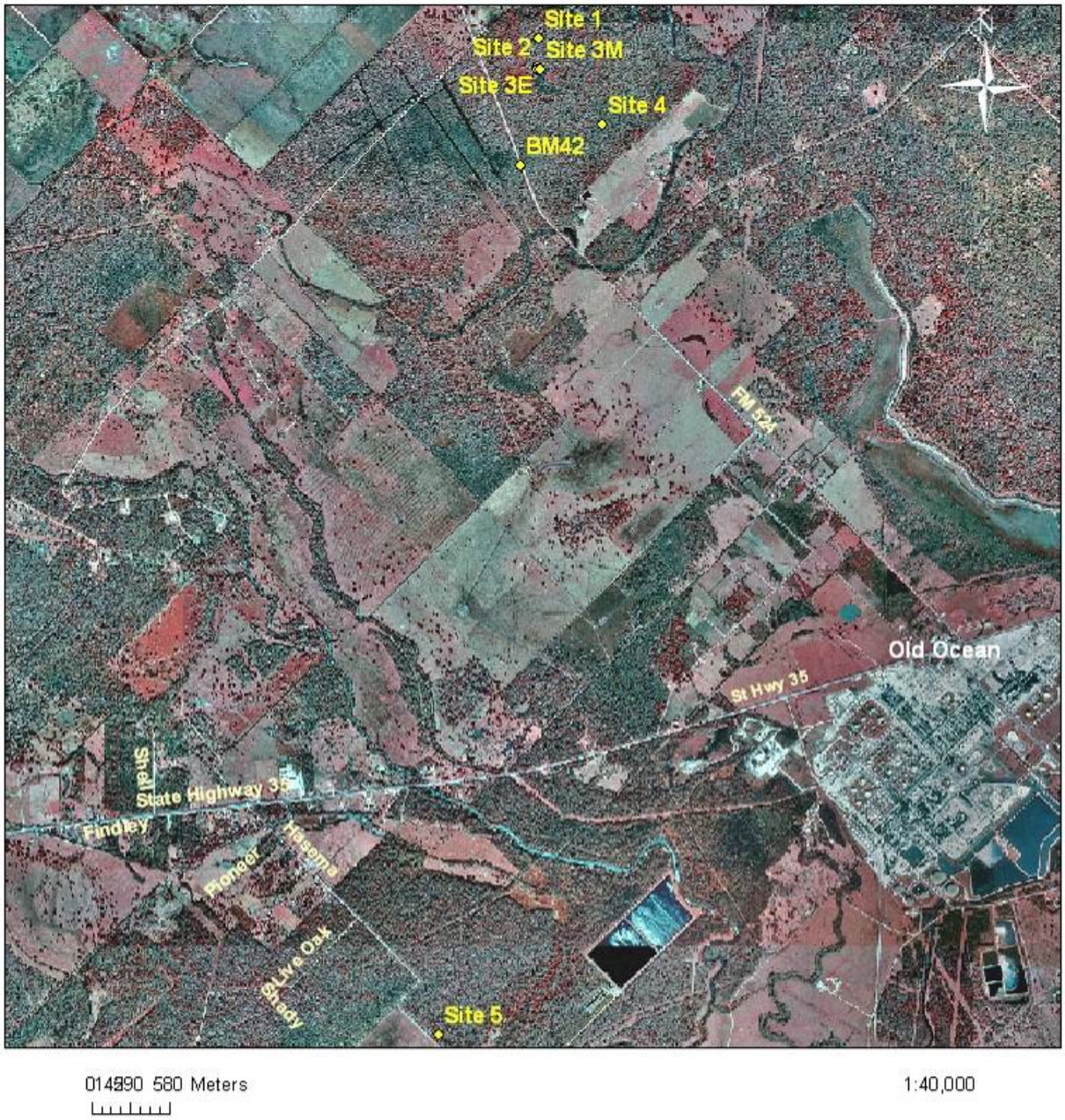


Fig. 4. 1:40,000 scale digital orthophoto showing study sites in Brazoria and Matagorda Counties. The Dance Bayou Unit monitoring area, Site 1 (location of Site 1 nonponded and Site 1 ponded), Site 2 (Site 2 nonponded), Site 3E (Site 3 ponded edge), Site 3M (Site 3 ponded middle), Site 4 (Site 4 ponded), and the Phillips Unit monitoring area, Site 5 (Site 5 nonponded). BM42 is bench mark 42 near a bridge on FM 524.

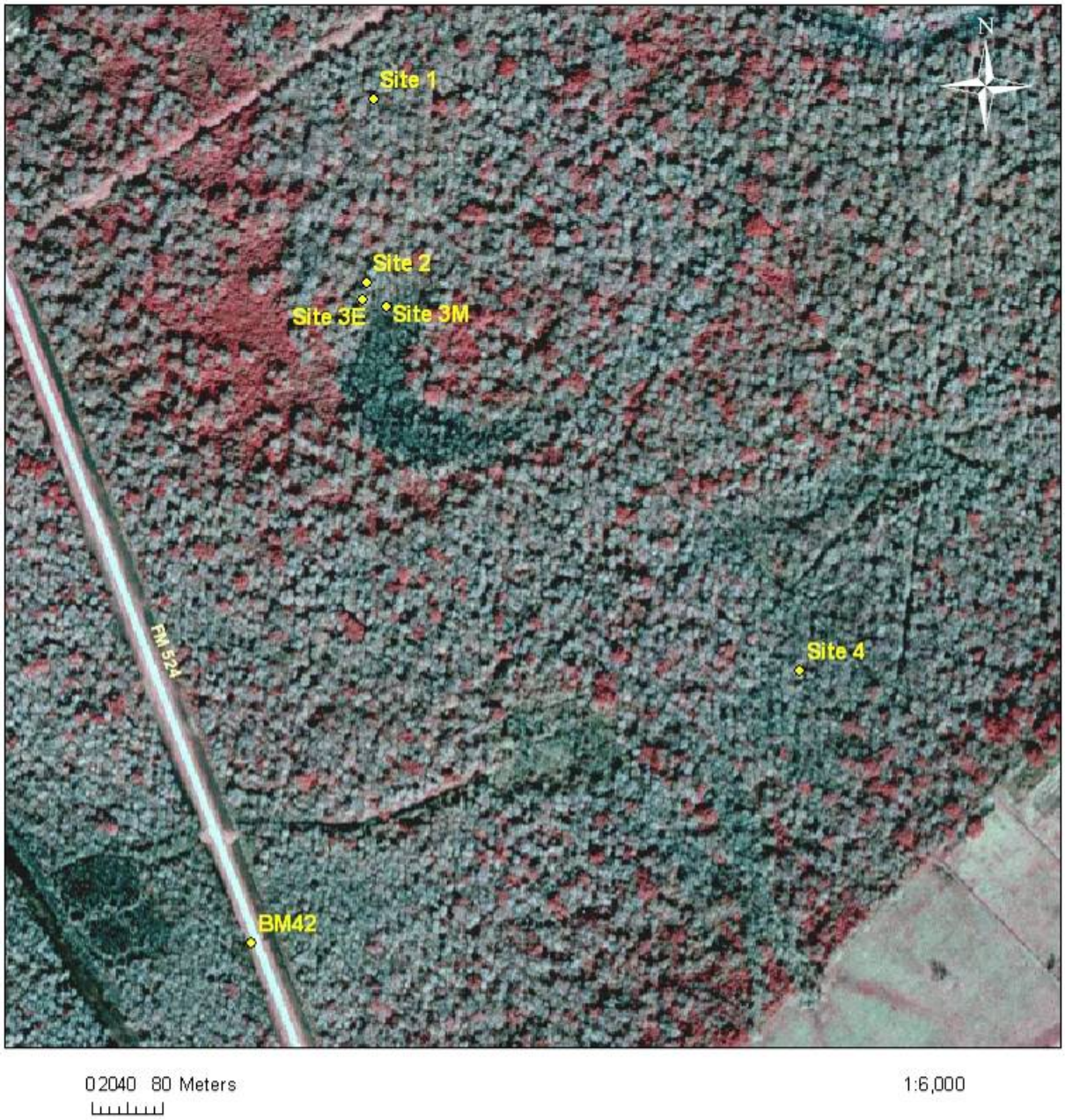


Fig. 5. 1:6,000 scale digital orthophoto showing monitoring sites in the Dance Bayou Unit area, Site 1 (location of Site 1 nonponded and Site 1 ponded), Site 2, (Site 2 nonponded), Site 3E (3 ponded edge), Site 3M (Site 3 ponded middle), and Site 4 (Site 4 ponded).

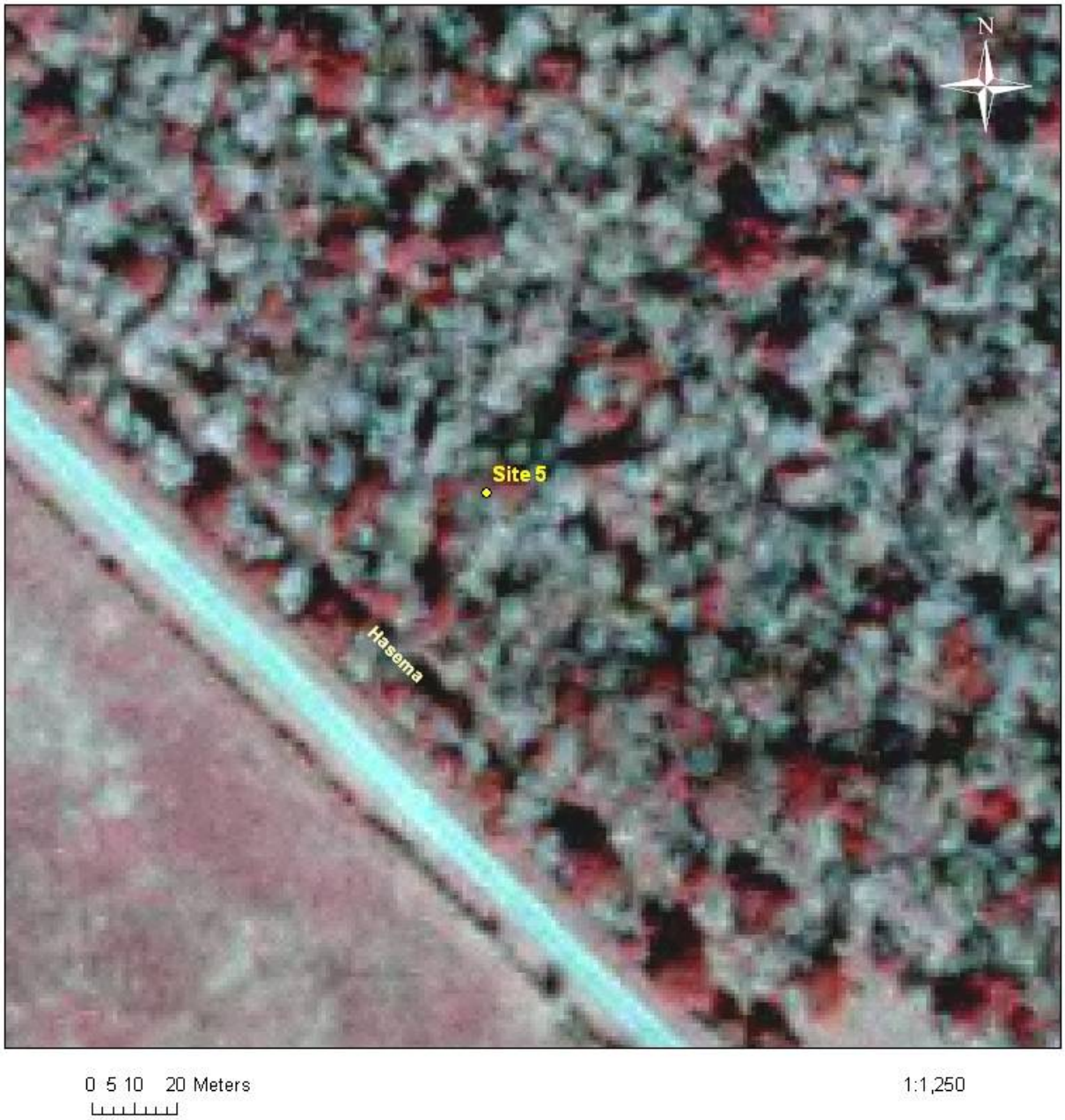


Fig. 6. 1:1,250 scale digital orthophoto showing monitoring site in the Phillips Unit area, Site 5 (Site 5 nonponded).

Monitoring Site Field Instrumentation

Generalized Layout

Each monitoring site was fenced with cattle panels of galvanized wire that delineated and protected the monitoring site area. Fenced areas ranged in size from about 12 m x 12 m to 10 m x 20 m. Piezometers were

installed in triplicate, and at sites with gilgai microrelief, they were installed in microlows. Eh electrodes were installed using five replications at each depth. At sites with distinct gilgai microrelief, Eh electrodes were installed in microhighs and microlows. Standards and installation procedures for piezometers, Eh electrodes, and other monitoring equipment were developed from the USDA-NRCS National Technical Committee on Aquic Soils field study guidelines (Griffin, 1991), and discussions and recommendations from meetings sponsored by the USDA-NRCS National Wet Soil Monitoring Project during this time period (Hudnall et al., 1992).

Automated Equipment

Due to the remote location of the monitoring sites, the cooperating agencies agreed to automate the monitoring equipment. Initial guidelines concerning materials, wiring, programming, and schematic drawings of monitoring equipment were provided by Dr. Allan Tiarks, U.S. Forestry Service, Baton Rouge, LA, and Dr. Wayne Hudnall, Louisiana State University, Baton Rouge, LA. Equipment modifications to address the very wet conditions expected in this bottomland hardwood study were made by Eugene Lindemann, P.E., Environmental Engineer, USDA-NRCS Temple, TX (Lindemann, 1998).

At each monitoring site a Campbell Scientific 21 XL Micrologger and a 16-channel multiplexer (Model AM416) were used to record data from the monitoring equipment. A 20-watt solar panel mounted on a 6-m steel pole tower and a 12-volt marine battery supplied power to the electronic equipment. A Texas Electrics tipping rain bucket (Model TR-525 I) was placed on the solar panel tower at each monitoring site. Pressure transducers (PX 26-00DV) were shop-fabricated and placed on the inside of the piezometers to record seasonal high water tables. Exposed wiring from the monitoring equipment to the data logger was threaded through 1.9-cm PVC pipe for protection from animals and the elements. Four pin wire connectors were used at key PVC pipe junctions and at field equipment to facilitate repairs and replacement when needed. Two temperature probes were used at each monitoring site, one at a depth of 50 cm to record soil temperature and one at 100 cm above ground to record air temperature.

Hydrology

Soil hydrology was measured with piezometers, soil moisture samples, and by measuring depths of ponding from permanent marks on 200-cm piezometer PVC pipes at each ponded site. Piezometers were built from 3.8-cm ID Schedule 40 PVC pipe. The recommended size of PVC pipe for piezometers size is 1.9-cm ID Schedule 40, but a larger pipe was necessary to allow insertion of the shop made automated pressure transducers. The PVC pipes were cut to 4 different lengths (80 cm, 100 cm, 150 cm, and 250 cm) to be installed at depths of 30 cm, 50 cm, 100 cm, and 200 cm with 50 cm of PVC pipe above ground (Hudnall, 1992). PVC pipes for piezometers in ponded locations were cut 25 cm longer. Piezometers designed to measure water tables at depths of 500 to 600 cm were made from 1.9-cm ID schedule 40 PVC pipe because automated monitoring equipment was not used.

Eight horizontal slits were cut in the lower 5 cm of each PVC pipe, and a piece of geofabric was glued to cover the slits and close the end of the pipe. The upper end of each piezometer was covered with a PVC cap with a small hole drilled in its side to facilitate air entry. The hole was drilled at an up angle to prevent rain water from entering the cap. Ground level was marked on each PVC pipe with a deep scratch mark and colored with a permanent black marker.

Triplicate piezometers were installed to the aforementioned depths and placed 1 m apart in rows of equal depths. In gilgai microrelief areas the 30- and 50-cm piezometers were placed in a single microlow and 100- and 200-cm piezometers were placed in an adjacent single microlow. An auger hole was dug slightly deeper

than the desired depth to place each piezometer. A round wire brush was used to scarify the bottom 10 to 20 cm of the auger hole. The wire brush was used to eliminate any smeared surfaces on the side wall that were caused by the bucket auger and might retard water movement. The bottom of the hole was filled with a small amount of fine sand, and the piezometer was lowered into the hole while checking the ground level mark for accuracy of depth placement. The lower 10 to 15 cm of the hole was backfilled with fine sand to cover the top of the geofabric. The hole was then filled to the surface with either the powdered form or the small chip form of bentonite. Care must be taken during this stage of the process to ensure that the bentonite is evenly distributed around the PVC pipe to prevent leaks in the future. Piezometers were installed under wet field conditions.

Water levels in the piezometers were recorded either manually or by data loggers. Manual measurements were made by using a two-stranded electric wire that was weighted on one end and connected in series to a battery and ohmmeter on the other end. Contact with the water by the two exposed ends of the copper wire was determined when the ohmmeter indicated the circuit was closed. The electric wire was marked in centimeters to measure depth to water from the top of the PVC pipe piezometer.

Subsequent to piezometer installation, soil samples were collected at depths of 10, 30, 50, 75 and 100 cm to determine gravimetric water content (USDA-NRCS, 2004). Due to time constraints, only duplicate samples were taken at the monitoring sites. At monitoring sites with distinct gilgai microrelief, only one sample at each depth was taken in the microhighs.

An 8-cm open clay bucket auger was used to collect samples under ponded or very wet conditions. A soil core about 7 cm in diameter and 10 cm long was extracted from the center of the bucket auger, and a relatively undisturbed soil sample was obtained from the middle of the soil core. About 50 gm of soil sample was placed in a standard soil metal weighing can. Cans were placed in an insulated container in the field and field weight was recorded within eight hours of field sampling. Samples were then oven dried for 12 to 16 hours and weighed to measure water loss.

Reducing Conditions

Soil reducing conditions were measured with permanently installed platinum (Pt) electrodes to directly measure soil reduction-oxidation (redox) potential (Eh). The presence of ferrous iron [Fe(II)] in the soil was determined with the chemical dye alpha, alpha dipyridyl (AADP dye) (Griffin, 1991; USDA-NRCS, 2005c; Vepraskas, 1995).

The redox potential was determined by inserting five replications of Pt electrodes into the soil at depths of 10, 30, and 50 cm. The electrodes were constructed using a method developed by Szogi and Hudnall, (1992) and modified based on research work by Owens (2001). The electrodes were constructed by attaching a short length of Pt wire to an insulated solid copper electrical wire. The copper wire was cut to appropriate lengths to ensure that the above ground end of the copper wire was above any ponded water.

The Pt wire (1.00-mm, 18 gauge) was cut into 1.5-cm segments for each electrode. The Pt wire segments were soaked in a mixture of concentrated nitric and hydrochloric acid for about four hours to remove contamination of other metals from the surface (Szogi and Hudnall, 1992; Owens, 2001). The segments were then soaked in distilled water overnight. An insulated, solid copper electrical wire (10 gauge) was used for the Pt electrode. About 0.5 cm of the insulation was removed from each end and the wire was accurately cut on one end to ensure a flat surface. A small hole, 1.00 mm in diameter and 5 mm deep was then accurately drilled in the middle of the copper wire in the flat surface. A small vise designed to hold the copper wire and a drill press to accurately drill the hole facilitates this process. The Pt wire was inserted into the hole and the copper wire was crimped to hold the Pt wire in place and complete the electrical connection. The exposed

copper wire/Pt tip was covered with a very high grade waterproof marine epoxy so about 5 mm of the Pt wire was exposed to the redox activity. The epoxy was covered with one layer of rubberized electrical tape to protect the epoxy from field conditions.

After the Pt electrodes were constructed, they were placed in a glass cylinder and covered with distilled water about 50 cm deep for 24 hours. This procedure checked for leaks around the Pt-copper wire/epoxy seal. The Pt electrodes were then calibrated in a ferrous-ferric sulfate reference solution at a redox potential of +430 mV. Electrodes which failed to agree within +/- 20 mV of the buffer standard were not used (Szogi and Hudnall, 1992; Owens, 2001). The ferrous-ferric sulfate reference solution is the most rigorous test for Pt electrode quality (Owens, 2001).

Care must be used in placing the Pt electrode into the soil to ensure the soft Pt wire is not bent and the epoxy seal broken. A 4.8-mm-diameter steel rod or wooden dowel was used to punch a pilot hole into the soil to within 1 cm of the appropriate depth of the Pt electrode. The Pt electrode was inserted into the pilot hole and gently pushed into the undisturbed soil to the appropriate depth. If the clay soil was dry, distilled water was poured down the hole to facilitate Pt probe insertion.

Redox potential was taken in the field with a portable Eh meter and a saturated calomel reference electrode. The main lead was attached to the Pt electrode with an alligator clip, and the reference electrode was placed into wet or moistened soil at the soil surface. Measurements were recorded after fairly constant readings were collected or readings drifted very slowly (in most cases after 3 to 5 minutes). Field Eh readings were adjusted by adding +244 mV in order to base field redox potential readings to the standard hydrogen reference electrode (Hudnall and Wilding, 1992).

The Hydric Soil Technical Standard for the USDA-NRCS-National Technical Committee for Hydric Soils (NTCHS) requires both anaerobic conditions and saturated conditions (USDA-NRCS, 2005c). A soil meets the "anaerobic conditions" part of this standard through positive AADP dye tests for ferrous iron or if redox potential (Eh) measurements of $\leq$ +175 mV at pH 7 exist [Eh = 595 – 60(pH)]. Eh values for three of the five replications of Pt electrodes at specific depths should meet this standard. The "saturated conditions" part of this standard is confirmed with piezometer data.

The AADP dye test for anaerobic conditions is a dominant (60% or more) positive reaction to AADP dye in a specific layer. The specific layer is 1/2 of the upper 12.5 cm for most sandy soils, 10 cm of the upper 30 cm for most loamy and clayey soils, or 1/2 of the upper 10 cm of soils that inundate but do not saturate to any significant depth (USDA-NRCS, 2005c).

For Vertisols and Vertic intergrades in Louisiana and Texas, Field Indicator F18 (Reducing Vertic) was used to determine anaerobic conditions. In clayey mineral soils that inundate but do not saturate to a significant depth, a 60% or more positive reaction to AADP dye in a layer at least 5 cm thick within the upper 15 cm meets Field Indicator F18 Reducing Vertic. The time period for anaerobic and saturated conditions for this field indicator is a minimum of 7 continuous days for a total of 28 cumulative days (USDA-NRCS, 2005a).

The NTCHS recommended that pH be determined on a saturated soil paste in place to determine soil pH at the time of the Eh readings. Due to the very clayey nature of the soils at the monitoring sites and time constraints, field soil pH was determined on 1:1 soil-water mixture.

The AADP dye test for ferrous iron in the soil was made to a 0.2% solution in neutral NH_4OAc (Hudnall and Wilding, 1992; Vepraskas, 1995). The AADP dye was stored in a light-proof container in a temperature-controlled laboratory and tested on a strongly reducing saturated soil sample (pH 5.5 fine sandy loam stored in

a quart jar) prior to each field use. New solutions were prepared at the beginning of each wet season. Dark brown glass eyedropper bottles were used as containers for AADP dye in the field.

AADP dye was used to test for the presence of ferrous iron in the soil during periods when the soils at the monitoring sites were moist to saturated or ponded. Soil cores from a bucket auger or soil slices from a sharpshooter shovel were obtained from depths up to 50 to 100 cm depending on field soil conditions. The surface of the soil core or slice was carefully and quickly removed with a high quality stainless steel knife to expose an uncontaminated soil surface. Once a fresh, uncontaminated soil surface was quickly exposed, AADP dye was sprayed over the soil surface with an eyedropper. As much as possible, the soil surface being tested with AADP dye was protected from direct sunlight due to the photo-reactive nature of the dye. After about 15 to 30 seconds the reaction of the AADP dye was observed, and soil depths, percent reaction of the dye, size and location of reaction, and intensity of reaction were recorded. Intensity of reaction was recorded as slightly positive (faint pink), positive (distinct pink), and very positive (distinct red). The AADP dye test was conducted as quickly as possible due to the potential of ferrous iron quickly oxidizing to ferric iron once the soil surface was exposed to air.

Soil Temperature

A 4-year study was initiated in 2001 by the USDA-NRCS National Soil Survey Center (NSSC) in Lincoln, Nebraska, to investigate soil temperature regimes in the southern United States. The study was the largest coordinated study of soil temperature in Soil Survey Division history (Mount et al., 2004). Technical review, coordination of equipment acquisition, and soft ware support to launch and download the data loggers in a uniform manner were provided by the NSSC.

The objective of the study was to gather soil temperature data in a comprehensive and uniform manner to determine the division between thermic and hyperthermic soil temperature regimes (Soil Survey Staff, 1999) in the southern United States. Air temperature was also reviewed from the closest weather station to develop the relationship with soil temperature at 50 cm.

Field temperature study sites were selected in moderately well drained to well drained loamy soils with representative landscapes in native rangeland. Data loggers were installed at each site at a depth of 50 cm. Soil temperature was measured 5 times a day to the nearest 0.01°C. Data were downloaded in Lincoln, Nebraska, at the NSSC at the end of each year (Mount et al., 2004). Soil temperature data were averaged by month and rounded to the nearest 0.1°C. An annual average was then determined and graphed. In addition to mean annual soil temperature (MAST), a mean summer temperature (MST) and a mean winter temperature (MWT) were calculated. The MST is the average for all the readings during June, July, and August while the MWT is the average for all the readings during December, January, and February.

Sixty-seven sites were initially selected in 2000 for the soil temperature regime study in Texas. Two sites were in the vicinity of the Columbia Bottomlands and the Dance Bayou and Phillips Plant Unit's bottomland hardwood study area. One site was approximately 37 km northwest of the Dance Bayou Unit study area in Wharton County near the town of Pierce on upland Telferner soils (TX14). The other site was approximately 27 km southeast of the Dance Bayou Unit study area in Brazoria County near the town of Brazoria on bottomland Norwood soils (TX09).

In May 2002 two additional data loggers for soil temperature studies were installed at the Dance Bayou Unit study area. One data logger (TX69) was installed at 50 cm below the soil surface in a microlow at Site 1 nonponded (TX39-1), and the other data logger (TX70) was installed at Site 3 ponded middle (TX39-5). Temperature data were gathered from May 2002 until May 2004.

Precipitation

Precipitation was recorded with 280-mm rain gauges installed at each of the five monitoring sites. Daily precipitation data from a National Weather Service Station (NWS) in West Columbia, Texas, (approximately 14 km east of the study area) were used to document daily precipitation events. National Water and Climate Center (NWCC) WETS Tables were used from Angleton, Texas, (approximately 36 km east of the study area) to determine monthly and yearly above normal, normal, and below normal monthly and yearly precipitation values (USDA-NRCS, 2002b). West Columbia and Angleton were within the 48 km radius of the monitoring sites that the NWS uses to select neighboring stations for estimating missing data (Sprecher and Warne, 2000). The Weather Channel (Channel 18, Victoria, Texas, television station) and a Houston television station (Channel 2, KPRC) were monitored on a daily basis to observe actual daily precipitation events at or near the study area.

Data Interpretation

Monitoring sites were visited and data was collected on a biweekly (every 2 weeks) schedule, with additional visits after major precipitation storm events. Storm events were determined from local media (television stations in Houston and Victoria).

The long term ICOMAQ Study in Texas documented the the soil hydrologic cycle (dry-wet-dry season) of the Texas Gulf Coast Prairie was usually from September of one year to August of the following year (12 months) (Griffin, 1991; Hudnall and Wilding, 1992). One of the standards for wet soil studies developed by NRCS-NTCHS was that a study should last at least through one dry-wet-dry season with normal precipitation (USDA-NRCS, 2002c). Faulkner et al. (1991) and Faulkner and Patrick, 1992, used the term “water-year” to describe this 12-month seasonal time period. Yearly precipitation totals were calculated on this water-year basis (Brazoria County, West Columbia, Texas) and compared to similar time periods of precipitation data and standards from the NWCC (USDA-NRCS 2002b) in Brazoria County, Angleton, Texas, to determine normal years of precipitation during the study.

Duration and frequency of periods of ponding, saturation, and reducing conditions of soils are important in wet soil studies and wetland determinations (Environmental Laboratory, 1987; USDA-NRCS, 2002c). The standard observation interval for the ICOMAQ Study in Texas and Louisiana was biweekly (every 2 weeks) (Hudnall and Wilding, 1992). During the ICOMAQ Study in Victoria County, standards were developed to analyze the biweekly observations to estimate duration and frequency of events. Researchers directly involved in the ICOMAQ Study agreed that ideally more frequent observations than 2 weeks were needed. On the other hand everyone also agreed the field data collected during the study should be used as much as possible (M. Vepraskas; L. Wilding, personal communication, 1993).

University soil scientist staff and NRCS soil scientists directly involved in the ICOMAQ study provided input and agreed on a method to analyze the biweekly observations to estimate duration of an event (M. Vepraskas; L. Wilding, personal communication, 1993). Total number of observed events and total number of observations were used as the base numbers. To obtain an estimate of duration of events, this data was analyzed based on the biweekly observations.

As a theoretical example, ponding was observed 8 times at a site during a 12-month period (24 observations during a dry-wet-dry season). When a ponding event occurred as an isolated event (in an example biweekly sequence, first 2-week observation site dry, second 2-week observation site ponded, third 2-week observation site dry), this counted as an observation of one event of less than 2-continuous-weeks ponding. If there was a second isolated ponding event (same circumstances as discussed previously), then this

was counted as two events of less than 2-continuous-weeks ponding. Two consecutive 2-week ponding observations (in an example biweekly sequence, first 2-week observation site dry, second 2-week observation site ponded, third 2-week observation site ponded , and fourth 2-week observation site dry) were counted as one event of 2-continuous-weeks ponding. Three consecutive 2-week ponding observations were counted as one event of 4-continuous-weeks ponding, and so on.

Using the previous example of 8 ponding observations out of 24 total observations, there were two isolated events of less than 2-continuous-weeks ponding (2 isolated ponding observations); one event of 2-continuous-weeks ponding (2 consecutive biweekly observations of continuous ponding); and one event of 6-continuous-weeks ponding (4 consecutive biweekly observations of continuous ponding). Based on these observations, the site ponded 33% of the time cumulative; and ponded 8% of the time for less than 2-continuous-weeks; 8% of the time for 2-continuous-weeks; and 17% of the time for 6-continuous-weeks.

Water-year periods were also used in conjunction with the growing season periods as currently estimated (Environmental Laboratory, 1987). Estimated growing season for Brazoria County, as determined by the Galveston District USACOE (K. Jaynes, personal communication, 2000) is from February 12 to December 12. Water-year estimated growing season would total 20 biweekly observations. Using the previous example of 8 observations of ponding, if 4 of the observations were during the nongrowing season, then cumulative ponding for the estimated growing season time was 20%. If 4 of the observations during the nongrowing season were the 6-continuous-weeks ponding, then the site ponded during the growing season 10% of the time for less than 2-continuous-weeks and 10% of the time for 2-continuous-weeks.

The same analysis for ponding durations was used to determine cumulative percent durations, and percent durations of reducing condition events measured with Pt electrodes and AADP dye.

Additional Field Observations

Ponded Conditions, Vegetation Changes, Color Signatures on Digital Orthophoto Maps

During several ponding events at the Dance Bayou Unit, boundaries between ponded and nonponded areas and vegetation changes between ponded and nonponded areas were determined in the vicinity of the monitoring sites. This was done over a period of several years when ponding depths at monitoring sites were either at or near average depths determined from previous field observations. Vegetation changes at boundaries between ponded and nonponded areas were determined by USFWS personnel at several different areas. Boundaries were marked with either engineer flags in the ground or in trees, or by placing short lengths of 1.9-cm PV pipe in the ground as bench marks (50 cm in ground, 30 cm above ground).

PVC pipe bench marks were placed at the outer edges of the ponded areas during optimum ponding events. The benchmarked locations were recorded with a GPS unit. Additional GPS readings and field notes were recorded along ponded and nonponded boundaries during several other ponding events. The GPS data points were located on a large printed copy of a digital orthophoto map of the area (scale 1/2,400), and field data were evaluated in relation to color patterns and tones on the digital orthophoto.

Vertical and Horizontal Movement of Soil and Piezometers

During the bottomland hardwood study a soil scientist staff member of the USACOE-WES in Vicksburg, Mississippi, requested information concerning problems with piezometer movement or failure during long term wet Vertisol studies in Texas. The inquiry was in response to similar questions posed during initial meetings and discussions by the USACOE to develop national standard procedures for hydrology studies for

wetland determination documentation. A previously reported upland Vertisol study (Laewest clay, fine, smectitic, hyperthermic Typic Hapluderts) in Texas indicated that after 5 years several piezometers had started to tilt significantly and, with time, some might become inoperable (Jacob et al., 1997).

To assist with this inquiry, vertical movement (heave) and horizontal movement (throw) were measured on 74 of the 102 piezometers installed at the Dance Bayou Unit monitoring sites in June 2004. The piezometers were selected based on accessibility to the sites, field determination of lack of major disturbance to the piezometer or ground surface around the piezometer, and estimated accuracy of initial installation depths.

Heave was determined either by measuring the distance between surface ground level in June 2004 and the 1996-98 permanent surface ground level mark on the PVC pipe, or by measuring the distance from ground level to the top of the piezometer PVC pipe. Throw was measured with a carpenter's level (122 cm in length) by placing one end of the level on the ground and holding the level vertically against the top rim of the piezometer where maximum tilt was observed. The distance from the ground end of the carpenter's level to the piezometer at ground level was measured and recorded. Piezometers with less than 2-cm throw were considered within normal limits of the original field installation. Piezometers with 2-cm or more throw were considered outside the normal limits due to soil or piezometer movement since they were installed.

The inside depth of the piezometers was also checked to determine whether or not soil had intruded into the geofabric covered open end of the piezometers or if the PVC pipe had collapsed due to shrink-swell pressures. At least one piezometer of each of the five depths was checked at each monitoring site.

Black Coatings on PVC Pipe Piezometers

Black coatings that accumulated on PVC pipes during the study were also observed to determine the relation of the coatings to ponding depths at the sites, and approximate time and ponding durations that occurred before the coatings formed. Samples of the black coatings on the PVC pipes at both ponded and nonponded sites were taken to determine the chemical and physical composition of the coatings.

3. RESULTS AND DISCUSSION

Soil Temperature

Background

Soil microbiologists recognized that the majority of soil microorganisms were sensitive to low temperatures and that both microbial populations and rates of metabolic activity decreased when soil temperatures dropped below 5° to 10°C (Rabenhorst, 2005). Some crop scientists identified the concept of "zero of vital temperature" which had an average of 4.4°C. This average number was developed from a wide range of data and may just accidentally represent the lower range for mesophyllic microorganism activity. The term "biologic zero" was not published within the soil or agriculture literature before the 1970's, and the first published use seems to be in the 1975 edition of *Soil Taxonomy* (Soil Survey Staff, 1975) (Rabenhorst, 2005).

The term "biologic zero" and the temperature of 5°C are discussed in two sections of the 1975 edition of *Soil Taxonomy* (Soil Survey Staff, 1975). The term "biologic zero" is used in the section discussing the aquic moisture regime in "Classes of soil moisture regimes." Briefly, this discussion states that the aquic moisture regime implies a reducing regime that is virtually free of dissolved oxygen because the soil is saturated. The duration of the period that the soil must be saturated to have an aquic regime is not known, but it must be at least a few days. Because dissolved oxygen is removed from ground water by respiration of microorganisms, roots, and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero (5 °C) at some time while the soil or horizon is saturated.

The 5°C temperature is also used in the "Soil temperature regimes" discussion part of the 1975 *Soil Taxonomy*. This section states that temperature controls the possibilities for plant growth and for soil formation. Between the temperatures of 0°C and 5°C, root growth of most plants and germination of most seeds is impossible. A horizon as cold as 5°C is a thermal pan to the roots of most plants. Temperature measurements are made at 50 cm because this depth is below daily changes in air temperature (Soil Survey Staff, 1975).

The growing season concept was originally used in soil surveys to indicate the types of crops a soil would support. It is questionable if the annual period of significant plant growth and the annual period of significant microbial growth are the same (Megonigal et al., 1996). Because soil temperature data are not readily available for most sites, specific growing season months are assigned to each soil temperature regime (USDA-SCS, 1991). Soil temperature regimes are in turn defined by mean annual soil temperature.

In most of the Texas Gulf Coast Prairie MLRA and Texas Gulf Coast Saline Prairie MLRA, soils are classified with hyperthermic temperature regimes. Soils with hyperthermic temperature regimes have mean annual soil temperatures of 22°C or higher, and the difference between mean summer and mean winter is more than 6°C at a depth of 50 cm from the soil surface (Soil Survey Staff, 1999). The assumed growing season period for hydric soils with hyperthermic temperature regimes is February to December (USDA-SCS, 1991).

Regulatory guidance for identifying the growing season is the portion of the year when the soil temperatures at 19.7 inches (50 cm) below the soil surface are higher than biologic zero (5°C) (Environmental Laboratory, 1987). For ease of determination this period can be approximated by the number of frost-free days. In the absence of local soil temperature data at individual sites, the growing season can be estimated from climatological data given in most NRCS county soil surveys. The growing season starting and ending dates will be generally determined based on the "28°F (2°C) or lower" air temperature

threshold at a frequency of "5 years in 10" (Williams, 1992). The estimated growing season for Brazoria County, Texas, as determined by USACOE Galveston District, is February 12th to December 12th (K. Jaynes, personal communication, 2000).

Dance Bayou Unit Soil Temperatures

Monthly air temperatures during the Dance Bayou Unit study were compared to normal monthly air temperatures from the WETS tables (USDA-NRCS, 2002b) for Brazoria County (Fig. 7). The monthly standard deviation for Harris County (northern adjacent county) was used to estimate a range for normal monthly air temperature because the standard deviation of normal monthly air temperatures for Brazoria County was not available. Monthly air temperatures during the winter months of the study in Brazoria County were typically within the Harris County monthly normal range, or were slightly higher. This difference could be expected because Harris County is farther north and therefore has slightly lower air temperatures than Brazoria County.

Recorded soil temperatures at the Dance Bayou Unit Site 1 nonponded (TX69) were only from May 2002 to November 2003 due to data logger failure during the remaining time periods. The data logger at Site 3 ponded (TX70) recorded temperatures from May 2002 to May 2004 (Mount, et al., 2004). Fig. 7 shows the comparison of soil temperatures at the two sites for the time period when both data loggers were functioning.

Coldest recorded soil temperatures at 50 cm were in the month of January. The January average coldest soil temperature at 50 cm at the Dance Bayou Unit for Site 1 nonponded (TX69) and Site 3 ponded (TX70) was 14.1 C for both sites (Fig. 8) (Appendix D). Daily soil temperature readings from the data loggers showed that the coldest recorded temperatures ranged from about 12°C to 13 C. Coldest temperatures lasted from periods of less than 24 hours (several consecutive 5-hour readings) to a maximum of 3 days (Mount, et al., 2004).

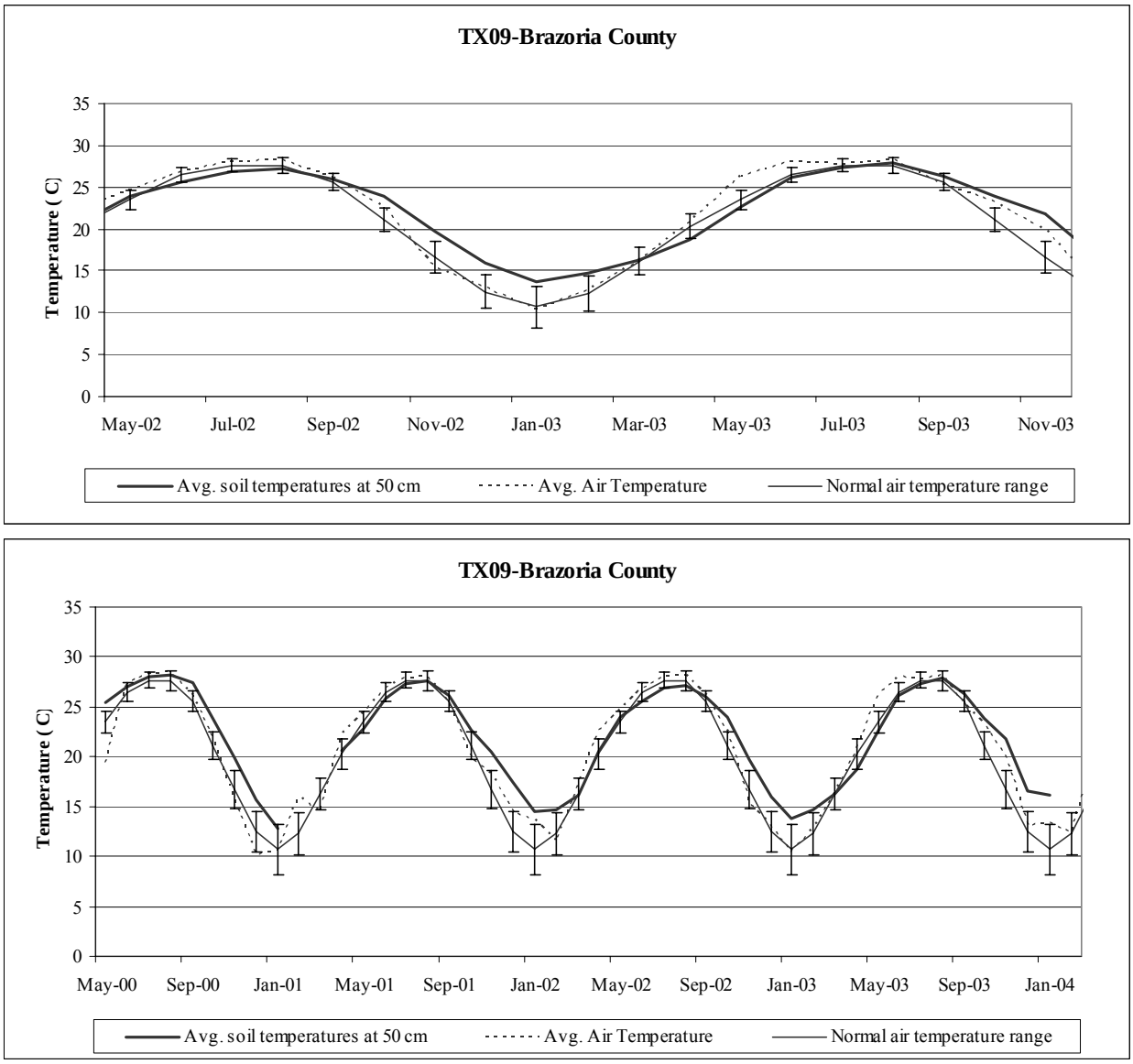
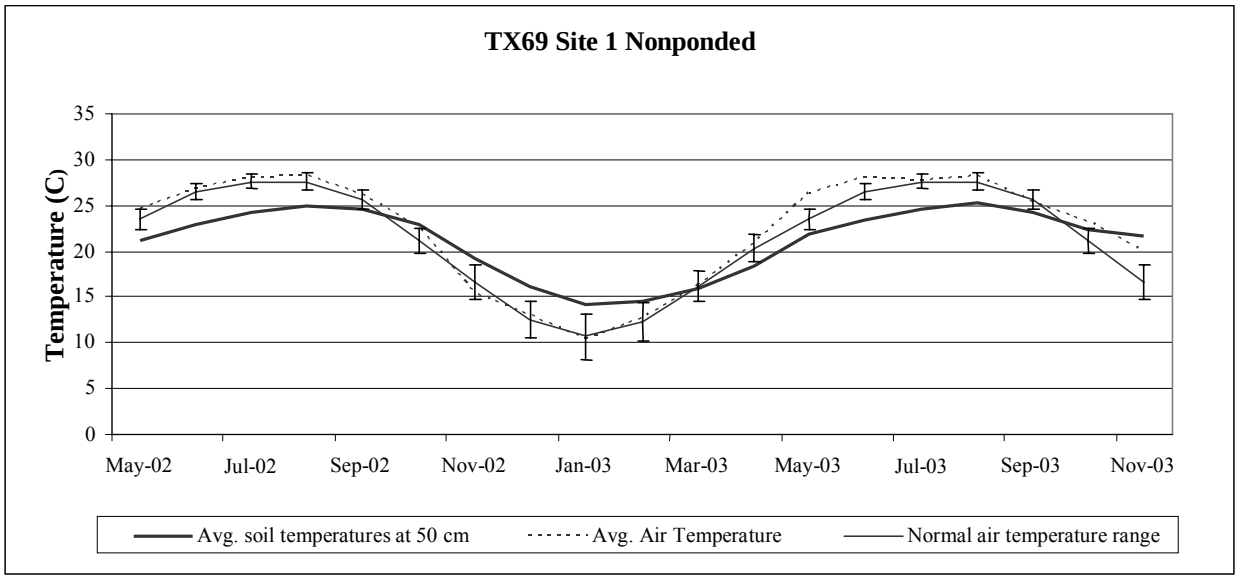


Fig. 7. Soil temperatures (TX09) at 50 cm; air temperatures, Brazoria, Brazoria County, Texas; and normal monthly air temperature range, Harris County, Texas. Top graph shows temperatures during the Dance Bayou temperature study time period. Bottom graph shows temperatures during the NSSC soil temperature regime study.



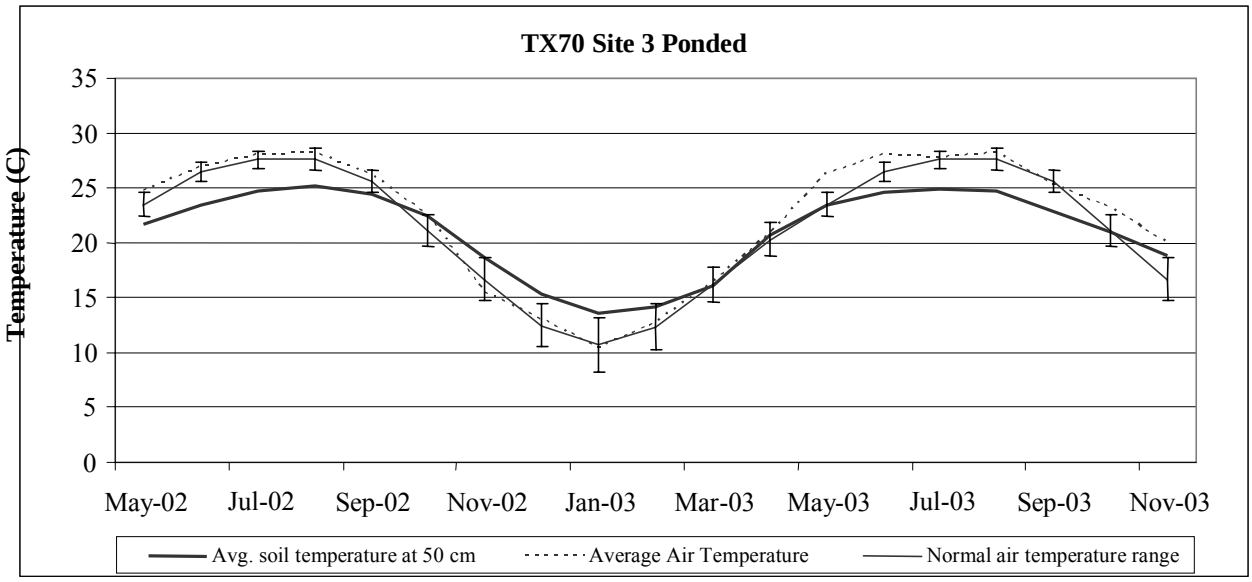


Fig. 8. Soil temperatures at 50 cm, Site 1 nonponded (TX69) and Site 3 ponded (TX70); air temperatures, Brazoria, Brazoria County, Texas; and normal monthly air temperature ranges, Harris County, Texas.

Soil Temperatures at Selected Sites in Texas Gulf Coast Prairie MLRA (NRCS National Thermic-Hyperthermic Study)

Analysis of other soil temperature monitoring sites in the Texas Gulf Coast Prairie MLRA that were part of the NRCS National Thermic-Hyperthermic Study for the Southern U.S. revealed similar trends to soil temperatures observed at the Dance Bayou Unit sites (Mount, et al., 2004). Two of the Thermic-Hyperthermic Study soil temperature monitoring sites were near the Dance Bayou Unit sites. Coldest soil temperatures at 50 cm were in the month of January at all of the monitoring sites. The average January soil temperature on upland Telferner soils (fine, hyperthermic Aquertic Chromic Hapludalfs) at 50 cm near the town of Pierce in Wharton County (approximately 37 km northwest of the Dance Bayou Unit study area) was 14.4°C (TX14).

The average January soil temperature on bottomland Norwood soils (fine-silty, hyperthermic Fluventic Eutrudepts) near the town of Brazoria in Brazoria County (approximately 27 km southeast of the Dance Bayou Unit study area) was 13.7°C (TX09) (Appendix D) (Mount, et al., 2004). Daily temperature readings from the data loggers showed that the coldest recorded temperatures were mainly in January, and ranged from about 9°C to 14°C. Coldest temperatures lasted for periods of less than 24 hours (several consecutive 5-hour readings) to a maximum of 4 days.

Two other soil temperature monitoring sites that were part of the National NRCS Thermic-Hyperthermic Study for the Southern U.S. were near the cities of Victoria near the southern end of the Texas Gulf Coast Prairie MLRA and Beaumont near the northern end. The soil temperature monitoring site near Victoria, Texas, (TX18) was on upland Telferner soils (fine, hyperthermic Aquertic Chromic Hapludalfs). The coldest soil temperature at this site was in the month of January, and the average soil temperature for the month was 13.5°C. The coldest recorded temperatures ranged from 8.8°C to 11.3°C for periods of 1 to 4 days (Appendix D) (Mount, et al., 2004). The coldest soil temperature on upland Morey soils (fine-silty, hyperthermic Oxyaquic Argiudolls) near Beaumont, Texas (TX02), was also during the month of January. Average soil temperature for January was 12.1°C and the coldest recorded temperatures during the month ranged from 9.2°C to 10.4°C for periods of 2 to 4 days.

The results of the bottomland hardwood soil temperature study part of the Thermic-Hyperthermic Study for the Southern U.S. (Mount et al., 2004) were similar to other studies in the Texas Gulf Coast Prairie MLRA (Miller, 1986; Mount et al., 2004) and in the southeastern United States (Megonigal et al., 1996; Mount et al., 2004; Slabaugh, J.D., 2006). Coldest soil temperatures usually occurred in the months of January and February. Over the past 25 years, all of the soil temperature studies documented that the growing season, as currently defined based on soil temperature (5°C) at 19.7 inches (50 cm) (Environmental Laboratory, 1987), was for a full 12 months each year.

In the Texas Gulf Coast Prairie MLRA study, average monthly soil temperatures at 50 cm in the coldest month, January, were well above 5°C. Recorded coldest daily temperatures in January were 5°C to 10°C and lasted for a few days to, at most, several weeks. Current regulatory guidance for estimating growing season in the absence of local field measurements in the Texas Gulf Coast Prairie MLRA, based on first and last frost dates given in most USDA-NRCS county soil surveys (Environmental Laboratory, 1987), should be revised to a 12-month growing season to reflect the findings of these studies.

Overview of Precipitation, Hydrology, and Reducing Conditions

Precipitation

Yearly Precipitation

Calendar year (yearly) precipitation data from the USDA National Climatic Data Center (NCDC) was analyzed for Angleton, Texas, (approximately 36 km east of the study area) for the previous 30 years of the bottomland hardwood study. Using the WETS Tables with thresholds of 30th and 70th percentile as ranges of normal (USDA-NRCS, 2002b), there were 8 years with above-normal precipitation, 14 years with normal yearly precipitation, and 8 years with below-normal precipitation out of the 30 years. In the 14 years with normal yearly precipitation, 33% of the months had above-normal monthly precipitation (average 4 with a range of 2 to 6 months), 37% of the months had normal monthly precipitation (average 4 with a range of 2 to 8 months), and 30% of the months had below-normal monthly precipitation (average 4 with a range of 2 to 6 months).

Using the same standard during the 6-year bottomland hardwood study (1997 to 2002), there were 4 years with normal yearly precipitation, and 2 years (1999 and 2000) with below-normal yearly precipitation. In the 4 years with normal yearly precipitation, 35% of the months had above-normal monthly precipitation (average 3 with a range of 3 to 5 months), 31% of the months had normal monthly precipitation (average 3 with a range of 3 to 5 months), and 33% of the months had below-normal monthly precipitation (average 3 with a range of 3 to 5 months).

Water-year Precipitation

Water-year (dry-wet-dry season, September of one year to August of following year) precipitation was also analyzed for Angleton, Texas, for the previous 30 years of the bottomland hardwood study. Water-year total precipitation was determined from the NCDC yearly precipitation data for Angleton, Texas. Using the WETS Tables with thresholds of 30th and 70th percentile as ranges of normal for the water-year, there were 10 water-years with above-normal precipitation, 13 water-years with normal yearly precipitation, and 7 water-years with below-normal precipitation out of the 30 water-years. In the 13 water-years with normal precipitation, 29% of the months had above-normal monthly precipitation (average 3 with a range of 2 to 5 months), 34% of the months had normal monthly precipitation (average 4 with a range of 2 to 7 months), and 37% of the months had below-normal monthly precipitation (average 4 with a range of 1 to 6 months).

Using the same standard for water-years (Angleton, Texas) during the 6-year bottomland hardwood study (1996-1997 to 2001-2002 water-years), there were 5 water-years with normal precipitation, and 1 water-year (1999-2000) with below-normal precipitation. In the 5 water-years with normal precipitation, 29% of the months had above-normal monthly precipitation (average 3 with a range of 2 to 4 months), 35% of the months had normal monthly precipitation (average 3 with a range of 3 to 6 months), and 35% of the months had below-normal monthly precipitation (average 3 with a range of 3 to 5 months).

Based on NWS precipitation data for West Columbia, Texas (approximately 14 km east of the study area), and the same standard previously discussed for water-years during the 6-year bottomland hardwood study (1996-1997 to 2001-2002), there were 5 water-years with normal precipitation, and 1 water-year (1999-2000) with below-normal precipitation. In the 5 water-years with normal precipitation, 27% of the months had above-normal monthly precipitation (average 3 with a range of 2 to 4 months), 37% of the months had normal monthly precipitation (average 4 with a range of 3 to 6 months), and 37% of the months had below-normal monthly precipitation (average 4 with a range of 3 to 5 months). Table 2 shows the monthly and water-year

precipitation from the NWS Station in West Columbia, Texas, and the 30% chance range of having more or less than monthly and yearly values from the NCDC in Brazoria County, Angleton, Texas (1972-2002). Appendix E contains NWS precipitation data, West Columbia, Texas, showing daily and monthly precipitation, normal monthly precipitation and ranges of normal monthly precipitation, and combined method 30-day rolling totals, 1996-1997 to 2001-2002 water-years.

Table 2. Water-year and monthly precipitation data from NWS Station in Brazoria County, West Columbia, Texas during the 6 water-year period of the bottomland hardwood study. Average monthly and water-year, and the 30% chance of having more or less than monthly and yearly values from NCDC, Brazoria County, Angleton, Texas (1972-2002). Each precipitation value is compared to the 30% chance range, and ranges are denoted as above-normal (A), normal (N), and below-normal (B).

							NCDC Precipitation		
								30 % chance will have	
Month	**1996-1997**	**1997-1998**	**1998-1999**	**1999-2000**	**2000-2001**	**2001-2002**	**Average*** **	less than	more than
	cm	cm	cm	cm	cm	cm	cm	cm	cm
Sept	13.03^{N}	28.80^{N}	54.33^{A}	8.86^{B}	14.76^{N}	15.14^{N}	19.21	11.41	28.80
Oct	4.11^{B}	24.72^{A}	16.43^{A}	2.41^{B}	7.67^{N}	12.22^{N}	10.97	4.74	13.08
Nov	3.96^{B}	11.05^{N}	16.94^{A}	1.53^{B}	32.99^{A}	15.27^{N}	12.74	6.28	15.59
Dec	11.20^{N}	9.21^{N}	6.65^{N}	6.10^{B}	11.02^{N}	16.97^{A}	10.77	6.38	13.08
Jan	6.99^{B}	4.19^{B}	1.65^{B}	6.07^{B}	12.55^{N}	5.74^{B}	12.21	7.03	14.85
Feb	12.12^{A}	15.49^{A}	4.80^{B}	4.22^{B}	0.94^{B}	2.41^{B}	8.97	5.00	10.92
Mar	29.67^{A}	5.26^{N}	11.02^{N}	5.18^{N}	9.47^{N}	2.43^{B}	9.87	4.82	12.23
April	27.25^{A}	2.01^{B}	1.75^{B}	8.13^{N}	0.48^{B}	7.75^{N}	9.67	4.62	11.85
May	17.32^{A}	0.00^{B}	9.22^{N}	18.16^{N}	7.39^{B}	3.68^{B}	13.67	8.28	16.85
June	8.28^{B}	5.51^{B}	8.33^{B}	6.63^{B}	22.45^{A}	12.19^{N}	16.51	9.49	19.94
July	7.29^{N}	3.51^{B}	16.40^{A}	0.86^{B}	10.41^{N}	11.84^{N}	10.97	3.79	13.00
Aug	2.84^{B}	16.33^{A}	1.17^{B}	1.5^{B}	24.84^{A}	25.2^{A}	12.79	6.28	15.62
Average	144.06^{N}	126.08^{N}	149.03^{N}	69.47^{B}	154.97^{N}	130.84^{N}	148.18	123.56	162.1
Difference between avg. and NCDC avg.	-4.12	-22.1	0.85	-78.71	6.79	-17.34			

***** Average value from NCDC Precipitation Data for Brazoria County, Angleton, Texas, 1972 - 2002.**

Hydrology

Ponding

Appendix F shows biweekly observations of ponding depths at the monitoring sites and monthly precipitation. During the 6-year bottomland hardwood study, there were 10 storm events with precipitation amounts of approximately 4.8 to 53.4 cm over periods of 1 to 9 days. From very dry field conditions in August, one event of 13.61 cm of precipitation over a period of 3 days caused 25-cm-deep ponding at Site 3 ponded and 10-cm-deep ponding at Site 4 ponded. Sites 1, 2, and 5 nonponded microlows, and Site 1 ponded had ponded water for less than 7 days. The majority of ponding at the monitoring sites was due to runoff from surrounding areas. Overbank flooding from Dance Bayou occurred only during major above-normal storm events, such as tropical storms.

The storm events in the fall months (5 events) had precipitation amounts ranging from about 6 to 53 cm over periods of 2 to 9 days and caused ponding at all of the bottomland hardwood study monitoring sites. Representative ponding depths at Sites 1 and 5 nonponded ranged from 1 to 8 cm in microlows. Drift lines were observed on the tops of microhighs after the larger precipitation events. Site 1 ponded ponding depths ranged from 2 to 21cm, with drift marks on vegetation and piezometers 25 cm above ground after the larger precipitation events. Site 3 ponded middle ponding depths ranged from 3 to 35 cm, with drift lines on trees and vegetation about 100 cm above ground after the larger precipitation events. Ponding depths at Site 4 ponded ranged from 3 to 33 cm, with drift lines on trees and vegetation about 50 cm above ground after the larger precipitation events.

Storm events in the winter and spring months (5 events) indicated that precipitation amounts ranging from about 5 to 8 cm over periods of 1 to 4 days caused similar ponding at most of the bottomland hardwood study monitoring sites. Depending on time of year and either continued precipitation and wet conditions, or the development of dry conditions, ponding durations lasted for less than 2 weeks to several months or more. Table 3 shows yearly mean and standard deviation of ponding depths for each site, and precipitation range from September 1996 to August 2002 based on the biweekly observations (Appendix G and H). A detailed description of ponding events and duration will be given during each monitoring site discussion.

Table 3. Ponding events summary from September 1996 to August 2002. Total number of biweekly ponding events (count) observed at each site; yearly mean and standard deviation of ponding depths for each site; ponding events observed during above-normal, normal, and below-normal monthly precipitation; ponding events observed in 5 cm/month precipitation increments to 20+ cm/month; and average monthly precipitation range from normal (cm).

Site	Analysis	Total ponding events	Above normal monthly precipitation	Normal monthly precipitation	Below normal monthly precipitation	0-5 cm/ month precip.	5-10 cm/ month precip.	10-15 cm/ month precip.	15-20 cm/ month precip.	20+ cm/ month precip
Site 1 Nonponded Microlow	Count	13	8	4	1	1	0	6	1	5
	Mean depth (cm)	3.5	4.1	2.8	1.0	–	–	–	–	–
	SD	1.71	1.64	1.26	–	–	–	–	–	–
Site 1 Ponded	Count	9	4	5	0	0	1	4	3	1
	Mean depth (cm)	9.9	9.8	10.0	0	–	–	–	–	–
	SD	3.89	2.22	5.15	–	–	–	–	–	–
Site 2 Nonponded Microlow	Count	0	0	0	0	0	0	0	0	0
	Mean depth (cm)	0	0	0	0	–	–	–	–	–
	SD	–	–	–	–	–	–	–	–	–
Site 3 Ponded Edge	Count	27	11	10	6	4	4	9	3	7
	Mean depth (cm)	4.3	5.3	4.2	2.8	–	–	–	–	–
	SD	3.50	4.38	2.71	1.21	–	–	–	–	–
Site 3 Ponded Middle	Count	73	16	31	26	20	15	20	8	10
	Mean depth (cm)	20.7	26.9	20.4	17.3.	–	–	–	–	–
	SD	7.85	4.75	7.56	7.64	–	–	–	–	–
Site 4 Ponded	Count	47	13	25	9	8	8	17	3	10
	Mean depth (cm)	9.9	12.2	9.7	7.2	–	–	–	–	–
	SD	5.71	6.52	5.86	1.99	–	–	–	–	–
Site 5 Nonponded Microlow	Count	11	7	3	1	1	0	5	0	5
	Mean depth (cm)	4.6	5.7	3.0	1.0	–	–	–	–	–
	SD	2.42	1.89	2.00	–	–	–	–	–	–
Precipitation	Average difference from normal (cm)		11.81	-1.23	-8.39	–	–	–	–	–
	SD		9.01	3.50	2.29	–	–	–	–	–

Soil Water

The soil water table is the surface of the water that fills a well or open auger hole (Vepraskas and Sprecher, 1997), or that level below which the soil is saturated with water (Environmental Laboratory, 1987). It is the upper level of *free water* that can flow out of the soil into an open bore hole, well, or piezometer. Free water flows through a soil under the influence of gravitational forces, and is not under tension or suction (Vepraskas and Sprecher, 1997).

Saturation occurs when all of the soil pores in a horizon are filled with water except for those containing entrapped air. The term *saturation* can be defined in two ways, as soil water pressure or as soil water content (Vepraskas and Sprecher, 1997). Saturation based on soil water pressure occurs when the soil water has a pressure equal to or greater than atmospheric pressure. Under these conditions, when the soil water pressure is greater than atmospheric pressure, water will flow out of the soil into an open borehole, well, or piezometer. In some clays free water can enter the soil at the surface and flow down cracks and remain in the cracks. These soils are not saturated because most of the water in the matrix or ped interiors does not have a pressure equal to or greater than atmospheric pressure (Vepraskas and Sprecher, 1997).

Saturation based on water content is when the soil water content equals the soil porosity (Vepraskas and Sprecher, 1997). Water content can be measured directly by taking a field sample of soil, drying it, and weighing it (gravimetric soil water). Porosity (pore space) can be estimated using an undisturbed soil sample and determining its bulk density, or by determining the sample's soil water content after all the pores have been filled with water.

Measured or estimated bulk density of a soil can be used to determine calculated percent total pore space. Coefficient of variation of soil bulk density samples can range from 10 to 40% due to natural soil variability (Kopp, 2000). Calculated percent total pore space of clay samples based on bulk density values from the NSSL characterization study of the monitoring sites (Appendix C) is about 58% in the upper 50 cm (bulk density of 1.1 g/cm^3), and about 50% at 100 cm (bulk density of 1.3 g/cm^3). Depending on several other soil physical parameters, gravimetric soil water (gravimetric water) at saturation can range from 36 to 53% in the upper 50 cm and from 23 to 43% at 100 cm (Dr. Larry Wilding, personal communication, 2002; Dr. Cristine Morgan, personal communication, 2006; Dr. Tom Hallmark, personal communication, 2006; Dr. Phillip Owens, personal communication, 2006).

NSSL soil water field samples taken during the characterization study in August 1998 showed volumetric soil water contents ranging from about 20 to 30% (18 to 20% calculated gravimetric water) in the upper 50 cm of the pedons, and 12 to 20% (9 to 15% calculated gravimetric water) at depths of 100 cm (Appendix C). NSSL volumetric soil water contents at field capacity (1/3 bar, <33 kPa) of clay samples from the characterization study ranged from 40 to 50% (36 to 45% calculated gravimetric water) in the upper 50 cm, and 30 to 36% (23 to 28% calculated gravimetric water) at depths of 100 cm. Measured soil water content for a representative upper layer clay sample at the monitoring sites was 50% volumetric water (45% calculated gravimetric water) at field capacity and 40% volumetric water (36% calculated gravimetric water) at wilting point (1500 kPa) (Owens, 2001).

Soil samples were taken for gravimetric water determination at all of the monitoring sites (10 sites total) over a 21-month period (October, 2000 to June, 2002, 2 water-year seasons) to determine seasonal soil water changes with depth and whether endoaquic or epiaquic conditions existed in the Vertisols. During the 21-month period, 18 soil sample dates were selected during seasonal wet and during seasonal dry periods. Soil water state of ped interiors was noted in the field as either moist class (soil surface dull and did not glisten) or wet class (soil surface glistens) (Soil Survey Staff, 1993; Schoeneberger et al., 2002). Appendix F shows gravimetric water percents at 10, 30, 50, and 100 cm for each date soil samples were taken, daily rainfall, and 30-day running total rainfall.

Four soil sample dates (January 17, 2001; March 13, 2001; November 16, 2001; and December 18, 2001) were chosen for analysis to document soil water trends during prolonged seasonal wet field conditions at the monitoring sites. Wet or ponded field conditions existed for 2 to 4 continuous months before the soil samples were taken on these dates. On three of the dates (January 17, 2001; November 16, 2001; and December 18, 2001) 6.2 to 8.4 cm precipitation occurred 4 to 7 days before soil samples were taken, and on one date (March 13, 2001) 4.6 cm precipitation occurred over a 14 day period before soil samples were taken. Four sample dates to document soil water trends during prolonged seasonal dry periods were also selected (October 1, 2000; May 24, 2001; August 4, 2001; and May 9, 2002). Table 4 has the data for the nonponded monitoring sites average gravimetric water content of the four sample dates taken at depths of 10, 30, 50, and 100 cm during prolonged seasonal wet periods, and the average gravimetric water content of the four sample dates taken at depths of 10, 30, 50, and 100 cm during prolonged seasonal dry periods. Table 5 shows the same data for the ponded monitoring sites.

Gravimetric water content during prolonged seasonal wet periods was highest at the surface and decreased with depth at all of the monitoring sites (Tables 4 and 5). Nonponded microhigh average percent gravimetric water in the 10-cm samples was 9 to 22% higher than in the 100 cm samples. Nonponded microlow average percent gravimetric water in the 10 cm samples was 11 to 15% higher than in the 100 cm samples. The ponded monitoring sites percent average gravimetric water in the 10 cm samples was 17 to 19% higher than in the 100 cm samples during prolonged seasonal wet periods. The same gravimetric water content trend also occurred during prolonged seasonal dry conditions, with soil water contents higher near the surface than in subsurface horizons. Gravimetric water content differences between prolonged seasonal wet periods and prolonged seasonal dry conditions at 100 cm were relatively small, ranging from 0 to 11% at most monitoring sites, with Site 3 ponded middle showing the greatest difference of 16%.

This trend in soil water content indicated the soils at the monitoring sites wet from the surface downward. Most soil water changes were in the upper 50 cm. At depths of 100 cm soil water changes between prolonged wet conditions and prolonged dry conditions were relatively small for the most part.

Internal soil water state classes are defined as dry, moist, and wet (Soil Survey Staff, 1993). Class limits are expressed both in terms of suction and gravimetric water content. *Dry* is separated from moist at 1500 kPa suction. *Wet* is separated from moist at the condition where water films are readily apparent. The water suction at the moist-wet boundary is assumed to be about 1 kPa for clays (Soil Survey Staff, 1993). Subclasses of wet are *wet nonsatiated* and *wet satiated*. In the wet nonsatiated subclass, soil particles glisten but no free water is present. In the wet satiated subclass free water is easily visible. Satiation implies minor amounts of entrapped air in the smallest pores. True saturation implies no entrapped air. Satiation, for practical purposes, approximates saturation (Schoeneberger et al., 2002).

Tables 6 and 7 show a summary of percent gravimetric water of soil samples taken on the same four different dates discussed previously during prolonged seasonal wet, ponded, and reducing conditions at the nonponded (Table 6) and ponded (Table 7) monitoring sites. Total number of samples taken at each depth, percent of soil samples with gravimetric water of <40%, 40 – 50%, and ≥50%, and percent of soil sample ped interiors that were soil water state moist or wet class are shown.

All soil samples taken on the four different dates during prolonged seasonal wet, ponded, and reducing conditions with <40% gravimetric water did not exhibit any sheen on soil sample ped interiors (all were dull) in the field, and were soil water class moist. Most soil samples with 40 to 50% gravimetric water did not exhibit any sheen on soil sample ped interiors, and were soil water class moist. A few soil samples did exhibit some sheen, and were soil water class wet. Soil samples with ≥50% or more gravimetric water had the highest percent of observed surface sheen on soil sample ped interiors, and were soil water class wet.

Field gravimetric water determinations have a fairly wide range of variability due to field conditions during sampling and the inherent variability of soil water in Vertisols (Jacob et al., 1997; Kopp, 2000). The gravimetric

water determinations do show trends that are helpful in understanding soil hydrology at the monitoring sites. Almost all of the soil samples with near 50% or more gravimetric water were soil water state class wet (surface glistened). The 50% gravimetric water was near the calculated total percent soil pore space (50 to 58%) and within the range of calculated and measured saturation percent (36 to 53%). The probability of wet satiated conditions (at or near saturated conditions) and free water existing in this group of gravimetric water samples was therefore very high.

Using the previously discussed standards for estimating saturation percent and soil water subclass wet satiated (free water, near saturated, or saturated conditions), soil water samples taken during the bottomland hardwood study indicate ponded soils are wet satiated in ped interiors to depths of 30 cm within about 2 weeks (earliest time samples were taken) from the beginning of an above normal precipitation event. Under continuous ponding, the soils are wet satiated in ped interiors to depths of 50 cm within about 3 weeks (earliest time samples were taken). Soil water in ped interiors at 100 cm changed very little between periods of wet conditions and periods of dry conditions at both ponded and nonponded sites. However, based on 200 cm piezometer readings early in the study, bypass flow (free water) under unsaturated conditions can occur to depths of at least 200 cm under certain field conditions such as ponding, or prolonged continuous above normal precipitation events (Owens, 2001).

During prolonged wet field conditions, most of the monitoring site microhigh soil samples in the upper 30 cm with <50% gravimetric water (79%) were soil water class moist indicating the soil did not have free water (Table 6). 21% of the soil samples with ≥50 gravimetric water in the upper 30 cm were mainly soil water class wet satiated indicating free water was present. At depths of 50 and 100 cm, all of the soil samples were <50% gravimetric water, and all soil samples were soil water class moist, indicating the soil did not have free water.

The soil water trend in the microhighs during prolonged wet field conditions was of decreasing soil water with depth, indicating the soils wet from the surface downward. Most soil samples in the upper 30 cm were soil water class moist with a few samples with soil water subclass wet satiated. This soil water trend indicated the microhighs may have a few periods of episaturated conditions during prolonged wet field conditions. All soil samples at 50 and 100 cm were soil water class moist indicating the soil did not have free water.

In the monitoring site microlows, 71% of the soil samples in the upper 30 cm had ≥50% gravimetric water during prolonged wet field conditions (Table 7). The soil samples with ≥50% gravimetric water had 71% with soil water class wet satiated and 29% soil water class moist. This soil water trend indicated most of the soil samples had free water in the upper 30 cm. At 50 cm, 92% of the soil samples had <50% gravimetric water, and most were soil water class moist with a few samples of soil water class wet satiated. Free water was not present in most cases at depths of 50 cm. All of the soil samples at 100 cm had <50% gravimetric water and all were soil water class moist, indicating the soil did not have free water at this depth.

The soil water trend in the microlows during prolonged wet field conditions was of decreasing soil water with depth, indicating the soils wet from the surface downward. The soil water content in the upper 30 cm of the microlows indicated most soil samples were soil water subclass wet satiated, with a few samples in soil water class moist. This soil water trend indicated the microlows have periods of episaturated conditions during prolonged wet field conditions. Episaturated conditions are limited mainly to the upper 30 cm, with a few instances of free water at depths of 50 cm. No free water was observed at depths of 100 cm.

Table 4. Sites 1, 2, and 5 nonponded, average percent gravimetric soil water content of samples taken in microhighs and microlows at 10, 30, 50, and 100 cm on four different dates over a 2-year period during seasonal wet and reducing conditions and on four different dates during seasonal dry conditions.

Sam-ple Depth cm	Average Percent Gravimetric Water Content[1]											
	Site 1 Nonponded Microhigh		Site 1 Nonponded Microlow		Site 2 Nonponded Microhigh		Site 2 Nonponded Microlow		Site 5 Nonponded Microhigh		Site5 Nonponded Microlow	
	Wet, Reducing	Dry Condition	Wet, Reducing	Dry Conditions	Wet, Reducing	Dry Conditions	Wet,	Dry Condition	Wet, Reducing	Dry Condition	Wet,	Dry Condition
10	55	33	55	39	49	34	62	42	43	26	49	29
30	43	24	52	37	42	30	53	38	40	22	39	27
50	36	28	47	37	38	28	48	35	41	22	40	25
100	33	26	40	34	37	27	41	32	34	23	34	24

Table 5. Site 1 ponded, 3 ponded edge, 3 ponded middle, and 4 ponded, average percent gravimetric soil water content from samples taken at 10, 30, 50, and 100 cm on four different dates over a 2-year period during seasonal wet, ponded, and reducing conditions and on four different dates during seasonal dry conditions.

Sample Depth cm	Average Percent Gravimetric Water Content[1]							
	Site 1 ponded		Site 3 ponded edge		Site 3 ponded middle		Site 4 ponded	
	Wet, Ponded, Reducing	Dry Conditions	Wet, Ponded, Reducing	Dry Conditions	Wet, Ponded, Reducing	Dry Conditions	Wet, Ponded, Reducing	Dry Conditions
10	47	37	61	41	61	40	44	29
30	37	31	56	37	54	38	34	26
50	36	33	52	36	48	36	34	23
100	30	31	42	34	42	28	26	21

[1] Percent gravimetric soil water is the average of soil water content at each depth for the four dates during wet field conditions and four dates during dry field conditions.

Soil water content for each date is the average of two field soil samples at each depth at all sites except microhighs, where only one field sample was taken at each depth.

Table 6. Nonponded sites (1, 2, and 5 nonponded), summary of gravimetric soil water samples taken on four different dates during seasonal wet, ponded, and reducing conditions at the monitoring sites; showing total number of samples at each depth, percent of soil samples with gravimetric water <40%, 40 to 50%, and ≥50%, and percent of soil sample ped interiors that were soil water state moist[1] or soil water state wet[2] class (Soil Survey Staff, 1993).

Depth cm	Number of soil samples[3] (each, microhigh, microlow)	Nonponded microhighs							Nonponded microlows						
		<40% gravimetric soil water, % of total samples[4]	40 – 50% gravimetric soil water			≥50% gravimetric soil water			<40% gravimetric soil water, % of total samples[4]	40 – 50% gravimetric soil water			≥50% gravimetric soil water		
			% of total samples	% moist[1]	% wet[2]	% of total samples	% moist[1]	% wet[2]		% of total samples	% moist[1]	% wet[2]	% of total samples	% moist[1]	% wet[2]
0-10 10-30	24	8	71	94	6	21	20	80	12	17	75	25	71	29	71
50	12	42	58	100	0	0	0	0	17	75	78	22	8	100	0
100	12	96	4	100	0	0	0	0	75	25	100	0	0	0	0

Table 7. Ponded sites (1 ponded, 3 edge, 3 middle and 4 ponded), summary of gravimetric soil water samples taken on four different dates during seasonal wet, ponded, and reducing conditions at the monitoring sites; showing total number of samples at each depth, percent of soil samples with gravimetric water of <40%, 40 to 50%, and ≥50%, and percent of soil sample ped interiors that were soil water state moist[1] or soil water state wet[2] class (Soil Survey Staff, 1993).

Ponded Sites								
Depth cm	Number of soil samples[3]	<40% gravimetric soil water, % of total samples[4]	40 – 50% gravimetric soil water			≥50% gravimetric soil water		
			% of total samples	% moist[1]	% wet[2]	% of total samples	% moist[1]	% wet[2]
0-10, 10-30	32	25	19	100	0	56	0	100
50	16	50	12	50	50	38	0	100
100	16	63	31	100	0	6	0	100

[1] Moist-- soil water state moist class, no water films observed; soil surface of ped interiors did not glisten (dull).
[2] Wet-- soil water state wet class, wet satiated subclass; water films observed; soil surface of ped interiors glistened (shiny), free water in soil.
[3] Soil sample number is average of two field soil samples at each depth at all sites except microhighs, where only one field sample was taken at each depth.
[4] All soil samples with less than 40% gravimetric soil water were soil water state moist class, no water films observed, soil surface of ped interior did not glisten (dull).

Soil water trends in the ponded sites were similar to the nonponded sites. During ponded field conditions, 56% of the soil samples from the upper 30 cm of the ponded sites had ≥50% gravimetric water and all were soil water subclass wet satiated indicating free water was present (Table 7). Forty-four percent of the soil samples had <50% gravimetric water and all were soil water class moist indicating free water was not present. At 50 cm, 62% of the soil samples had <50% gravimetric water. Most soil samples were soil water class moist with a few soil water sub class wet satiated, indicating free water was not present for the most part. Thirty-eight percent of the samples at 50 cm had ≥50% gravimetric water and all were soil water subclass wet satiated indicating free water was present. At 100 cm almost all (94%) of the soil samples had <50% gravimetric water and were soil water class moist. Very few samples at 100 cm had ≥50% gravimetric water (6%), indicating the soil did not have free water for the most part.

The soil water trend in the ponded monitoring sites was of decreasing soil water with depth, indicating the soils wet from the surface downward during wet and ponded field conditions. Most of the upper 30-cm soil samples were soil water subclass wet satiated indicating presence of free water and episaturation. Site 3 ponded edge and site 3 ponded middle tended to be wetter (more free water) to depths of 30 and 50 cm than Site 1 ponded and Site 4 ponded. Only a very few soil samples had free water at depths of 100 cm, and these were limited to Site 3 ponded middle (Table 7).

Two of the deep piezometers (Site 4 ponded, 625 cm; Site 5 nonponded, 465 cm) at the bottomland hardwood study monitoring sites recorded free water at those depths, and three of the deep piezometers (Site 1 nonponded, 400 cm; Site 2 nonponded, 500 cm; and Site 3 ponded, 400 cm) were dry during the study (Fig. 9). Free water in the two deep piezometers occurred almost year-round and water levels were deeper than 300 cm below the surface. The bottom of the deep piezometers was in loamy and sandy soil material below the clay layers.

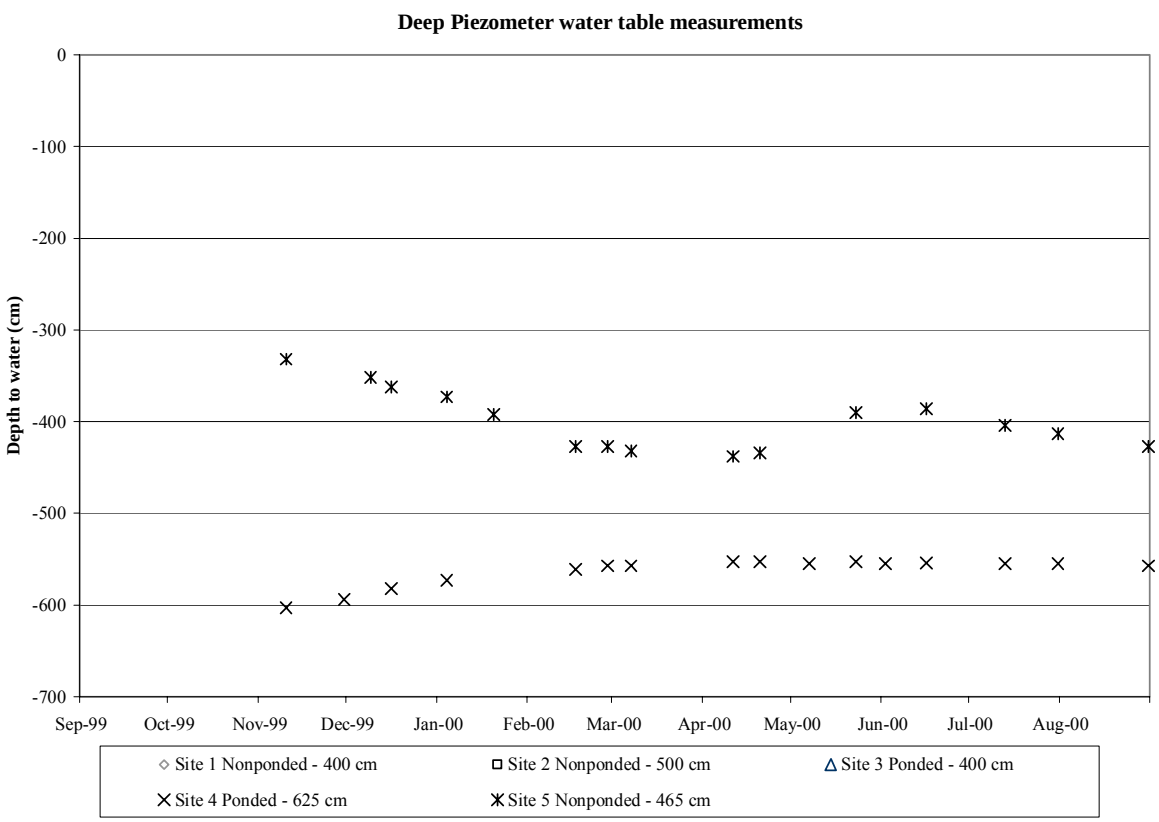


Fig. 9. Deep piezometer measurement of water tables at the monitoring sites.

Reducing Conditions

Accurate measurement of soil reducing conditions in the field is a difficult and time consuming process. Current standards for field measurements of soil reducing conditions are Eh readings with Pt electrodes and the AADP dye test for ferrous iron. These two methods are not precise measurements, but they do show and reflect current soil reducing conditions and also changes in soil reducing conditions over time (Szogi and Hudnall, 1992; Vepraskas and Faulkner, 2001; USDA-NRCS, 2005c).

Appendix H shows the biweekly reducing conditions measured with AADP dye and corrected Eh readings at each of the monitoring sites. During the bottomland hardwood study there were four distinct large storm events at the monitoring sites (May 19, 2000; November 16, 2000; August 29, 2001; August 14, 2002). Duration of the storm events was from less than 1 day to 4 days. Precipitation amounts during the storms ranged from approximately 10.8 to 22.9 cm. Field conditions were relatively dry for several months before the storm events. The monitoring sites were visited to take Eh readings and conduct the AADP dye test for ferrous iron as soon as field conditions allowed after the storm events. The purpose of these additional visits was to document how fast reducing conditions developed in the nonponded and ponded Vertisols. This information will be discussed in more detail for each monitoring site in the following sections.

In several places at the monitoring sites, runoff water from the large storm events was flowing 5 to 10 cm deep into Site 3 ponded edge and Site 3 ponded middle. Several soil samples from the upper 5 cm of different nonponded areas beneath the flowing water showed immediate, 100% very positive AADP dye reaction. Reaction of surface clay in these areas was about pH 5.0 to 5.5.

Eh readings were carefully recorded at three (Site 3 ponded edge, Site 3 ponded middle, and Site 4 ponded) of the four ponded sites. Eh values of at least three of the five Pt electrodes showed strong reducing conditions at 10, 30, and 50 cm at all three ponded sites within 3 to 8 days from the start of the storm events. The soil matrix did not appear wet satiated below about 10 to 15 cm. Ped faces were wet below that depth, however. AADP dye reaction was 100% very positive in the upper 10 cm of the soil within 7 to 8 days from the start of two of the storm events (similar to Eh values). After two other storm events, positive reaction to AADP dye in the upper 10 cm lagged behind reducing conditions measured by Eh values by 9 to 10 days (AADP dye positive reaction after 12 to 13 days ponding).

AADP dye measurements at Site 3 ponded middle (pH 5.5 in upper 11 cm to pH 6.7 at 38 to 64 cm) indicated that a continuous ponding period of 5 to 8 weeks passed before any positive reaction was observed at 50 cm. After continuous ponding for 16 weeks, positive AADP dye reaction at 50 cm was approximately 60% of the soil matrix. After approximately 25 weeks continuous ponding, AADP dye reaction was 100% positive in the upper 50 cm and 60% positive from 50 to 75 cm. No AADP dye reaction was recorded below about 75 cm (pH 7.5 at 64 to 95 cm). Cumulative percent reducing conditions (Eh) were similar at all depths, indicating that development of reducing conditions occurred rather rapidly in the upper 50 cm of the soil under ponded or episaturated conditions (Table 9).

Site 1 nonponded microlow Eh readings were very similar to the ponded sites after the distinct large storm events. However, there was not a positive reaction to AADP dye in the upper part of the soil during this time. During the length of the study, a few positive reactions to AADP dye (less than about 40% of the soil matrix) were observed in the upper 5 cm of the soil during prolonged periods of above-normal wet conditions. Site 1 nonponded microhigh did not develop reducing conditions based on Eh readings and AADP dye reaction during these storm events. On several occasions, sodium dithionite was sprinkled on the soil in the AADP dye test areas, and the reaction was an immediate, very bright red, which indicated adequate levels of iron in the soil.

Field results of reducing conditions measured by Eh readings and AADP dye were not always consistent (Tables 8 and 9). This was especially true at sites similar to Site 1 nonponded (gilgai, microlow), where wet, ponded, and therefore reducing conditions were infrequent and of short duration for the most part. Soil reaction may also play a part in the AADP dye reaction because soils with near neutral pH must undergo stronger (Fig. 13) and possibly longer reducing conditions before ferrous iron forms.

The same comparison of Site 3 ponded edge and Site 3 ponded middle (Table 9) shows that the cumulative percent of Eh readings for reducing conditions and positive reaction to AADP dye were closely similar in the upper 10 cm of the soil. However the two measurements were not similar at 30 and 50 cm. At 30 and 50 cm positive reaction to AADP dye lagged 4 to 8 weeks after development of reducing conditions measured by Pt electrodes.

We are not sure of the reasons for the disparity between Eh measured reducing conditions and positive AADP dye reaction with soil depth in these Vertisols. Field observations during the bottomland hardwood study indicate a possible correlation to clay moisture status and positive reaction to AADP dye. The correlation seemed to be that as the soil developed either near wet satiated (moist, moderately sticky, surface dull) or wet satiated conditions (wet: non-satiated or wet: satiated, very sticky, surface shiny with moisture) with depth, positive reaction to AADP dye developed. Soil reaction may also play a part as previously discussed, because reaction increases with depth in all of the studied soils.

Similar observations were made in the Texas Gulf Coast Prairie MLRA during the ICOMAQ field study (upland Vertisol and Alfisol in ponded prairie depression) (Miller and Owens, 2004), Dr. Phillip Owens graduate field study (several upland Alfisols and bottomland hardwood Vertisols) (Owens, 2001), and the Sharkey soils in lower Mississippi Valley study (Slabaugh, 2006). These field observations seem to be reasonably well documented, and further study is needed to determine the reasons for the disparity between Eh measured reducing conditions and AADP dye reaction at depths below 15 to 30 cm in loamy and clayey soils under episaturated conditions.

Table 8. Sites 1, 2, and 5 nonponded, cumulative percent reducing conditions based on Eh readings and ≥ 60% positive reaction to AADP dye (ferrous iron) at 10, 30, and 50 cm in microhighs and microlows over a 2-year period during seasonal wet conditions.

Sample Depth cm	Cumulative percent reducing conditions based on Eh readings and ≥ 60% positive reaction to AADP dye (ferrous iron)											
	Site 1 Nonponded Microhigh		Site 1 Nonponded Microlow		Site 2 Nonponded Microhigh		Site 2 Nonponded Microlow		Site 5 Nonponded Microhigh		Site 5 Nonponded Microlow	
	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADPDye
10	0	0	15	0	–	–	0	0	13	0	9	4
30	4	0	17	0	–	–	14	0	26	0	30	0
50	10	0	14	0	–	–	17	0	26	0	26	0

Table 9. Sites 1 ponded, 3 ponded edge, 3 ponded middle, and 4 ponded, cumulative percent reducing conditions based on Eh readings and ≥ 60% positive reaction to AADP dye (ferrous iron) at 10, 30, and 50 cm over a 2-year period during seasonal wet conditions.

Sample Depth cm	Cumulative percent reducing conditions based on Eh readings and ≥ 60% positive reaction to AADP dye (ferrous iron)							
	Site 1 ponded		Site 3 ponded edge		Site 3 ponded middle		Site 4 ponded	
	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADP Dye	Reducing conditions Eh	Reducing conditions AADP Dye
10	2	8	40	35	64	56	44	44
30	2	0	42	21	67	33	44	9
50	8	0	42	4	67	27	46	0

Soil Properties

Soil Morphology

Nonponded Sites

Sites 1 nonponded, 2 nonponded, and 5 nonponded were on a flood plain with distinct gilgai microrelief with microhigh, microslope, and microlow surface features. Associated subsurface features were chimney, intermediate, and bowl (Fig. 10). Microlows made up about 10% of the microrelief. Average elevation difference between the top of microhighs and the bottom of microlows was 13 cm, and ranged from 6 to 19 cm. Depth of the very bottom of microlows with blackened leaves averaged 5 cm deep and ranged from 2 to 8 cm. Microlows (blackened leaf area) were about 50 to 100 cm wide and 100 to 300 cm long. Horizontal distance between tops of microhighs was about 2 to 3 m.

Subsurface chimneys were reddish Bk or Bkss calcareous clay (Appendix B) that originated about 100 to 150 cm below the surface. The chimneys extended upward to near the surface under microhighs or the upper part of the intermediate surface features. In three dimensions, chimneys were cone or wave-crest-shaped, about 50 to100 cm in diameter near the base and narrowed to about 10 to 30 cm in diameter near the surface. In a few areas, subsurface chimneys extended to the surface (puff). Subsurface bowls under the microlows were black noncalcareous clays to depths of 100 to 150 cm below the surface (Appendix B) (Fig. 10). Subsurface intermediate areas were transition zones between the bowl and chimney.

All sites with distinct gilgai had over 60% predominately smectitic clay content in the upper 100 cm of the microlows (Table 10). Site 4 ponded, and microhighs at Sites 2 nonponded, 3 ponded, and 5 nonponded had less than 60% predominately smectitic clay content in the upper 100 cm. Depth to loamy materials ranged from about 170 to 300 cm. This information will be discussed in greater detail in the following sections concerning each monitoring site.

Ponded Sites

Sites 1 ponded, 3 ponded edge, and 3 ponded middle were on a flood plain in concave abandoned channels. Site 4 ponded was on a flood plain in a flat or backswamp depression. Distinct microrelief surface features were not present in these ponded landscapes. Site 3 ponded edge had gilgai microrelief starting above the average ponding edge. There were scattered subtle microhighs and microlows (relief of 5 to 10 cm and 1 to 3 m in diameter) in these relatively broad concave to flat landscapes. Most of the microhighs were associated with large trees.

The subsurface chimneys at Sites 1 ponded, 3 ponded edge, 3 ponded middle, and 4 ponded were, in most cases, distributed more randomly in the landscape. Subsurface chimneys were reddish Bk or Bkss calcareous clay (Appendix B) that originated about 100 to 150 cm below the surface and extended to near the surface (Fig. 11). Soil in the bowls between the chimneys was black noncalcareous clay. At Site 3 ponded middle the chimneys were distorted and discontinuous as revealed by the trenches across the position. In several places the outer edges of the reddish clay chimney and black clay of the subsurface bowl were intermixed together in large discontinuous blocks indicating severe subsurface turbation.

The intermixing of the chimney and bowl subsurface materials at Site 3 ponded middle in this manner indicated the possibility that the uprooting and tipping over of large trees (tree-tip) in the past may have caused the subsurface turbation. Even though the surface of these areas was not typical of tree-

tip mound and tree-tip pit local-scale topography, we believe this process had a major part in the mixing of the subsurface features.

During the length of the field study, at least 6 very large tall trees were observed to fall in the vicinity of Sites 1 nonponded and ponded, Site 2 nonponded, Site 3 ponded edge, and Site 3 ponded middle. In one case a tree fell suddenly during a windy day while observations were being made in the field. In the other cases the large tall trees developed a distinct lean over a period of several months or years. As the trees leaned steeper over time, the trees either fell slowly during a period of several months, or else fell suddenly during a storm event. The root balls were approximately less than 1 m thick, 1 to 2 m high and 2 to 3 m wide above the ground. Holes left in the ground were less than 1 m deep at most. In almost all cases the soil attached to roots of the trees had parts of reddish clay chimney material attached.

Bowl and chimney subsurface features were not observed along the 10-m-long trench dug for the soil characterization study at Site 4 ponded. The pedon that was described (Appendix B) was in a slight depression about 5 to 10 cm deep and about 2 m in diameter. Soil at Site 4 had less than 60% (58% weighted average clay content, 25 to 100 cm) predominately smectitic clay content in the upper 100 cm. This information will be discussed in greater detail in the following sections concerning each monitoring site.

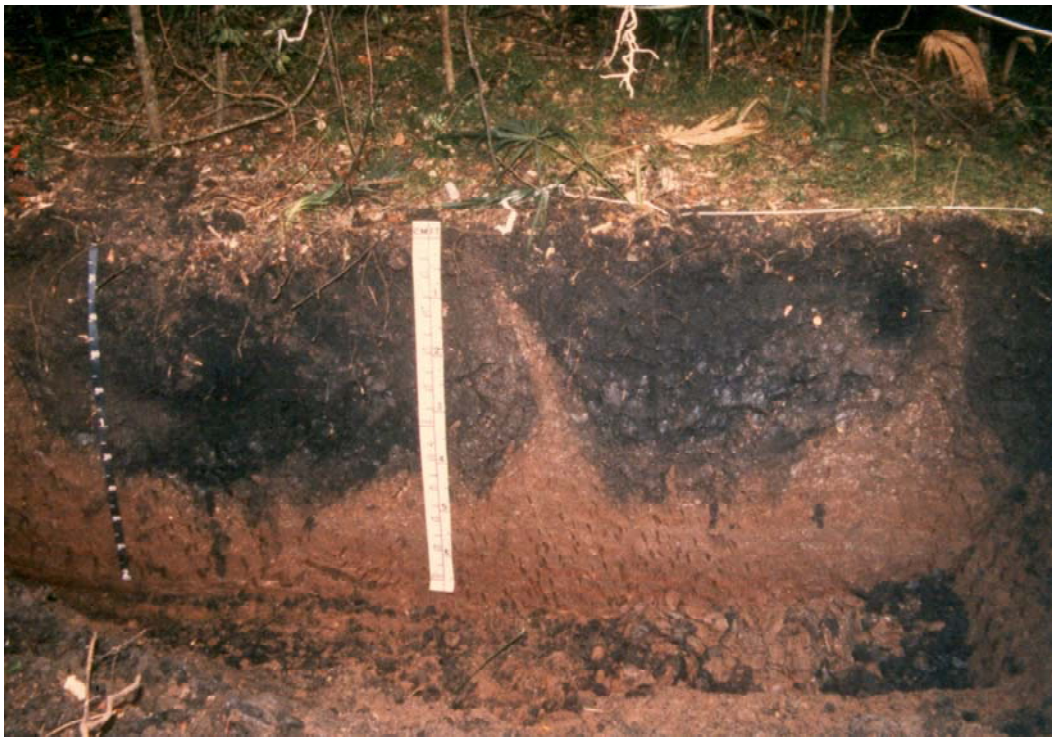


Fig. 10. Site 1 nonponded. Top, landscape showing gilgai microrelief with temporary ponding of microlows. Bottom, soil profile showing subsurface features; chimney and intermediate to right of white tape and bowl to left of white tape (tape scale 2 m long).

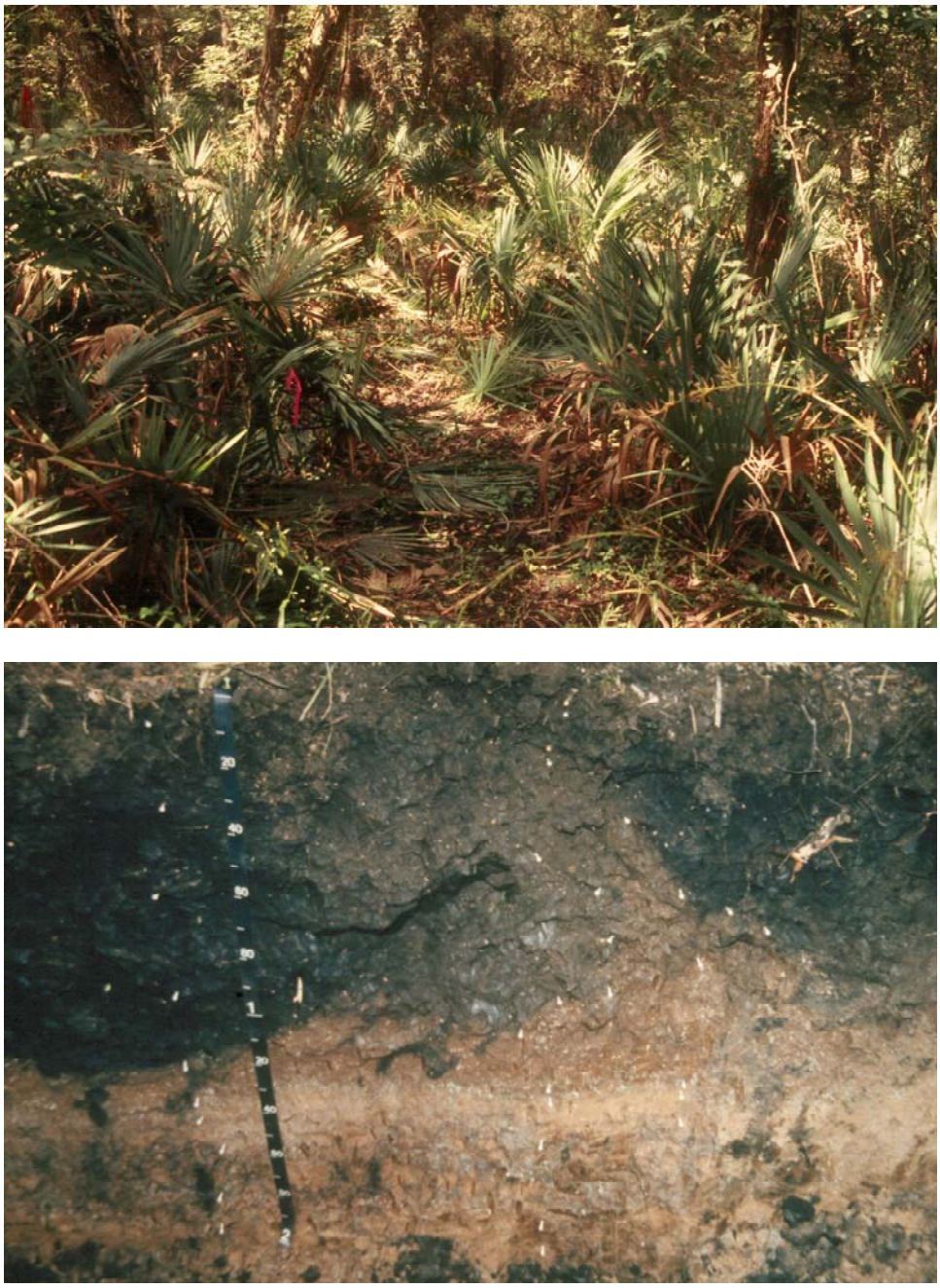


Fig. 11. Site 3 ponded edge. Top, landscape with ponded area in foreground and vegetation change at ponded/nonponded edge at top ¼ of photograph. Bottom, soil profile showing subsurface features, chimney, intermediate and bowl (scale tape 2 m long).

Fig. 12. Ponded monitoring site landscapes. Top, Site 1 ponded, with vegetation change between ponded (left ¾ of photograph) and nonponded (upper right corner ¼) areas; Middle, Site 3 ponded middle; Bottom, Site 4 ponded, with an indistinct ponded microlow at bottom right corner of photograph.

Table 10. Monitoring sites, National Soil Survey Laboratory (NSSL) profile numbers, weighted average percent clay of 0 to 50 cm[1], and family taxonomic classification[2] (all smectitic clay mineralogy).

Monitoring Site	NSSL Profile Number	% clay [1]	Classification [2]
1 Nonponded microhigh	S98TX-39-1A	68	very-fine Chromic Hapludert
1 Nonponded microlow	S98TX-39-1	75	very-fine Typic Hapludert
1 Ponded microhigh	S98TX-39-2A	68	very-fine Aeric Calciaquert
1 Ponded microlow	S98TX-39-2	67	very-fine Typic Epiaquert
2 Nonponded microhigh	S98TX-39-3A	62	fine Chromic Hapludert
2 Nonponded microlow	S98TX-39-3	71	very-fine Typic Hapludert
3 Ponded edge microhigh	S98TX-39-4A	76	very-fine Aeric Calciaquert
3 Ponded edge microlow	S98TX-39-4	77	very-fine Typic Epiaquert
3 Ponded middle microhigh	S98TX-39-5A	65	fine Aeric Calciaquert
3 Ponded middle microlow	S98TX-39-5	72	very-fine Aeric Epiaquert
4 Ponded	S98TX-39-6	58	fine Typic Epiaquert
5 Nonponded microhigh	S98TX-39-7A	44	fine Chromic Hapludert
5 Nonponded microlow	S98TX-39-7	60	very-fine Typic Hapludert

[1] Weighted average percent total clay, 0 to 50 cm.
[2] Weighted average percent total clay, 25 to100 cm of particle-size control section. Very-fine family is ≥60% weighted average clay; fine family is 35 to 60% weighted average clay (Soil Survey Staff, 1999).

Soil Chemical and Physical Property Comparisons

Table 10 shows monitoring site microrelief location from the August 1998 NRCS-NSSL soil characterization study (microhigh and microlow), NSSL Profile Numbers, weighted average percent total clay from 0 to 50 cm, and soil taxonomic classification. Table 11 shows selected soil chemical and physical properties of nonponded and ponded microhigh and microlow soil samples taken from the monitoring sites during the August 1998 NRCS-NSSL soil characterization study (Appendix B and C). Soil reaction (pH, saturated soil water paste and 1:1 soil water), percent organic matter (calculated from percent total carbon), percent acid oxalate extractable iron (soluble, noncrystalline iron hydroxides), percent dithionite-citrate extractable manganese (total manganese), cation exchange capacity (CEC, meq/100 gm), and percent clay are shown for the A horizons and upper Bw horizons (total depth about 40 to 50 cm). The following discussions of chemical and physical properties concern only microlows (where present).

Soil reaction (pH)

Soil reaction (pH) influences formation of redox features because in acid soil systems iron and manganese are more soluble during reducing conditions. Iron and manganese are less soluble during reducing conditions in neutral or more alkaline soil systems. The nearly amorphous $Fe(OH)_3$ minerals (ferrihydrite) reduce at a higher Eh value for a given pH than do the crystalline minerals of FeOOH (goethite) or Fe_2O_3 (hematite) (Vepraskas and Faulkner, 2001). Concentrations of iron hydroxide and other minerals in the soil also play a part in the reduction process due to mixed redox potential and buffering effects. Smaller concentrations of an iron hydroxide in a soil will reduce faster and become

soluble in the soil system at a given pH than larger concentrations of the same iron hydroxide at the same pH (Dr. Bruce James, personal communication, 1998) (Fig. 13).

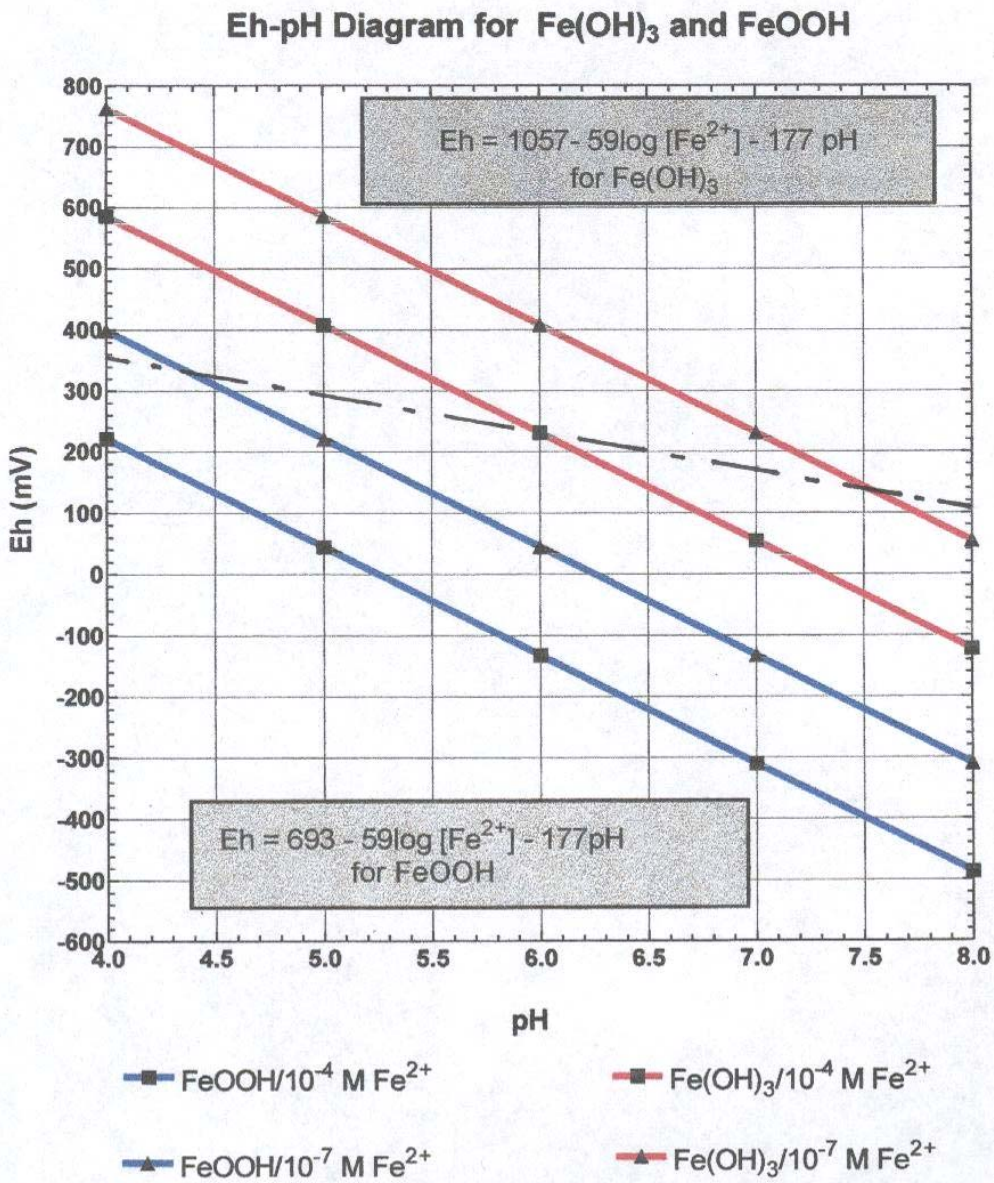


Fig. 13. Eh-pH diagram showing the threshold value (oxidized-reduced) and stability of different forms and concentrations of iron hydroxides (Dr. Bruce James, Professor of Soil Chemistry, University of Maryland. Presented at National Wet Soil Monitoring and Standards Conference, Baton Rouge, LA. 1998). Dashed line represents current NRCS-NTCHS aerobic-anaerobic condition boundary (Eh = [595 – (60 x pH)]).

Determining field pH during ponding and reducing condition events was difficult at the monitoring sites due to the differences in bowl and chimney subsurface features, and the unique fact that soil reaction, both pH and noncalcareous or calcareous soil conditions, could change dramatically over very short distances of less than 1 m in these Vertisols. Field pH determined periodically during the study was near NRCS-NSSL pH values (1:1 soil-water). To maintain consistency and accuracy, the NRCS-NSSL saturated paste pH values and field Eh values (corrected Eh readings of three out of five Pt electrodes that met the reducing condition standard) were used to determine reducing conditions based on the NRCS-NTCHS Eh-pH standard (Fig. 13).

In the microlows, the nonponded sites soil reaction (saturated paste) in the A horizon ranged from pH 6.6 at Sites 1 and 2 nonponded to pH 6.7 at Site 5 nonponded. Soil reaction in the Bw horizon at nonponded sites ranged from pH 6.5 and 6.7 at Sites 1 and 2 nonponded respectively to pH 7.2 at Site 5 nonponded. At ponded sites soil reaction in the A horizon ranged from pH 5.0 and 5.5 at Sites 3 ponded middle and 3 ponded edge, respectively, to pH 6.5 and 7.3 at Sites 1 and 4 ponded, respectively (additional soil samples from several other areas near Site 4 ponded indicated typical A horizon soil reaction was near neutral rather than slightly acid as determined from the pedon sampled during the NRCS-NSSL characterization study). Soil reaction in the Bw horizon at ponded sites ranged from pH 5.8 and 5.9 at sites 3 ponded edge and 3 ponded middle to pH 6.7 and 7.4 at Sites 1 and 4 ponded respectively. Soil reaction in ponded sites was generally more acid than nonponded sites, with the exception of Site 4 ponded.

Total Carbon and Calculated Percent Organic Matter

Soil organic matter (OM) content is important for many reasons. A respiring microbial population is essential to the formation of reducing soils, and a readily available OM source is necessary for the microbes to carry out this process (Vepraskas and Faulkner, 2001). Calculated values for soil percent OM can be determined from total carbon content (Appendix C) by the following formula; percent organic matter = [total carbon − {0.12 x %$CaCo_3$ }] x 1.724 (Wayne Gabriel, Personal Communication, 2006). Percent OM for about the upper 40 cm of the soils sampled at all of monitoring sites is shown in Table 11.

In the microlows at nonponded sites, A horizon OM content ranged from 5% at Site 5 nonponded to 7% at Site 1 nonponded. OM content in the Bw horizon of the nonponded sites ranged from 4% at Sites 2 and 5 nonponded to 6% at Site 1 nonponded. The ponded sites A horizon OM content ranged from 6% at Sites 1 ponded and 3 ponded edge to 7% at Sites 3 ponded middle and 4 ponded. OM content in the Bw horizon of the ponded sites ranged from 3% at Site 4 ponded to 4% at Sites 3 ponded edge and 3 ponded middle. OM content was higher in the upper 50 cm of most soils at the monitoring sites compared to other Texas Gulf Coast Prairie Vertisols.

Cation Exchange Capacity

Cation exchange capacity (CEC, meq/100 g) is the quantity of ions held in exchangeable form, or the sum total of exchangeable cations that a soil can adsorb, and is an important component of soil fertility. CEC is determined predominately by type and amount of clay minerals and soil organic matter. Smectitic clays have the highest CEC of the clay minerals.

In the microlows at nonponded sites, A horizon CEC ranged from 46 meq/100 g at Site 5 nonponded to 65 meq/100 g at Site 1 nonponded. CEC in the Bw horizon of the nonponded sites ranged from 44 meq/100 g at Site 5 nonponded to 62 meq/100 g at Site 1 nonponded. CEC in the ponded sites A horizon

ranged from 51 meq/100 g at Site 4 ponded to 57 meq/100 g Site 3 ponded edge. CEC in the Bw horizon of the ponded sites ranged from 42 meq/100 g at Site 4 ponded to 56 meq/100 g at Site 3 ponded. CEC was similar in the upper 50 cm of all soils at the monitoring sites compared to other Texas Gulf Coast Prairie Vertisols.

Iron (Percent Acid-Ammonium Oxalate Extractable)

Acid-ammonium oxalate (acid oxalate) is used as a selective dissolution extractant for organically complexed iron and noncrystalline iron hydroxides in soil. Acid oxalate does not extract crystalline iron hydroxides (USDA-NRCS, 2004). A more reliable and accurate estimation of soil properties and a better understanding of the soil exchange complex is provided by this analysis (Fred Kaisaki, personal communication, 2006).

In microlows at nonponded sites, A horizon acid oxalate iron content ranged from 0.27% at Site 5 nonponded to 0.33% at Site 1 nonponded. Iron content in the Bw horizon of the nonponded sites ranged from 0.25% at Site 5 nonponded to 0.40% at Site 1 nonponded. The ponded sites A horizon acid oxalate iron content ranged from 0.39% at Sites 3 ponded middle and 4 ponded to 0.65% at Site 3 ponded edge. Iron content in the Bw horizon of the ponded sites ranged from 0.24% at Site 4 ponded to 0.62% at Site 3 ponded edge. Acid oxalate iron was higher in the upper 50 cm of most soils at the monitoring sites compared to other Texas Gulf Coast Prairie Vertisols.

Manganese (Percent Dithionite-citrate Extractable)

Dithionite-citrate extractable manganese (Mn) is a measure of total soil Mn. A total extract of Mn is used by the NRCS-NSSL due to the relatively low concentrations of Mn in typical soils (Fred Kaisaki, personal communication, 2006).

In microlows at nonponded sites, A horizon dithionite-citrate manganese content ranged from 0.04% at Site 5 nonponded to 0.06% at Site 2 nonponded. Manganese content in the Bw horizon of the nonponded sites ranged from 0.03 and 0.05% at Sites 1 and 5 nonponded respectively to 0.18% at Site 2 nonponded. The ponded sites A horizon dithionite-citrate manganese content ranged from 0.01% at Sites 3 ponded middle and 4 ponded to 0.03% and 0.05% at Sites 1 ponded and 3 ponded edge respectively. Manganese content in the Bw horizon of the ponded sites ranged from 0.01% at Sites 3 ponded middle and 4 ponded to 0.03% and 0.04% at Sites 1 ponded and 3 ponded edge, respectively. Dithionite-citrate manganese was lower in the upper 50 cm of most soils at the monitoring sites compared to other Texas Gulf Coast Prairie Vertisols.

Clay

Smectitic clay was the predominate clay mineral at all of the monitoring sites (Appendix C). Smectitic clays have high CEC capacity, and have high shrink-swell characteristics during wetting and drying cycles. The clay content of A horizons in microlows at nonponded sites ranged from 59% at Site 5 nonponded to 74% at Site 1 nonponded (Table 11). Clay content of Bw horizons in microlows at nonponded sites ranged from 60% at Site 5 nonponded to 75% at Site 1 nonponded. Clay content of A horizons in microhighs at nonponded sites ranged from 50% at Site 5 nonponded to 67% at Site 1 nonponded. Clay content of Bw horizons in microhighs at nonponded sites ranged from 40% at Site 5 nonponded to 68% at site 1 nonponded. The clay content of A horizons in microlows at ponded sites ranged from 65% at Site 1 ponded to 76% at Site 3 ponded edge. The clay content of Bw horizons in

microlows at ponded sites ranged from 63% at Site1 ponded to 78% at Site 3 ponded edge. Site 4 ponded A horizon had 60% clay content, and the Bw horizon had 57% clay content. Clay content in the upper 50 cm of all soils at the monitoring sites was similar compared to other Texas Gulf Coast Prairie Vertisols (fine and very-fine family Taxonomic classification).

Table 11. Selected soil chemical and physical properties of A horizons (upper 10 to 20 cm) and upper part of the Bw horizons (to depths of 40 to 50 cm) of pedons sampled during the August 1998 NRCS-NSSL soil characterization study.

Chemical and physical properties	Site 1 nonponded microhigh	Site 1 nonponded microlow	Site 1 ponded microhigh	Site 1 ponded microlow	Site 2 nonponded microhigh	Site 2 nonponded microlow	Site 3 ponded edge microhigh	Site 3 ponded edge microlow	Site 3 ponded middle microhigh	Site 3 ponded middle microlow	Site 4 ponded	Site 5 nonponded microhigh	Site 5 nonponded microlow
A horizon pH SP[1]	6.70	6.60	6.60	6.50	6.90	6.60	5.50*	5.50	5.20*	5.00	7.30*	7.00	6.70
A horizon pH 1:1[1]	7.40	7.20	7.00	6.80	7.40	7.00	5.90	5.90	5.70	5.50	6.80*	7.30	7.50
Bw horizon pH SP[1]	7.40	6.50	6.90	6.70	7.30	6.70	6.50	5.80*	6.40	5.90*	7.40*	7.30	7.20*
Bw horizon pH 1:1[1]	7.60	6.90	7.10	5.90	7.60	6.60	6.90	6.60	6.90	6.20	7.50*	8.00	7.60
A horizon OM[2] %	5	7	4	6	6	6	7	6	5	7	7	7	5
Bw horizon OM[2] %	4	6	2	4	6	4	3	4	5	4	3	2	4
A horizon CEC[3]	48.10	65.00	51.90	52.00	46.66	61.00	58.00	57.00	35.00	53.00	51.00	42.30	46.00
Bw horizon CEC[3]	44.00	62.00	51.10	49.00	38.10	59.00	53.80	56.00	38.20	52.00	42.00	26.00	44.00
A horizon Fe[4] %	0.21	0.33	0.48	0.48	0.22	0.28	0.68	0.65	0.58	0.39	0.39	0.19	0.27
Bw horizon Fe[4] %	0.15	0.40	0.41	0.47	0.12	0.34	0.47	0.62	0.23	0.54	0.24	0.07	0.25
A horizon Mn[5] %	0.05	0.05	0.06	0.05	0.05	0.06	0.02	0.03	0.01	0.01	0.01	0.04	0.04
Bw horizon Mn[5] %	0.05	0.05	0.05	0.03	0.06	0.18	0.06	0.04	0.02	0.01	0.01	0.05	0.03
A horizon clay %	67.00	74.00	67.00	65.00	66.7	70.00	77.50	75.50	72.10	71400	60.00	49.60	59.00
Bw horizon clay %	68.00	75.00	70.00	63.00	60.90	72.00	76.80	77.50	59.90	73.00	57.00	40.00	60.00

[1]SP, pH soil-water saturated paste. 1:1, pH one part soil to one part water.
[2]OM, percent organic matter calculated from percent total carbon.
[3]CEC, ammonium acetate cation exchange capacity (meq/100g).
[4]Fe, percent acid-ammonium oxalate extractable iron (poorly crystalline iron hydroxides).
[5]Mn, percent dithionite-citrate extractable manganese (total).
*Saturated paste pH not determined by NRCS-NSSL. Site 4 saturated paste pH determined from representative soil samples by Texas A&M University.

Monitoring Site Field Study Results

Site 1 Nonponded microhigh

Soil morphology

The Site 1 nonponded microhigh soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig. 14, Appendix J) classifies as a very-fine, smectitic, hyperthermic Chromic Hapludert (Appendix B). The surface layer is calcareous, slightly alkaline, black clay 10 cm thick. From 10 to 20 cm is calcareous, slightly alkaline, very dark gray clay. Between the depths of 20 and 46 cm is calcareous, slightly alkaline, 70% dark grayish brown and 30% dark gray clay. From 46 to 78 cm is calcareous, slightly alkaline, brown clay.

The results of the 150-m soil transect (Fig.14, Appendix I), indicated the microhighs in this area were similar to the upper 50 cm of the microhigh profile described at the NRCS-NSSL soil characterization study site. Additional redox features observed in the upper 50 cm of microhighs along the 150-m transect were 1- to 2-mm red masses (masses of oxidized iron) that ranged from less than 1% to 1%, and less than 1% 1- to 3-mm iron-manganese nodules with distinct boundaries.

Fig. 14 shows the field ID numbers, location of the monitoring site (1-MS), soil characterization site (1-CP), 150-m soil transect location (1-T1 to 1-T4), and location of additional field notes. Appendix I and J have the field ID numbers, brief field notes, relative elevations, and latitude and longitude coordinates for each of the numbers shown in Fig. 14.

Hydrology

Site 1 nonponded microhighs never ponded (Appendix F). Runoff from above-normal precipitation events and tropical storms did leave drift marks on tops of microhighs on three different occasions during the 6-year study. Runoff water from higher areas during above-normal precipitation events and tropical storms flowed from the north and east across the monitoring site and then flowed south-southeast along a weakly defined low.

Reducing conditions, AADP dye, and Eh measurements

Appendix H shows the biweekly AADP dye and Eh observations during the study. During the 1996-2002 and 2000-2002 water-years there were no positive reactions to AADP dye recorded on microhighs at the monitoring site. During the 2000-2002 water-years there were no reducing conditions (Eh $\leq$ +193 mV) measured at 10 cm (Appendix K). At 30 cm, cumulative reducing conditions (Eh $\leq$ +181 mV) were 4%. Durations were several events of less than 2-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +151 mV) were 10%. Durations ranged from one event of less than 2-continuous-weeks, to one event of 2-continuous-weeks.

During the 1996-2002 and 2000-2002 growing season water-years, there were no positive reactions to AADP dye recorded in microhighs at the monitoring site. During the 2000-2002 growing season water-year there were no reducing conditions (Eh) measured at 10 cm. At 30 cm, cumulative reducing conditions (Eh) were 2%. Duration was one event of less than 2-continuous-weeks. At 5 cm, cumulative

reducing conditions (Eh) were 7%. Durations were one event of less than 2-continuous-weeks, and one event of 2-continuous-weeks.

Hydric soil classification and hydrology

Site 1 nonponded microhigh did not meet any of the 2005 NRCS-NTCHS soil field indicators for loamy and clayey hydric soils, or Field Indicator F18, Reducing Vertic (USDA-NRCS 2005a). During normal precipitation months and years the site did not meet the hydrology criteria for frequent ponding or flooding duration (at least 7 days) during the growing season (February 12 to December 12, Brazoria County, Texas) (Environmental Laboratory, 1987), (USDA-NRCS, 2005a).

Site 1 nonponded microhigh did not meet any of the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site did not meet the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding or flooding duration (Environmental Laboratory, 1987). The site also did not meet the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 1 Nonponded microlow

Soil morphology

The Site 1 nonponded microlow soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig. 14, Appendix J) classifies as a very-fine, smectitic, hyperthermic Typic Hapluderts (Appendix B). The surface layer is neutral, black clay 14 cm thick. From 14 to 57 cm is neutral, black clay.

The results of the 150-m soil transect (Fig. 14, Appendix I,) indicated the microlows in this area were similar to upper 50 cm of the microlow profile described at the NRCS-NSSL soil characterization study site. Additional redox features observed in the upper 50 cm of microlows along the 150-m transect were 1- to 2-mm red masses (masses of iron accumulation) that ranged from less than 1% to 1%, and less than 1% 1- to 3-mm iron-manganese nodules with distinct boundaries. A few 5- to 10-mm masses of brownish clay were observed in the upper 50 cm of some microlows. The brownish clays were due to mixing of deeper reddish and brownish clays with near-surface layers by crayfish activity or Vertisol shrink-swell properties, and were not considered redox features.

Appendix J lists identification numbers shown in Fig. 14, brief field notes for the monitoring sites and 150-m soil transect, relative elevations, and latitude and longitude for each of the field notes.

Hydrology

Average ponding depth at Site 1 nonponded microlow was 3.5 cm and ranged from 3 to 8 cm (Table 3, Appendix F). The average ponding depth closely matched the average measured depth of blackened leaves in the bottom of microlows observed during the soil transects (5 cm, range 2 to 8 cm).

During the 1996-2002 water-years, Site 1 nonponded microlow (Fig. 14) cumulative ponding was 11%. The microlow ponded 61% of the time during above-normal precipitation months, 31% of the time during normal precipitation months, and 8% of the time during below-normal precipitation months (Table

3, Appendix F). Durations of all ponding events were less than 2-continuous-weeks (Appendix K). During the 2000-2002 water-years, Site 1 nonponded microlow cumulative ponding was 8%. Durations of ponding events were less than 2-continuous-weeks.

During the 1996-2002 growing season water-years, Site 1 nonponded microlow cumulative ponding was 7%. Durations of all ponding events were less than 2-continuous-weeks. During the 2000-2002 growing season water-year, microlow cumulative ponding was 5%. Durations of all ponding events were less than 2-continuous-weeks.

Reducing conditions, AADP dye, and Eh measurements

Appendix H shows the biweekly AADP dye and Eh observations during the study. During the 1996-2002 and 2000-2002 water-years there were no positive reactions to AADP dye recorded in microlows at the monitoring site. During the 2000-2002 water-years cumulative reducing conditions (Eh $\leq$ +199 mV) at 10 cm were 15% (Appendix K). Durations ranged from several events of less than 2-continuous-weeks, to two events of 2-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh $\leq$ +205 mV) were 17%. Durations were several events of less than 2-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +187 mV) were 14%. Durations ranged from several events of less than 2-continuous-weeks, to two events of 2-continuous-weeks.

During the 1996-2002 and 2000-2002 growing season water-years, there were no positive reactions to AADP dye recorded in microlows at the monitoring site. During the 2000-2002 growing season water-years cumulative reducing conditions (EH) at 10 cm were 10% (Appendix K). Durations ranged from several events of less than 2-continuous-weeks, to one event of 2-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh) were 12%. Durations were several events of less than 2-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh) were 10%. Durations were several events of less than 2-continuous-weeks.

Hydric soil classification and hydrology

Site 1 nonponded microlow did not meet any of the 2005 NRCS-NTCHS soil field indicators for loamy and clayey hydric soils, or Field Indicator F18, Reducing Vertic (USDA-NRCS 2005a). Ponding in the microlow was predominantly in months with above normal precipitation, and lasted mainly for less than 2-continuous-weeks duration. Based on periodic additional observations during the study, during normal precipitation months and years the site did not usually meet the hydrology criteria for frequent ponding or flooding duration (at least 7 days) during the growing season (February 12 to December 12, Brazoria County, Texas) (Environmental Laboratory, 1987) (USDA-NRCS, 2005a).

Site 1 nonponded microlow did not meet any of the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site did not meet the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding or flooding duration (Environmental Laboratory, 1987). The site also did not meet the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

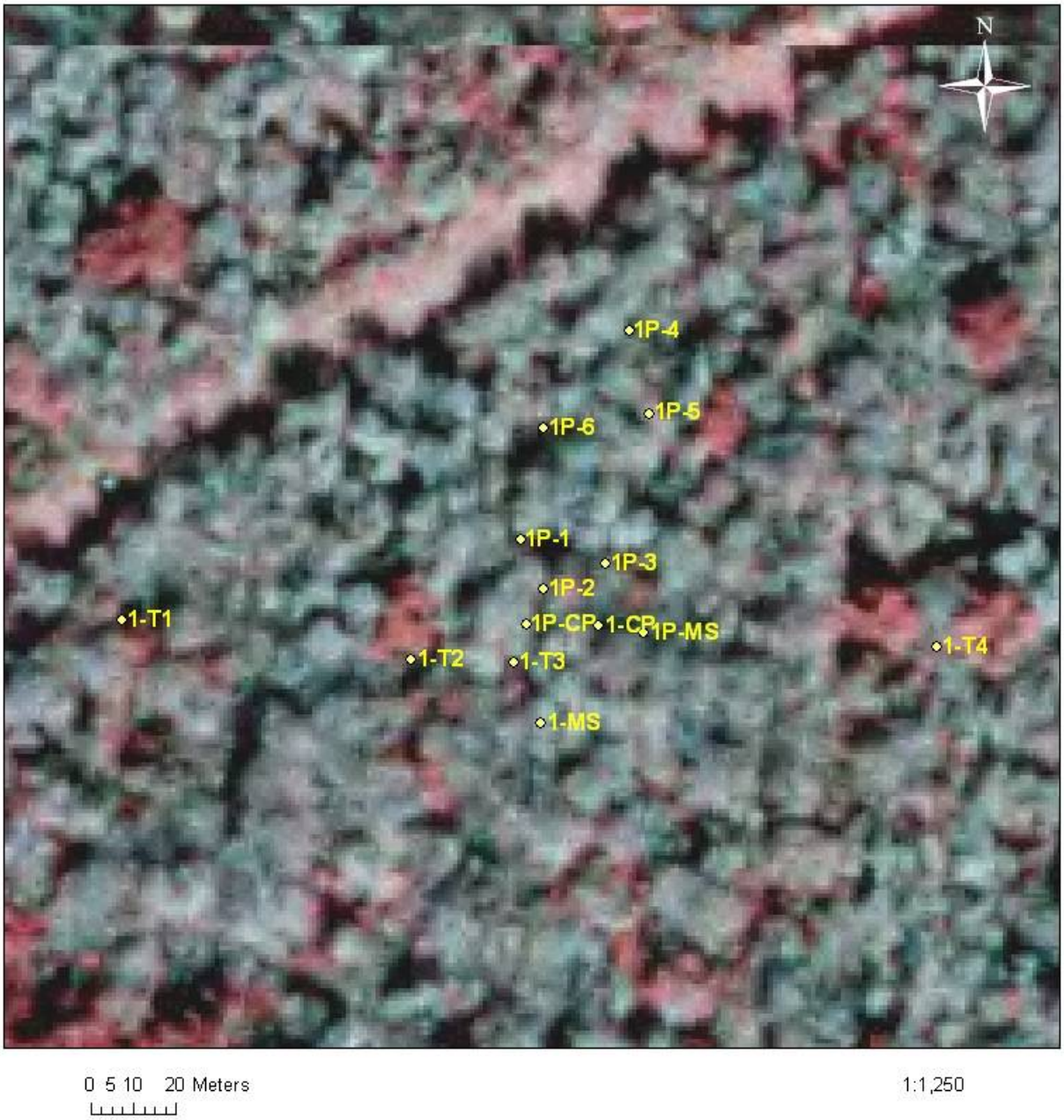


Fig. 14. 1:1,250 scale digital orthophoto showing locations of Site 1 nonponded monitoring site (1-MS) and soil characterization profile location (1-CP); Site 1 ponded monitoring site (1P-MS) and soil characterization profile location (1P-CP); selected points along the 150-m soil transect (1-T1, 1-T2, 1-T3, 1-T4); PVC bench mark for ponding depths (1P-2); and outer edges of main ponded area during a typical ponding event when middle area was ponded approximately 10 cm deep (1P-1, 1P-3, 1P-4, 1P-5, 1P-6).

Site 1 Ponded

Soil morphology

The Site 1 ponded microhigh soil profile described during the NRCS-NSSL soil characterization study in an area of indistinct gilgai microrelief (Fig. 14, Appendix J) classifies as very-fine, smectitic, hyperthermic Aeric Calciaquert (Appendix B). The surface layer is neutral, black clay 14 cm thick. From 14 to 44 cm is neutral, black clay. From 44 to 64 cm is calcareous, slightly alkaline, brown clay, with few masses of reddish brown clay 1 to 2 mm in size. The masses of reddish brown clay are the result of mixing of deeper reddish and brownish clays with near surface layers by crayfish activity or Vertisol shrink-swell properties, and are not redox features.

Site 1 ponded microlow soil profile described during the NRCS-NSSL soil characterization study in an area of indistinct gilgai microrelief classifies as very-fine, smectitic, hyperthermic Typic Epiaquert (Appendix B). The surface layer is neutral, black clay 19 cm thick. From 19 to 27 cm is neutral, black clay. From 27 to 99 cm is slightly alkaline, black clay. Fig. 12 shows the landscape and vegetation at Site 1 ponded.

The results of the 150-m soil transect (Fig. 14, Appendix I), indicated the microhighs and microlows in this area were similar to the upper 50 cm of the microhigh and microlow profile described at the NRCS-NSSL soil characterization study site. In the ponded area of Site 1 ponded, additional redox features observed in the upper 50 cm along the 150-m transect were 1- to 2-mm red masses (masses of oxidized iron) that range from less than 1% to 1%, less than 1% brownish masses of oxidized iron on faces of peds, and less than 1 to 1%, 1- to 3-mm iron-manganese nodules with distinct boundaries. A few 5- to 10-mm masses of brownish clay were observed in the upper 50 cm of a few microlows. The brownish clays were due to mixing of deeper brownish and reddish clays with near surface layers by crayfish activity or Vertisol shrink-swell properties, and were not considered redox features. Careful observations were made of amounts of iron coatings on calcium carbonate nodules in the upper 50 cm of the soil profiles in ponded and nonponded areas. A definite trend was not observed of amounts of iron coatings on calcium carbonate nodules predominating in either ponded or nonponded soils. Fig. 14 shows the locations of the monitoring site, soil characterization site, 150-m soil transect location, and location of outer edges of ponding during a typical ponding event.

Fig. 14 shows the field ID numbers, location of the monitoring site (1P-MS), soil characterization site (1P-CP), 150-m soil transect location (1-T1 to 1-T4), location of ponded areas (1P-1 to 1P-6) and location of additional field notes. Appendix I and J have the field ID numbers, brief field notes, relative elevations, and latitude and longitude coordinates for each of the numbers shown in Fig. 14.

Hydrology

Average ponding depth at Site 1 ponded was 9.9 cm and ranged from 6 to 19 cm. Drift marks on piezometers and vegetation in the area after a very large precipitation event were about 25 cm (Table 3, Appendix F). The average ponding depth matched the outer edge of ponding either at or very near the start of Cherokee sedge vegetation (vegetation above ponded water edge), and coincided with observations of 10-cm ponding depths measured on the permanent PVC pipe bench mark in the middle of the ponded area.

Runoff water from higher areas typically entered the location of Site 1 ponded from the north and east side of the shallow abandoned channel. During above-normal precipitation events, water flowed out

of the shallow abandoned channel at the southeast end toward the south-southeast along a weakly defined low, and occasionally across the gilgai microrelief at Site 1 nonponded.

Ponded water remained mostly clear through the fall, winter, and early spring months. During some periods in early spring the deeper parts turned dark. Water insects, snails, frog eggs, and tadpoles were observed in the water throughout the ponded areas every year during these time periods. On one occasion (January, 2002) the water froze overnight with a thin (2- to 3-mm) sheet of ice. All of the ice melted by about 10 a.m. the following morning.

During the 2000-2002 water-years, Site 1 ponded cumulative ponding was 17%. The site ponded 44% of the time during above-normal precipitation months, 56% of the time during normal precipitation months, and did not pond during below-normal precipitation months (Table 3, Appendix F). Durations of ponding events were four events of less than 2-continuous-weeks, and one event of 6-continuous-weeks (Appendix K).

During the 2000-2002 growing season water-years, Site 1 ponded cumulative ponding was 15%. Durations of ponding events were three events of less than 2 -continuous-weeks, and one event of 4-continuous-weeks (Appendix K).

Reducing conditions, AADP dye observations

Positive AADP dye reactions observed at Site 1 ponded during ponded and reducing conditions always started at the immediate soil surface, and were similar to AADP dye reactions observed at Site 3 ponded middle and Site 3 ponded edge. The positive reactions to AADP dye during ponded conditions are described in detail in the "Reducing conditions, AADP dye observations" of Site 3 ponded.

On several occasions while obtaining soil samples for the AADP dye test, brownish or yellowish calcareous clay chimneys with redox features (mainly masses of oxidized iron along root channels and pores) were encountered within 25 to 30 cm. AADP dye test was very positive in the black surface layers, but quickly changed to faint pink and then no reaction with depth in the brownish or yellowish calcareous clay layers (W. L. Miller, 2002 unpublished data).

Appendix H shows biweekly AADP dye observations during the study. During the 2000-2002 water-years cumulative positive reactions to AADP dye within the upper 10 cm were 8%. Durations were four events of less than 2-continuous-weeks. Positive reactions to AADP dye were never observed at 30 and 50 cm.

During the 2000-2002 growing season water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 5%. Durations were two events of less than 2-continuous-weeks. Positive reactions to AADP dye were never observed at 30 and 50 cm.

Reducing conditions, Eh readings

Appendix H shows biweekly Eh readings during the study. During the 2000-2002 water-years, cumulative reducing conditions (Eh $\leq$ +202 mV) at 10 cm were 2% (Appendix K). Duration was one event of less than 2-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh $\leq$ +193 mV) were 2%. Duration was one event of less than 2-continuous-weeks. At 50 cm, cumulative reducing conditions

(Eh ≤ +183 mV) were 8%. Duration was one event of 6-continuous-weeks. The long duration reducing conditions at 50 cm occurred during the one 4-continuous-weeks ponding event.

During the 2000-2002 growing season water-years, no reducing conditions (Eh) were measured at any depths (Appendix K).

Hydric soil classification and hydrology

Site 1 ponded did not meet any of the 2005 NRCS-NTCHS soil field indicators for loamy and clayey hydric soils, or Field Indicator F18, Reducing Vertic (USDA-NRCS 2005a).

Ponding events were predominantly less than 2-weeks duration except for one event in November-December 2001. During those months approximately 23 cm precipitation occurred periodically during about 18 days. Based on additional field observations during that time, once the precipitation stopped,, ponding depth dropped 5 cm over a 2-day period, and 14 days later was not ponded.

Field notes during one other ponding event with approximately the same amount of precipitation (about 28 cm) over a similar time period (November 1 to November 20, 2000), indicated the site was not ponded on November 13th, but was ponded 9 cm on November 20th. Without additional precipitation, the site was not ponded on November 28th, eight days later.

Ponding events and durations at Site 1 ponded might meet the NRCS-NTCHS 7-day minimum ponding requirement in most years during the growing season for hydric soil classification. The chance for meeting the same requirement is probably higher on a yearly basis. A detailed statistical analysis, which is beyond the scope of this report, might provide additional insight as to ponding durations and events based on precipitation events (Environmental Laboratory, 1987) (USDA-NRCS, 2005a).

Site 1 ponded did not meet any of the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site did not meet the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding or flooding duration (Environmental Laboratory, 1987). The site also did not meet the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 2 Nonponded microhigh

Soil morphology

The Site 2 nonponded microhigh soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig.15, Appendix J) classifies as a fine, smectitic, hyperthermic Chromic Hapluderts (Appendix B). The surface layer is calcareous, slightly alkaline, very dark gray clay 18 cm thick with less than 1% brownish masses of oxidized iron lining pores. From 18 to 33 cm is calcareous, slightly alkaline, 85% brown and 15% yellowish red clay with less than 1% brownish masses of oxidized iron lining pores. Between the depths of 33 and 55 cm is calcareous, slightly alkaline, brown clay with less than 1% brownish masses of oxidized iron lining pores.

The results of the 150-m soil transect (Fig.15, Appendix I), indicated the microhighs in this area were similar to the upper 50 cm of the microhigh profile described at the NRCS-NSSL soil

characterization study site. Additional redox features observed in the upper 50 cm of microhighs along the 150-m transect were 1- to 2-mm red masses (masses of iron oxidized iron) that were less than 1%.

The first four or five nonponded profile descriptions at the very beginning and very end of the 150-m soil transect (Fig. 15, 3PM-T1 to 3PM-T5, ends of 150-m transect) were not Vertisols, but were tending toward Mollisols (Vertic subgroup of Mollisols). The soils in these areas did not have distinct slickensides in the soil profile, lacked distinct gilgai microrelief, and textures were silty clay loam and clay loam in the upper 10 to 40 cm surface layers.

Fig. 15 shows the field ID numbers, location of the monitoring site (2-MS), soil characterization site (2-CP), 150-m soil transect location (3PM-T1 to 3PM-T5), and location of additional field notes. Appendix I and J have the field ID numbers, brief field notes, relative elevations, and latitude and longitude coordinates for each of the numbers shown in Fig. 15.

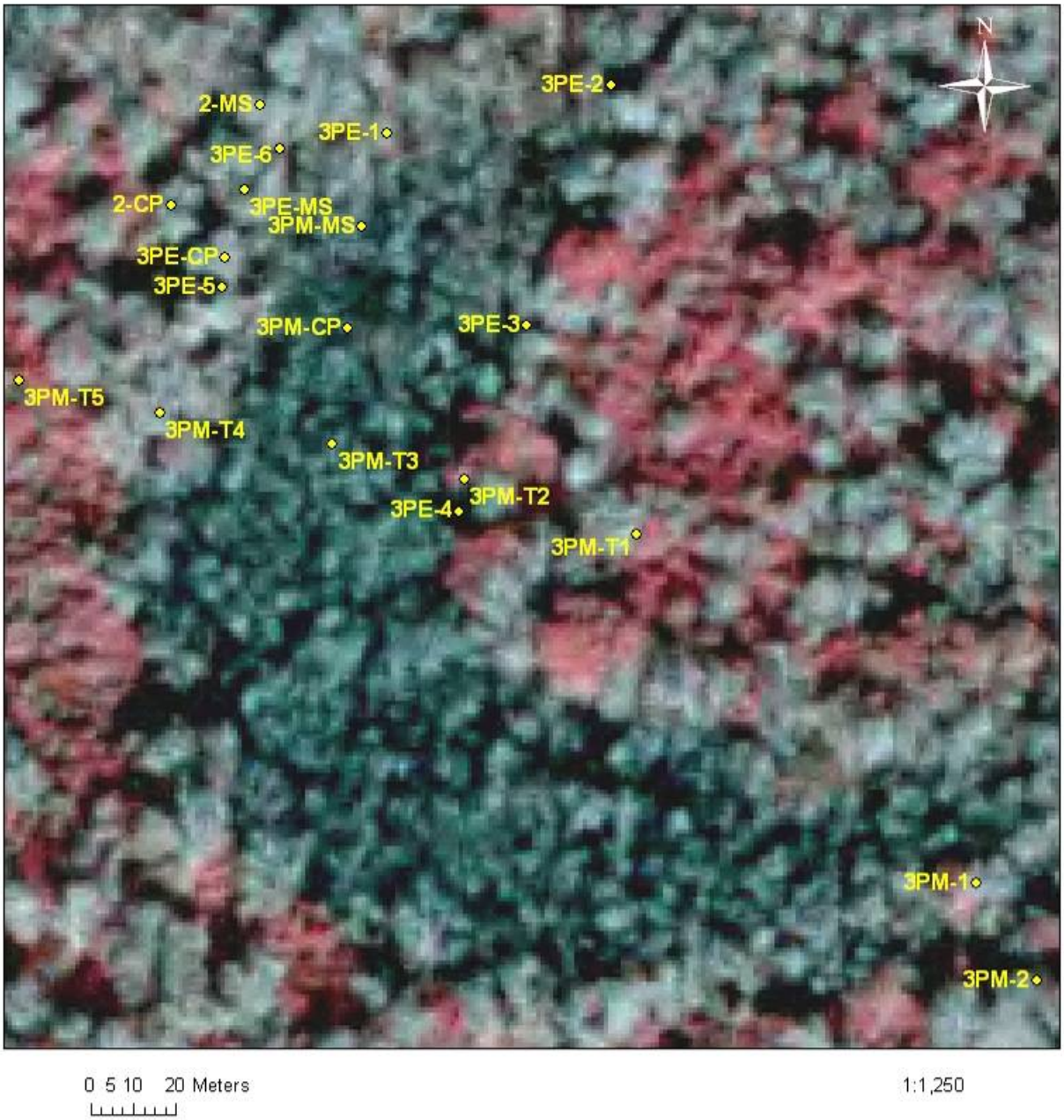


Fig. 15. 1:1,250 scale digital orthophoto showing field ID numbers and the following:
a) Monitoring site locations of Site 2 nonponded (2-MS) and soil characterization profile location (2-CP); Site 3 ponded edge (3PE-MS) and soil characterization profile location (3PE-CP); and Site 3 ponded middle (3PM-MS) and soil characterization profile location (3PM-CP).
b) Selected points along the 150-m soil transect, east end (3PM-T1), middle of ponded area (3PM-T3), and west end (3PM-T5). Ponded edges when Site 3 ponded middle ponded 20 to 25 cm and also at ponded/nonponded vegetation change (3PM-T2, 3PM-T4, 3PE-1, 3PE-2, 3PE-3, 3PE-4, 3PE-5, 3PE-6). Cut in natural levee at southeast end of abandoned channel, north end (3PM-1) and south end (3PM-2).

Hydrology

Site 2 nonponded microhighs never ponded (Appendix F). Runoff from above-normal precipitation events and tropical storms did leave drift marks on tops of microhighs on three different occasions during the 6-year study. On one occasion, drift marks in vegetation were 25 cm above ground level. Runoff water from higher areas during above normal precipitation events and tropical storms flowed from the northeast across the monitoring site toward the abandoned channel and Sites 3 ponded edge and 3 ponded middle.

Reducing conditions, AADP dye, and Eh measurements

Reducing conditions measured with AADP dye were conducted periodically during wet periods on Site 2 nonponded microhighs. Positive reactions to AADP dye were never observed (W. L. Miller, unpublished data, 2002). Eh measurements were not conducted on a microhigh at Site 2 nonponded.

Hydric soil classification and hydrology

Site 2 nonponded microhigh did not meet any of the 2005 NRCS-NTCHS soil field indicators for loamy and clayey hydric soils, or Field Indicator F18, Reducing Vertic (USDA-NRCS 2005a). During normal precipitation months and years, the site did not meet the hydrology criteria for frequent ponding or flooding duration (at least 7 days) during the growing season (February 12 to December 12, Brazoria County Texas) (Environmental Laboratory, 1987) (USDA-NRCS, 2005a).

Site 2 nonponded microhigh did not meet any of the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years, the site did not meet the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding or flooding duration (Environmental Laboratory, 1987). The site also did not meet the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 2 Nonponded microlow

Soil morphology

The Site 2 nonponded microlow soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig. 15, Appendix J) classifies as a very-fine, smectitic, hyperthermic Typic Hapludert (Appendix B). The surface layer is neutral, black clay 20 cm thick with less than 1% brownish masses of oxidized iron in interiors of peds. From 20 to 44 cm is neutral, black clay with less than 1% brownish masses of oxidized iron in interiors of peds. Between the depths of 44 and 88 cm is neutral, black clay with less than 1% fine brownish masses of oxidized iron in interiors of peds.

The results of the 150-m soil transect (Fig. 15, Appendix I) indicated the microlows in this area were similar to the upper 50 cm of the microlow profile described at the NRCS-NSSL soil characterization study site. Careful observations were made of amounts of iron coatings on calcium carbonate nodules in the upper 50 cm of the soil profiles in ponded and nonponded areas. A definite trend was not observed of amounts of iron coatings on calcium carbonate nodules predominating in either ponded or nonponded soils. Additional redox features observed in the upper 50 cm of microlows along the 150-m transect were

1- to 2-mm red masses (masses of iron accumulation) that were less than 1%, and less than 1% 1- to 3-mm iron-manganese nodules with distinct boundaries. A few 5- to 10-mm masses of brownish clay were observed in the upper 50 cm of some microlows. The brownish clays were due to mixing of deeper reddish and brownish clays with near surface layers by crayfish activity or Vertisol shrink-swell properties, and were not considered redox features.

Appendix J lists identification numbers shown in Fig. 15, brief field notes for the monitoring sites and 150-m soil transect, relative elevations, and latitude and longitude for each of the field notes.

Hydrology

Ponding at Site 2 nonponded microlow did not occur during the study. The long axis of the microlow was orientated up and down the short slope toward the abandoned channel, and runoff water drained freely downslope. Runoff from above normal precipitation events and tropical storms did leave drift marks on tops of microhighs, and could be several centimeters deep flowing downslope in the microlow shortly after these storm events.

Reducing conditions, AADP dye, and Eh measurements

Appendix H shows the biweekly AADP dye and Eh observations during the study. During the 2000-2002 water-years, there were no positive reactions to AADP dye recorded in microlows at the monitoring site. During the 2000-2002 water-years, no reducing conditions (Eh $\leq$ +199 mV) were recorded at 10 cm (Appendix K). At 30 cm, cumulative reducing conditions (Eh $\leq$ +223 mV) were 14%. Durations were several events of less than 2-continuous-weeks and two events of 2-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +181 mV) were 17%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 2-continuous-weeks, and one event of 4-continuous-weeks.

During the 2000-2002 growing season water-years, there were no positive reactions to AADP dye recorded in microlows at the monitoring site. No reducing conditions (Eh $\leq$ +199 mV) were recorded at 10 cm (Appendix K). At 30 cm, cumulative reducing conditions (Eh) were 10%. Durations were several events of less than 2-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh) were 10%. Durations were several events of less than 2-continuous-weeks.

The measured reducing conditions (Eh) at depth in the microlow were problematic. The reducing conditions were recorded during wet periods. Soil moisture samples taken during about the middle of the reducing condition periods indicate the soil at 10 to 50 cm was not wet satiated (Table 4, Appendix F), and was even dryer at 100 cm, effectively ruling out the possibility that the reducing conditions were caused by endosaturated conditions (apparent water table). Reducing conditions developed fairly quickly to depths of 50 cm during wet periods. As the soil surface dried out, aerobic conditions developed at the surface, and with time developed at 50 cm.

Hydric soil classification and hydrology

Site 2 nonponded microlow did not meet any of the 2005 NRCS-NTCHS soil field indicators for loamy and clayey hydric soils, or Field Indicator F18, Reducing Vertic (USDA-NRCS 2005a). Ponding did not occur in the microlow, and observed brief periods of runoff were after storm events. During normal precipitation months and years the site did not meet the hydrology criteria for frequent ponding or flooding duration (at least 7 days) during the growing season (February 12 to December 12, Brazoria County, Texas) (Environmental Laboratory, 1987) (USDA-NRCS, 2005a).

Site 2 nonponded microlow did not meet any of the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site did not meet the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding or flooding duration (Environmental Laboratory, 1987). The site also did not meet the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 3 ponded edge

Soil morphology

The Site 3 ponded edge microhigh soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig.15, Appendix J) classifies as a very-fine, smectitic, hyperthermic Aeric Calciaquerts (Appendix B). The surface layer is moderately acid, very dark gray clay 15 cm thick with less than 1% brownish masses of oxidized iron on faces of peds, and 2% fine reddish masses of clay. From 15 to 30 cm is neutral black clay. Between the depths of 30 and 66 cm is calcareous, slightly alkaline, dark grayish brown clay.

The Site 3 ponded edge microlow soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig.15, Appendix J) classifies as a very-fine, smectitic, hyperthermic Typic Epiaquerts (Appendix B). The surface layer is moderately acid, black clay 13 cm thick with 2% reddish and brownish masses of oxidized iron and iron-manganese masses lining pores. From 13 to 34 cm is moderately acid, black clay with 1% brownish masses of oxidized iron lining pores. Between the depths of 34 and 61 cm is neutral, black clay.

The site selected for the soil characterization study was right at the outer edge of ponding (ponded edge) (outer edge of ponding previously documented based on average ponded depth in middle of 20 cm), at the start of the Cherokee sedge vegetation and at the start of distinct gilgai microrelief above the ponded edge. Below the ponded edge, gilgai microrelief was indistinct. Close examination of the soils in the trench dug across the nonponded-ponded landscape boundary also indicated that easily identifiable redox features were below the ponded edge boundary. Above the ponded edge boundary either no redox features were observed or less than 1% redox features were observed.

Field work in areas above the ponded edge during the 6-year study indicated that Vertisols with distinct gilgai microrelief occurred along the northern end of the abandoned channel on the west, north, and east sides in areas just north of the 150-m transect (Fig. 15, 3PM-T1 to 3PM-T5, ends of 150-m transect). Distinct gilgai microrelief in this area ends at the ponded edge. Below the ponded edge and within the ponded area, only indistinct gilgai was observed. Most of the field observations of soils within the ponded area of the abandoned channel were Vertisols. Microlows just above the ponded edge tended to merge into the ponded area. Cherokee sedge also was observed in this area starting just above the ponded edge. Soils south of the 150-m transect and above the ponded edge tended to be Mollisols with loamy surface layers. Fig. 15 shows site numbers and locations where field notes were taken and Appendix I and J have the corresponding site numbers and field notes.

Additional redox features observed in the upper 50 cm of ponded edge microlows along the 150-m transect were 1- to 2-mm red masses (masses of oxidized iron) that ranged from less than 1% to 1%, approximately 5 to 10% masses of oxidized iron along root channels and on faces of peds. At depths of about 10 to 50 cm, 1- to 3-mm iron-manganese nodules with distinct boundaries ranged from less than 1 to 1% (Appendix I). A few masses of yellowish and brownish clay up to 1 to 2 cm in size were also

observed during the soil transect. The masses of yellowish and brownish clay were the result of mixing of deeper yellowish and brownish clays with near surface layers by crayfish activity or Vertisol shrink-swell properties. These were not considered as redox features.

Fig. 15 shows the field ID numbers, location of the monitoring site (3PE-MS, soil characterization site (3PE-CP), 150-m soil transect location (3PM-T1 to 3PM-T5), ponded edge (3PE-1 to 3PE-5) and location of additional field notes. Appendix I and J have the field ID numbers, brief field notes, relative elevations, and latitude and longitude coordinates for each of the numbers shown in Fig. 15.

Hydrology

Average ponding depth at Site 3 ponded edge was 4 cm (Table 3, Appendix H). Ponding depths typically ranged from 3 to 12 cm deep, with deeper ponding for brief periods from tropical storms (Site 3 ponded middle Hydrology section). The ponded edge was either at or very near the start of Cherokee sedge vegetation (vegetation above ponded water edge) when ponding depths of 20 to 25 cm were measured on the permanent PVC pipe benchmark (200-cm piezometer) at Site 3 ponded middle.

During the 1996-2002 water-years, Site 3 ponded edge cumulative ponding was 22%. The site ponded 41% of the time during above-normal precipitation months, 37% of the time during normal precipitation months, and 22% of the time during below-normal precipitation months (Table 3, Appendix F). Durations of ponding events were mainly for 2-continuous-weeks and longer, and ranged from several events of less than 2-continuous-weeks, to a maximum of one event of 10-continuous-weeks (Appendix K). During the 2000-2002 water-years Site 3 ponded edge cumulative ponding was 21%. Durations of ponding events ranged from several events of less than 2-continuous-weeks to one event of 2-continuous-weeks, and one event of 10-continuous-weeks.

During the 1996-2002 growing season water-years, Site 3 ponded edge cumulative ponding was 15%. Durations of ponding events ranged from several events of less than 2-continuous-weeks, to several events of 4-continuous-weeks. During the 2000-2002 growing season water-years Site 3 ponded edge cumulative ponding was 10%. Durations of ponding events ranged from several events of less than 2-continuous-weeks, to one event of 2-continuous-weeks.

Reducing conditions, AADP dye

Appendix H shows biweekly AADP dye observations during the study. During the 1996-2002 water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 25%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 14-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 8%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 12-continuous-weeks. At 50 cm cumulative positive reactions to AADP dye were 7%. Durations ranged from several events of less than 2-continuous-weeks, to two events of 2-continuous-weeks.

During the 2000-2002 water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 35%. Durations ranged from several events of less than 2-continuous-weeks to one event of 14-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 21%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 12-continuous-weeks. At 50 cm cumulative positive reactions to AADP dye were 2%. Duration was one event of 2-continuous-weeks.

During the 1996-2002 growing season water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 19%. Durations ranged from several events of less than 2-continuous-weeks, to two events of 4-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 6%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 4-continuous-weeks. At 50 cm positive reactions to AADP dye were not observed during the 1996-2002 growing season water-years.

During the 2000-2002 growing season water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 23%. Durations ranged from several events of less than 2-continuous-weeks, to two events of 4-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 14%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 4-continuous-weeks. At 50 cm positive reactions to AADP dye were not observed during the 2000-2002 growing season water-years.

Reducing conditions, Eh readings

Appendix H shows biweekly Eh readings during the study. During the 2000-2002 water-years cumulative reducing conditions (Eh $\leq$ +253 mV) at 10 cm were 40%. (Appendix K). Durations ranged from 4-continuous-weeks to 16-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh $\leq$ +247 mV) were 42%. Durations ranged from 4-continuous-weeks to 16-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +187 mV) were 42%. Durations ranged from 4-continuous-weeks to 16-continuous-weeks.

During the 2000-2002 growing season water-years, cumulative reducing conditions (Eh) at 10 cm were 22%. (Appendix K). Durations ranged from several events of less than 2-continuous-weeks, to one event of 4-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh) were 30%. Durations ranged from several events of less than 2-continuous-weeks, to two events of 4-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh) were 32%. Durations ranged from two events of 2-continuous-weeks, to three events of 4-continuous-weeks.

Hydric soil classification and hydrology

Site 3 ponded edge met the 2005 NRCS-NTCHS Field Indicator F6 (Redox Dark Surface) and F18 (Reducing Vertic) (USDA-NRCS 2005a). During normal precipitation months and years, the site met the hydrology criteria of minimum durations for ponding. Ponding was for long and very long durations during the growing season each year (Environmental Laboratory, 1987) (USDA-NRCS, 2005a). Ponding was also for long and very long durations on a yearly basis.

Site 3 ponded edge met the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site met the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding duration (Environmental Laboratory, 1987). The site also met the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 3 ponded middle

Soil morphology

The Site 3 ponded middle microhigh soil profile described during the NRCS-NSSL soil characterization study in an area of indistinct gilgai microrelief (Fig. 15, Appendix J) classifies as fine, smectitic, hyperthernic Aeric Calciaquert (Appendix B). The surface layer is moderately acid, black clay 11 cm thick, with a few brownish masses of oxidized iron on faces of peds and along root channels and pores. From 11 to 20 cm is neutral, black clay with a few reddish masses of oxidized iron on slickensides. From 20 to 50 cm is calcareous, slightly alkaline, dark gray clay with a few brownish masses of oxidized iron along root channels and pores, and a few masses of yellowish brown clay 1 to 2 cm in size. The masses of yellowish brown clay are the result of mixing of deeper reddish and brownish clays with near surface layers by crayfish activity or Vertisol shrink-swell properties, and are not considered redox features.

The Site 3 ponded middle microlow soil profile described during the NRCS-NSSL soil characterization study in an area of indistinct gilgai microrelief classifies as very-fine, smectitic, hyperthernic Aeric Epiaquert (Appendix B). The surface layer is strongly acid, black clay 11 cm thick with few reddish, brownish and yellowish masses of oxidized iron along root channels and pores. From 11 to 38 cm is slightly acid, very dark gray clay with few reddish and brownish masses of oxidized iron on faces of peds and along root channels and pores. From 38 to 64 cm is neutral, very dark gray clay with brownish iron depletions on slickensides. Fig. 12 shows the landscape and vegetation at Site 3 ponded.

The results of the 150-m soil transect (Fig. 15, Appendix I), indicated the microhighs and microlows in this area were similar to the upper 50 cm of the microhigh and microlow profile described at the NRCS-NSSL soil characterization study site. Careful observations were made of amounts of iron coatings on calcium carbonate nodules in the upper 50 cm of the soil profiles in ponded and nonponded areas. A definite trend was not observed of amounts of iron coatings on calcium carbonate nodules predominating in either ponded or nonponded soils. Additional redox features observed in the upper 50 cm of ponded microlows along the 150-m transect were 1- to 2-mm red masses (masses of oxidized iron) that ranged from less than 1% to 1%. The upper 15 to 20 cm of the soil had approximately 2 to 5% masses of oxidized iron along root channels and on faces of peds. From about 15 to 20 cm to depths of 30 to 40 cm, 5 to 15% masses of oxidized iron were along root channels and on faces of peds. At depths of about 10 to 50 cm, 1- to 3-mm iron-manganese nodules with distinct boundaries ranged from less than 1 to 1%.

Field observations in the area around Site 3 ponded middle during the 6 year study period indicated that concentrations (amounts) of redox features in the upper 50 cm varied from area to area across the ponded landscape. During ponding periods, redox features were observed in the upper 50 m of soils while sampling for the AADP dye test and also while obtaining gravimetric soil moisture samples. During prolonged periods of saturation and strong reducing conditions in the upper 30 cm, it appeared that redox features (masses of oxidized iron) on faces of peds decreased in amounts or disappeared. Redox features along root channels and pores seemed to remain under these conditions. Numerous very strong reactions to AADP dye were observed in the soil matrix (ped interiors) surrounding root channels and pores during these conditions.

Fig. 15 shows the field ID numbers, location of the monitoring site (3PM-MS), soil characterization site (3PM-CP), 150-m soil transect location (3PM-T1 to 3PM-T5), and location of additional field notes. Appendix I and J have the field ID numbers, brief field notes, relative elevations, and latitude and longitude coordinates for each of the numbers shown in Fig. 15.

Hydrology

Runoff water from higher areas typically entered the location of Site 3 ponded middle from the north and northeast end of the abandoned channel. During above-normal precipitation events, runoff water also entered from the northwest end of the abandoned channel, flowing across Site 2 nonponded. Water flowed out of the abandoned channel at the southeast end toward the east and southeast along a weakly defined low, and also through a cut in the southeast end natural levee toward Site 4 ponded. Fig. 15 shows the locations of the monitoring site, soil characterization site, 150-m soil transect location, and location of outer edges of ponding during a typical ponding event. Appendix J has the field ID numbers, brief field notes, relative elevations, and latitude and longitude coordinates for each of the numbers shown in Fig. 15.

Ponded water remained mostly clear through the fall, winter, and early spring months. During some periods in early spring the deeper parts turned dark. Small fish, water insects, snails, frog eggs, and tadpoles were observed in the water throughout the ponded areas every year during these time periods. In late spring to mid summer months when the ponded water was less than about 5 to 10 cm deep in the middle of the abandoned channel, anoxic conditions may have developed based on smell of the disturbed water. On one occasion (January, 2002) the water froze overnight with a thin (2- to 3-mm) sheet of ice. All of the ice melted by about 10 a.m. the following morning.

Average ponding depth at Site 3 ponded middle was 21 cm (Table 3, Appendix F). Ponding depths typically ranged from 3 to 35 cm with a maximum of about 100 cm for brief periods from tropical storms. Ponded water levels above 25 to 30 cm at Site 3 ponded middle receded fairly rapidly until levels were below the natural outlets at the southeast end of the abandoned channel (Appendix J). The outer edge of ponding was either at or very near the start of Cherokee sedge vegetation (vegetation above ponded water edge) when ponding depths of 20 to 25 cm were measured on the permanent PVC pipe benchmark (200-cm piezometer) at Site 3 ponded middle.

During the 1996-2002 water-years, Site 3 ponded middle cumulative ponding was 67%. The site ponded 22% of the time during above-normal precipitation months, 42% of the time during normal precipitation months, and 36% of the time during-below normal precipitation months (Table 3, Appendix F). Durations of ponding events were mainly for 22-continuous-weeks and longer, and ranged from one event of less than 2-continuous-weeks to a maximum of 32-continuous-weeks (Appendix K). During the 2000-2002 water-years, Site 3 ponded middle cumulative ponding was 56%. Durations of ponding events ranged from 22- to 28-continuous-weeks.

During the 1996-2002 growing season water-year, Site 3 ponded middle cumulative ponding was 72%. Durations of ponding events were mainly for 6-continuous-weeks and longer, and ranged from one event of 2-continuous-weeks to a maximum of 20-continuous-weeks (Appendix K). During the 2000-2002 growing season, water-years Site 3 ponded middle cumulative ponding was 47%. Durations of ponding events were mainly for 6-continuous-weeks and longer, and ranged from 2-continuous-weeks to 12-continuous-weeks.

Reducing conditions, AADP dye observations

Positive AADP dye reactions observed during ponded and reducing conditions always started at the immediate soil surface. Many observations were made during the length of the study at the middle (ponded at least 15 cm deep) and outer edge of ponding to determine if the water was ever reducing and

contained ferrous iron. Positive reaction to AADP dye in clear water was never observed. Samples taken of the soil surface (upper 2 to 5 mm) under ponded conditions always had an immediate, very positive reaction to AADP dye. The positive reaction to AADP dye was observed in soil samples taken in both the middle and outer edge of ponding. Small, shallow (less than 5 mm deep) areas of clear ponded water at the outer edge of ponding never had a positive reaction to AADP dye. When the soil surface was disturbed and mixed with the water, an immediate very positive reaction to AADP dye was observed in the muddied water.

On several occasions while obtaining soil samples for the AADP dye test, brownish or yellowish calcareous clay chimneys with redox features (mainly masses of oxidized iron along root channels and pores) were encountered within 25 to 30 cm. AADP dye test was very positive in the black surface layers, but quickly changed to faint pink and then no reaction with depth in the brownish or yellowish calcareous clay layers (W. L. Miller, unpublished data, 2002).

Appendix H shows biweekly AADP dye observations during the study. During the 1996-2002 water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 64%. Durations ranged mainly from 20- to 32-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 36%. Durations ranged mainly from 2- to 26-continuous-weeks. At 50 cm cumulative positive reactions to AADP dye were 14%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 24-continuous-weeks.

During the 2000-2002 water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 56%. Durations ranged mainly from 20- to 30-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 33%. Durations ranged from several events of less than 2-continuous-weeks, to one event of 26-continuous-weeks. At 50 cm cumulative positive reactions to AADP dye were 27%. Duration was one event of 24-continuous-weeks.

During the 1996-2002 growing season water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 58%. Durations ranged mainly from 8- to 18-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 32%. Durations ranged mainly from 8- to 14-continuous-weeks. At 50 cm cumulative positive reactions to AADP dye were 8%. Durations ranged mainly from several events of less than 2-continuous-weeks, to one event of 6-continuous-weeks.

During the 2000-2002 growing season water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 47%. Durations ranged mainly from 2- to 12-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 25%. Durations were two events of 8-continuous-weeks. At 50 cm cumulative positive reactions to AADP dye were 22%. Durations were one event of 6-continuous-weeks, and one event of 8-continuous-weeks.

Reducing conditions, Eh readings

Appendix H shows biweekly Eh readings during the study. During the 2000-2002 water-years, cumulative reducing conditions (Eh $\leq$ +295 mV) at 10 cm were 64%. (Appendix K). Durations ranged from several events of less than 2-continuous-weeks, to 30-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh $\leq$ +241 mV) were 67%. Durations ranged from several events of less than 2-continuous-weeks, to 32-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +193 mV) were 67%. Durations ranged from several events of less than 2-continuous-weeks to 24-continuous-weeks.

During the 2000-2002 growing season water-years, cumulative reducing conditions (Eh) at 10 cm were 57%. (Appendix K). Durations ranged from several events of less than 2-continuous-weeks to 12-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh) were 60%. Durations ranged from several events of less than 2-continuous-weeks, to 12-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh) were 60%. Durations ranged from several less than 2-continuous-weeks events to 12-continuous-weeks.

Hydric soil classification and hydrology

Site 3 ponded middle met the 2005 NRCS-NTCHS Field Indicator F6 (Redox Dark Surface) and F18 (Reducing Vertic) (USDA-NRCS 2005a). During normal precipitation months and years the site met the hydrology criteria of minimum durations for ponding. Ponding was for long and very long durations during the growing season each year (Environmental Laboratory, 1987) (USDA-NRCS, 2005a). Ponding was also for long and very long durations on a yearly basis.

Site 3 ponded middle met the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site met the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding duration (Environmental Laboratory, 1987). The site also met the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 4 ponded

Soil morphology

The Site 4 ponded soil profile described during the NRCS-NSSL soil characterization study in an area of indistinct gilgai microrelief (Fig. 16, Appendix J) classifies as a fine, smectitic, hyperthermic Typic Epiaquert (Appendix B). The surface layer is slightly acid black clay 14 cm thick, with less than 1% masses of oxidized iron on faces of peds and on pore linings. From 14 to 44 cm is slightly alkaline very dark gray clay with less than 1% iron-manganese masses and less than 1% reddish masses of oxidized iron lining pores. From 44 to 82 cm is moderately alkaline, dark gray clay with 1% black iron-manganese nodules with calcareous rinds, and 1% brownish masses of oxidized iron lining pores.

The profile described above was the only area (about 1 to 2 m wide) exposed that had any easily visible redox features along the 10 m long trench (about 2 m deep) dug for the characterization study. This was verified not only by the USDA-NRCS local soil scientists participating in the study, but also by Dr. Larry Wilding (Soils Professor, Texas A&M University), and Dr. Steve Sprecher (Wetland Specialist, USACOE, WETS). The decision was made to describe the soil in this particular area in the hopes of learning more about the redox features as they occur in this landscape.

The presence or absence of easily identifiable redox features in the landscape near and at Site 4 ponded are problematic based on several different field studies during length of the 6-year monitoring study. Before the location and orientation of the trench for the August 1998 soil characterization study was selected, 12 shallow profiles (50 cm deep) were examined by USDA-NRCS local soil scientists in the immediate vicinity of the monitoring site to determine soil characteristics. Only 2 of the 12 shallow profiles had visible redox features, and the features were less than 2% (W L. Miller, W. G. Chervenka, unpublished data, 1998). Similar observations were made previously during the May, 1996, interagency

field study in the same general area where it was noted that "abundance of redox concentrations varies considerably over short distances; generally in lower positions" (Wakeley, 1996).

The site was visited in May, 2000, by members of the NRCS-NTCHS team during one of the field exercises for the Advanced Hydric Soils Training for Soil Scientists class in Houston, Texas. Soil scientists on the NRCS-NTCHS dug several profiles to 50 cm deep in the immediate vicinity of the monitoring site and the characterization pit location and did not find easily identifiable redox features. Based on these observations they considered the soils not to be hydric, and that the area probably was not a wetland (W L. Miller, unpublished data, 2000).

In August, 2000, a 150-m soil transect was orientated in a northwest, southeast direction, with one end of the transect near the Site 4 ponded monitoring site (Fig. 16, Appendix I). The transect was orientated so that 15 of the soil profiles (Appendix I, Profiles No. 4-1-15 to 4-1-30) were in known ponded areas along the northwest end of the transect (Fig. 16, Appendix J, 4P-T1 to 4P-T3) and 15 of the soil profiles (Appendix I, Profiles No. 4-1-15 to 4-1-30) were in known predominately nonponded areas (Fig. 16, 4P-T3 to 4P-T4) along the southeast end of the transect. Vegetation changes along the transect at what was thought to be the boundary between ponded and nonponded areas were previously identified in the field by USDI Fish and Wildlife biologists (P. Glass, unpublished data, 2000). The boundary was in the immediate vicinity of location 4P-T3 shown in Fig. 16 (Appendix J). During later normal ponding events (ponded at least 10 cm at the monitoring site) the ponded–nonponded area and boundary was verified on several occasions (W L. Miller, unpublished data, 2000-2002).

The results of the 150-m soil transect (Fig. 16, Appendix I) indicated that most of the soils in the ponded area along the transect were not similar in several ways to the profile described during the NRCS-NSSL soil characterization study. The profiles described in the ponded area were alkaline and calcareous in the upper 50 cm except for the last three (4-1-28 to 4-1-30) near the Site 4 ponded monitoring site. Additional redox features observed in the upper 50 cm of the ponded areas along the 150-m transect were $\leq$ 1 mm red masses (masses of oxidized iron) that ranged from less than 1% to 1%. The transect profiles described in the ponded area were similar in color and texture to the soil profile described during the NRCS-NSSL soil characterization study (mollic colored clay in the upper 50 cm) (Appendix I, Profiles No. 4-1-15 to 4-1-30). Careful observations were made of amounts of iron coatings on calcium carbonate nodules in the upper 50 cm of the soil profiles in ponded and nonponded areas. A definite trend was not observed of amounts of iron coatings on calcium carbonate nodules predominating in either ponded or nonponded soils.

A few masses of brownish clay 1 to 20 mm in size were also observed in the upper 50 cm of some profiles. The masses of brownish clay were the result of mixing of deeper reddish and brownish clays with near surface layers by crayfish activity or Vertisol shrink-swell properties, and were not considered redox features. No calcareous chimneys were observed along the transect. On a few occasions while obtaining soil samples for the AADP dye test to the north and northwest sides of Site 4 ponded monitoring site, brownish or yellowish calcareous clay chimneys were encountered within 30 to 50 cm (W L. Miller, unpublished data 2002).

In July, 2003, an interagency field study was conducted at the monitoring sites. During this field study 1 to 2% masses of brownish oxidized iron on faces of peds and on pore linings were found in the upper 50 cm of several profiles in the immediate area of Site 4 ponded, and in the area where profiles were described along the 150-m soil transect near Site 4 ponded (W L. Miller, R. Griffin, C. Nobel, unpublished data, 2003). One of the profiles was in the area of ATV tracks to the monitoring site. This profile was discounted due to the compaction of the upper 10 cm and alteration of soil structure and consistence.

In August, 2005 several additional soil samples were collected near Site 4 ponded in what were believed to be more representative areas of soils in the area. Samples were collected at 0 to 10 cm and 15 to 30 cm. Texas A&M University Soil Characterization Laboratory determined soil pH in saturated paste and in 1:1 soil to water. Soil reactions were approximately pH 7.3 in the upper 10 cm and pH 7.5 at 15 to 30 cm (Dr. C.T. Hallmark, unpublished data, 2005).

Fig. 16 shows the field ID numbers, location of the monitoring site (4P-MS), soil characterization site (4P-CP), 150-m soil transect location (4P-T1 to 4P-T4), approximate location of outer edge of ponding during average ponding depths at Site 4 ponded and vegetation change (4P-T3). Appendix I and J have the field ID numbers, brief field notes, and latitude and longitude coordinates for each of the numbers shown in Fig. 16.

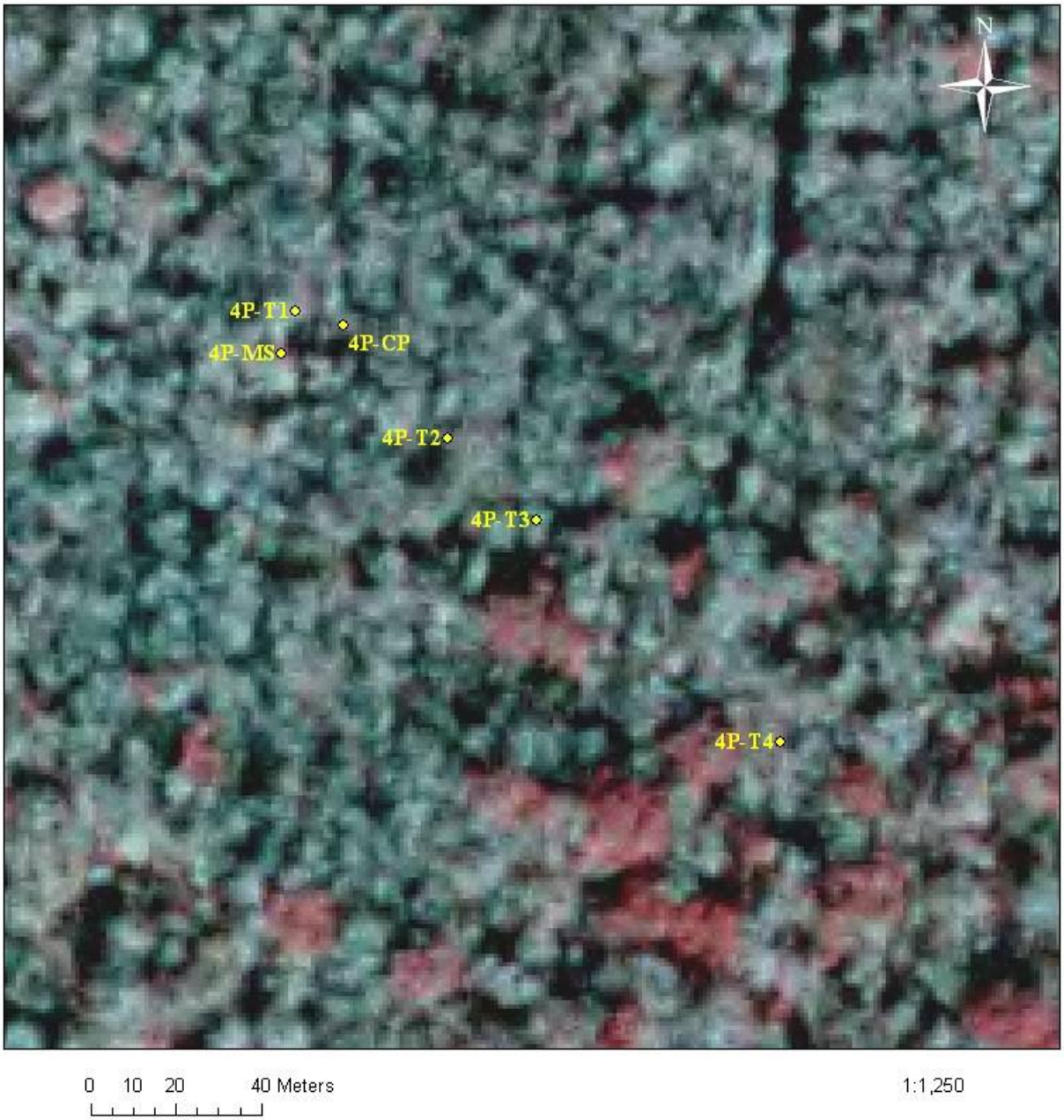


Fig. 16. 1:1,250 scale digital orthophoto showing field ID numbers and locations of Site 4 ponded monitoring site (4P-MS), soil characterization profile location (4P-CP), and selected points along the 150-m soil transect (4P-T1, soil transect No. ST 4-1-30, ponded) (4P-T2, ponded) (4P-T3, soil transect No. ST 4-1-14 nonponded and approximate boundary of vegetation change and ponded/nonponded boundary) (4P-T4, soil transect No. ST 4-1-0 nonponded).

Hydrology

Runoff water from higher areas typically entered the location of Site 4 ponded from the northwest and from the east depending on precipitation events. Water flow was west toward FM 524. The site experienced backwater flooding from Dance Bayou on a few occasions based on water flow direction.

Ponded water remained mostly clear through the fall, winter, and early spring months. During some periods in early spring and summer deeper ponded parts turned dark. Small fish, water insects, snails, frog eggs, and tadpoles were observed in the water throughout the ponded areas every year during these time periods. In late spring to mid summer months when the ponded water was less than about 2 to 3 cm deep, anoxic conditions may have developed based on smell of the disturbed water. On one occasion (January, 2002) the water froze overnight with a thin (2- to 3-mm) sheet of ice. All of the ice melted by about 10 a.m. the following morning.

Average ponding depth at Site 4 ponded was 10 cm (Table 3, Appendix F). Ponding depths typically ranged from 3 to 33 cm with a maximum of about 50 cm deep for brief periods from tropical storms. Ponded water levels above 10 to 15 cm at Site 4 ponded receded fairly rapidly until levels were below natural outlets to the west.

During the 1996-2002 water-years, Site 4 ponded cumulative ponding was 44%. The site ponded 28% of the time during above-normal precipitation months, 53% of the time during normal precipitation months, and 19% of the time during below-normal precipitation months (Table 3, Appendix F). Durations of ponding events were mainly for 4-continuous-weeks and longer, and ranged from several events of less than 2-continuous-weeks, to a maximum of one event of 24-continuous-weeks (Appendix K). During the 2000-2002 water-years, Site 4 ponded cumulative ponding was 38%. Durations of ponding events ranged from several events of less than 2-continuous-weeks, to a maximum of one event of 14-continuous-weeks.

During the 1996-2002 growing season water-year, Site 4 ponded cumulative ponding was 35%. Durations ranged from severalevents of less than 2-continuous-weeks, to a maximum of two events of 10-continuous-weeks (Appendix K). During the 2000-2002 growing season water-years, Site 4 ponded cumulative ponding was 27%. Durations of ponding events ranged from several events of less than 2-continuous-weeks, to a maximum of two events of 4-continuous-weeks.

Fig. 17 shows the location of 27 observations (P1 to P27) taken over a 2-day period when ponding at Site 4 ponded was near 10 cm deep (11 cm on first day, 8 cm on second day). The main purpose of the observations was to trace ponded areas and determine the direction of water flow from Site 4 ponded. In general, water flows from Site 4 along a series of low-relief abandoned channels until it reaches a relatively large open flat to the east of FM 524. There are one or two low-relief ridges in a northwest to northeast direction to the west of Site 4 ponded (vicinity of field note P16 and P19), that appear to block water flow to the west once water levels reach about 10 cm deep at Site 4 ponded.

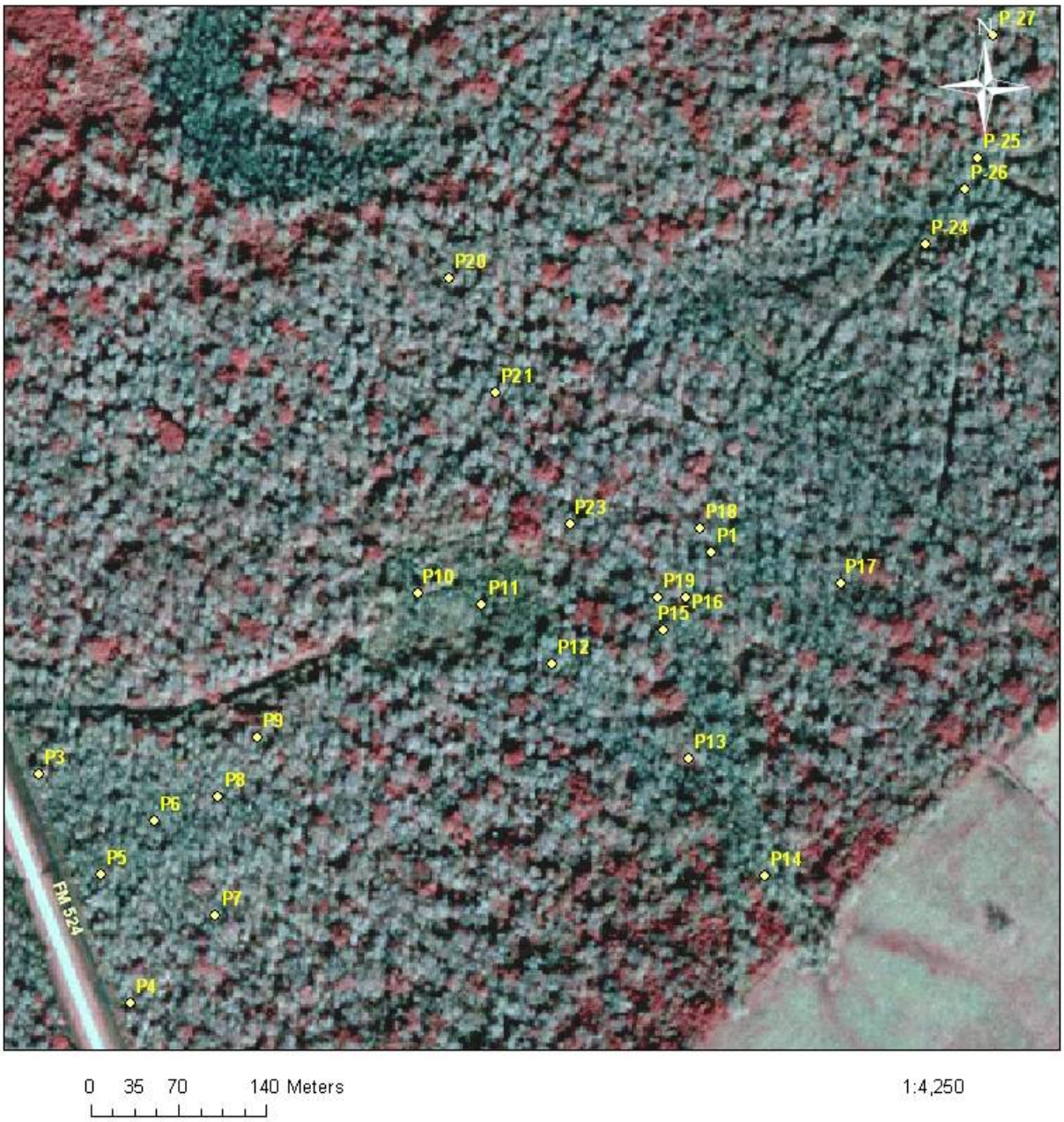


Fig. 17. 1:4,250 scale digital orthophoto showing field ID numbers of field notes to determine ponding boundaries, vegetation changes, and direction and path of water flow west from the area of Site 4 ponded.

Reducing conditions, AADP dye observations

Positive AADP dye reactions observed during ponded and reducing conditions always started at the immediate soil surface. AADP dye reactions were similar to those discussed in detail in the Site 3 ponded middle narrative.

Appendix H shows biweekly AADP dye observations during the study. During the 1996-2002 water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 38%. Durations were mainly for more than 4-continuous-weeks and ranged from several events of less than 2-continuous -weeks to a maximum of one event of 24-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 3%. Duration was one event of 6-continuous-weeks. At 50 cm positive reactions to AADP dye were not observed during the 1996-2002 water-years.

During the 2000-2002 water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 44%. Durations were one event of 4-continuous-weeks, and two events of 14-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 9%. Durations were one event of, less than 2-continuous-weeks, and one event of 4-continuous-weeks. At 50 cm positive reactions to AADP dye were not observed during the 1996-2002 water-years.

During the 1996-2002 growing season water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 30%. Durations ranged mainly from 4- to 18-continuous-weeks (Appendix K). At 30 cm cumulative positive reaction to AADP dye at 30 cm was 1%. Duration was one event of, less than 2-continuous-weeks. At 50 cm positive reactions to AADP dye were not observed during the 1996-2002 growing season water-years.

During the 2000-2002 growing season water-years cumulative positive reactions to AADP dye within the upper 10 cm were 27%. Durations ranged from several events of less than 2-continuous-weeks, to two events of 4-continuous-weeks (Appendix K). Cumulative positive reactions to AADP dye at 30 cm were 2%. Duration was one event of less than 2-continuous-weeks. At 50 cm positive reactions to AADP dye were not observed during the 2000-2002 growing season water-years.

Reducing conditions, Eh readings

Appendix H shows biweekly Eh readings during the study. During the 2000-2002 water-years cumulative reducing conditions (Eh $\leq$ +229 mV) at 10 cm were 44%. (Appendix K). Durations ranged mainly from 4-continuous-weeks to one event of 16-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh $\leq$ +199 mV) were 44%. Durations ranged mainly from 4-continuous-weeks to 14-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +169 mV) were 46%. Durations were one event of 16-continuous -weeks to one event of 30-continuous-weeks.

During the 2000-2002 growing season water-years, cumulative reducing conditions (Eh) at 10 cm were 30%. (Appendix K). Durations ranged from several events of less than 2-continuous-weeks, to two events of 4-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh) were 30%. Durations ranged from several events of less than 2-continuous-weeks, to two events of 4-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh) were 33%. Durations ranged mainly from one event of 8-continuous-weeks to one event of 10-continuous-weeks.

Hydric soil classification and hydrology

Site 4 ponded did not meet the 2005 NRCS-NTCHS Field Indicator F6 (Redox Dark Surface), but did meet Field Indicator F18 (Reducing Vertic) (USDA-NRCS 2005a). During normal precipitation months and years the site met the hydrology criteria of minimum durations for ponding. Ponding was for long and very long durations during the growing season each year (Environmental Laboratory, 1987) (USDA-NRCS, 2005a). Ponding was also for long and very long durations on a yearly basis.

Site 4 ponded did not meet the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site met the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding duration (Environmental Laboratory, 1987). The site also met the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 5 Nonponded microhigh

Soil morphology

The Site 5 nonponded microhigh soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig. 6, Appendix J) classifies as a fine, smectitic, hyperthermic Chromic Hapludert (Appendix B). The surface layer is calcareous, slightly alkaline, black clay 12 cm thick. From 12 to 28 cm is calcareous, slightly alkaline, dark brown clay. Between the depths of 28 and 63 cm is calcareous, slightly alkaline, brown clay. Additional soil transects were not conducted at this monitoring site.

Hydrology

Site 5 nonponded microhigh never ponded (Appendix F). Runoff from above normal precipitation events and tropical storms did leave drift marks on tops of microhighs on three different occasions during the 6-year study. Direction of the flow was difficult to determine, but appeared to be in a southeasterly direction.

Reducing conditions, AADP dye, and Eh measurements

Appendix H shows the biweekly AADP dye and Eh observations during the study. During the 1996-2002 and 2000-2002 water-years, there were no positive reactions to AADP dye recorded on microhighs at the monitoring site.

During the 2000-2002 water-years, cumulative reducing conditions (Eh $\leq$ +175 mV) at 10 cm were 13% (Appendix K). Duration was one event of 4-continuous-weeks. At 30 cm, cumulative reducing conditions (Eh $\leq$ +157 mV) were 26%. Durations were one event of less than 2-continuous-weeks, and one event of 8-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +139 mV) were 26%. Durations were one event of less than 2-continuous-weeks, and one event of 8-continuous-weeks.

During the 1996-2002 and 2000-2002 growing season water-years, there were no positive reactions to AADP dye recorded in microhighs at the monitoring site. During the 2000-2002 growing season

water-year, there were no reducing conditions (Eh) measured at 10 cm. At 30 cm, cumulative reducing conditions (Eh) were 5%. Duration was one event of less than 2-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh) were 16%. Durations were one event of less than 2-continuous-weeks, and one event of 2-continuous-weeks.

The measured reducing conditions at depth in the microhigh were problematic. The reducing conditions were recorded during wet periods. Soil moisture samples taken during about the middle of the reducing condition periods indicate the soil at 10 to 50 cm was not wet satiated (Table 4, Appendix G), and was even dryer at 100 cm, effectively ruling out the possibility that the reducing conditions were caused by endosaturated conditions (apparent water table).

Hydric soil classification and hydrology

Site 5 nonponded microhigh did not meet any of the 2005 NRCS-NTCHS soil field indicators for loamy and clayey hydric soils, or Field Indicator F18, Reducing Vertic (USDA-NRCS 2005a). During normal precipitation months and years the site did not meet the hydrology criteria for frequent ponding or flooding duration (at least 7 days) during the growing season (February 12 to December 12, Brazoria County Texas) (Environmental Laboratory, 1987) (USDA-NRCS, 2005a).

Site 5 nonponded microhigh did not meet any of the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site did not meet the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding or flooding duration (Environmental Laboratory, 1987). The site also did not meet the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Site 5 Nonponded microlow

Soil morphology

The Site 5 nonponded microlow soil profile described during the NRCS-NSSL soil characterization study in an area of distinct gilgai microrelief (Fig. 6, Appendix J) classifies as a very-fine, smectitic, hyperthermic Typic Hapludert (Appendix B). The surface layer is calcareous slightly alkaline, black clay 23 cm thick. From 23 to 43 cm is calcareous, slightly alkaline black clay. From 43 to 65 cm is calcareous, slightly alkaline, very dark gray clay. Additional soil transects were not conducted at this monitoring site.

Hydrology

Average ponding depth at Site 5 nonponded microlow was 5 cm, and ranged from 1 to 5 cm (Table 3, Appendix F). The average ponding depth closely matched the average measured depth (4 cm, range 2- to 8 cm) of blackened leaves in the bottom of microlows.

During the 1996-2002 water-years, Site 5 nonponded microlow (Fig. 6) cumulative ponding was 13%. The microlow ponded 64% of the time during above-normal precipitation months, 27% of the time during normal precipitation months, and 9% of the time during below-normal precipitation months (Table 3, Appendix F). Durations of ponding events were mainly less than 2-continuous-weeks with one event

of 2-continuous-weeks. (Appendix K). During the 2000-2002 water-years, Site 5 nonponded microlow cumulative ponding was 9%. Duration of ponding events was one event of less than 2-continuous-weeks.

During the 1996-2002 growing season water-year Site 5 nonponded microlow cumulative ponding was 8%. Durations of all ponding events were less than 2-continuous-weeks. During the 2000-2002 growing season water-year, no ponding events were recorded in the microlow.

Reducing conditions, AADP dye

Appendix H shows the biweekly AADP dye observations during the study. During the 1996-2002 water-years cumulative positive reaction to AADP dye within the upper 10 cm was 2%. Durations were two events of less than 2-continuous-weeks. At 30 and 50 cm positive reactions to AADP dye were never observed. During the 2000-2002 water-years, cumulative positive reaction to AADP dye within the upper 10 cm was 4%. Duration was one event of, less than 2-continuous-weeks. At 30 and 50 cm positive reactions to AADP dye were never observed during the 2000-2002 water-years.

During the 1996-2002 growing season water-years cumulative positive reactions to AADP dye within the upper 10 cm were 10%. Duration was one event of, less than 2-continuous-weeks. At 30 and 50 cm positive reactions to AADP dye were never observed. During the 2000-2002 growing season water-years, cumulative positive reactions to AADP dye within the upper 10 cm were 5%. Duration was one event of less than 2-continuous-weeks. At 30 and 50 cm positive reactions to AADP dye were never observed.

Reducing conditions, Eh readings

Appendix H shows biweekly Eh readings during the study. During the 2000-2002 water-years cumulative reducing conditions (Eh $\leq$ +193 mV) at 10 cm were 4%. (Appendix K). Duration was one, event of less than 2 weeks. At 30 cm, cumulative reducing conditions (Eh $\leq$ +163 mV) were 30%. Duration was one event of 12-continuous-weeks. At 50 cm, cumulative reducing conditions (Eh $\leq$ +145 mV) were 26%. Duration was one event of 10-continuous-weeks.

During the 2000-2002 growing season water-years, no reducing conditions (Eh) were measured at 10 cm (Appendix K). At 30 cm, cumulative reducing conditions were 16%. Durations were one event of less than 2-continuous-weeks, and one event of to 2-continuous-weeks. At 50 cm, cumulative reducing conditions were 5%. Duration was one event of less than 2-continuous-weeks.

The measured reducing conditions at depth in the microlow were problematic. The reducing conditions were recorded during wet periods. Soil moisture samples taken during about the middle of the reducing condition periods indicated the soil at 10 to 50 cm was not wet satiated (Table 4, Appendix G), and was even dryer at 100 cm, effectively ruling out the possibility that the reducing conditions were caused by endosaturated conditions (apparent water table).

Hydric soil classification and hydrology

Site 5 nonponded microlow did not meet any of the 2005 NRCS-NTCHS soil field indicators for loamy and clayey hydric soils, or Field Indicator F18, Reducing Vertic (USDA-NRCS 2005a). Ponding in the microlow was predominantly in months with above-normal precipitation, and lasted mainly for less than 2-continuous-weeks duration. Based on periodic additional observations during the study, during

normal precipitation months and years the site did not usually meet the hydrology criteria for frequent ponding or flooding duration (at least 7 days) during the growing season (February 12 to December 12, Brazoria County Texas) (Environmental Laboratory, 1987) (USDA-NRCS, 2005a).

Site 5 nonponded microlow did not meet any of the 87 Manual field indicators for nonsandy soils, with bottomland hardwood Vertisols in this area being considered problem soils (Wakeley, 1996). During normal precipitation months and years the site did not meet the hydrology criteria of a minimum of 5% of the growing season (14 consecutive days) for frequent ponding or flooding duration (Environmental Laboratory, 1987). The site also did not meet the hydrology requirement on a yearly basis (18 continuous days) during normal precipitation months and years.

Additional Field Observations

Ponded Conditions, Vegetation Changes, Color Signatures on Digital Orthophoto Maps.

Fig. 17 shows the location of 27 observations (P1 to P27) taken over a 2-day period when ponding at Site 4 ponded was near 10 cm deep (11 cm on first day, 8 cm on second day). Ponding depths, brief soil profile notes (all surfaces were clay), brief vegetation observations, landscape features, and latitude and longitude also were recorded (Appendix J). All of the soils observed in the ponded areas lacked redox features (a few fine iron-manganese nodules were observed in some profiles) in the upper 50 cm. Most soils in the large open flat were alkaline and calcareous. The observations and recorded locations documented that differences in the color patterns on the digital orthophoto are good indicators of the boundary between ponded and nonponded areas, and also distinct vegetation changes (Fig. 17).

Vertical and Horizontal Movement of Soil and Piezometers

Vertical (heave) and horizontal (throw) movement of soil and piezometers were measured after 8 years at the bottomland hardwood study monitoring sites to determine if soil or piezometer movement had resulted in problems with measuring episaturated conditions at the monitoring sites (Bragg and Miller, 2006). Piezometers were originally constructed of schedule 40 PVC pipe and were placed in triplicate sets at depths of 30, 50, 100, and 200 cm, with a single 500 cm deep piezometer at three nonponded and four ponded sites in 1996. Ground level was permanently marked on each piezometer.

Precipitation in the first half of 2004 was abnormally high in the region which resulted in about the wettest possible field conditions when heave and throw measurements were made in June. Heave and throw were measured on 74 of the 102 piezometers at the Dance Bayou Unit monitoring sites. Piezometers were selected based on accessibility to the sites in June, field determination of lack of major disturbance to the piezometer or ground surface around the piezometer, and estimated accuracy of initial installation depths.

Heave was determined by the difference between the permanent ground mark on the piezometers and surface ground level observed in June, 2004. Heave ranged from 0 to 9 cm. Throw was determined by how much the above ground part of the piezometers was out of plumb. Throw ranged from less than 2 cm to 5 cm.

Statistical analysis indicated less heave occurred in the 30, 50, and 100 cm piezometers than in the 200 and 500 cm piezometers. The difference in heave amounts between the shallow piezometers and the deep piezometers was believed to be due to wet field conditions causing the clay to swell (heave) in the upper 50 to 100 cm, so that the piezometers at shallower depths moved upward with the soil. The 200 and 500 cm piezometers did not move as much because the lower portions were below the depth of major

moisture changes and were anchored in dryer soil. No functional failure was found in any of the piezometers.

During the course of the 6-year study similar measurements were made at Site 3 ponded edge to document ponding depths and the possibility of soil heave. Seven permanent PVC bench marks were placed at the outer edge of ponding around the north end of the abandoned channel. The permanent PVC bench marks were made of 80-cm-long schedule 40 PVC pipes that were driven into the ground until 30 cm was left above ground. In November, 2000, water depths were permanently marked on each of the seven PVC pipe bench marks, and ponding depth at Site 3 ponded middle was recorded from the 200 cm piezometer ponding bench mark.

Over the next 3 years, ponding depths at Site 3 middle and the outer edge PVC bench marks were recorded on 6 different dates during normal ponding events. Using the ponded depth at Site 3 ponded middle as a reference, ponded water depths on the seven PVC bench marks at the outer edge of ponding varied from 2 to 8 cm from the original permanent mark on the PVC pipes after 3 years.

Analysis of Blackish Coatings on PVC Pipes at Nonponded and Ponded Monitoring Sites

Distinct blackish coatings on PVC pipe piezometers were first documented at the ponded sites after one event of 2-continuous-months ponding, and two events of 5-continuous-months ponding within a 2 water-year period. Coatings on the PVC pipes at the ponded sites were about 2 to 5 cm long and several cm above ground. During the field observations, it was noted that PVC pipe piezometers at nonponded sites also had blackish coatings near ground level, and coatings were about the same length or slightly shorter than those at the ponded sites.

Samples were taken from Site 2 nonponded, Site 3 ponded, and Site 4 ponded. Samples of the blackish coatings were taken from PVC pipes at both nonponded and ponded locations by carefully scraping the blackish materials from several of the PVC pipes at each location. Analysis for percent OM (organic matter), percent Fe_2O_3 and percent MnO_2 was by the Texas A&M University Soil Characterization Laboratory (analysis by loss of weight from heating, and x-ray diffractogram).

Blackish coatings on PVC pipe piezometers at the ponded sites correlated very closely to average ponding depths at the sites. Analysis of the blackish material from Site 2 nonponded was 20.5% OM, 2.3% Fe_2O_3, and 0.05% MnO_2. Analysis of the blackish material from Site 3 ponded was 67% OM, 3.4% Fe_2O_3, and 0.77% MnO_2. Analysis of the blackish material from at Site 4 ponded was 28.1% OM, 3.9% Fe_2O_3, and 3.18% MnO_2. The x-ray diffractogram indicated there were no peaks for hematite, goethite, or other sesquioxides (Dr. T. Hallmark, unpublished data, 2006). Even though this study was an approximation of what the blackish coatings might be due to the small sample size, there was a trend that the coatings were composed predominately of organic matter and clay sized soil particles (Dr. T. Hallmark, personal communication, 2006).

4. SUMMARY AND CONCLUSIONS

Bottomland Hardwood Vertisol Study in the Texas Gulf Coast Prairie

The Interagency Soil Characterization and Hydrological Monitoring Prohject, Brazoria County, Texas, Bottomland Hardwood Vertisols Study (bottomland hardwood study) in the Texas Gulf Coast Prairie was initiated to study soil morphology, hydrology, reducing conditions, soil temperature (growing season), and plant communities to better understand and characterize wet Vertisols (mainly the Pledger soils), and jurisdictional wetland areas in the Columbia Bottomlands. The results of the study were to be used as a basis for developing regional wetland determination guidance as needed in the Texas Gulf Coast Prairie Columbia Bottomlands (Wakely, 1996; Wakely, 2002). Monitoring sites were selected in 1996 by members of the cooperating agencies in Brazoria and Matagorda Counties, Texas. Six monitoring sites were selected at the USFWS Dance Bayou Unit of the San Bernard National Wildlife Refuge in the vicinity of Dance Bayou in Brazoria County, and one monitoring site was selected at the Phillips Unit of the San Bernard National Wildlife Refuge in Matagorda County.

Associated automated equipment such as data loggers, tipping rain gauges, etc. were installed at each monitoring site. Sites were visited every 2 weeks (biweekly) to check on the automated equipment and to take manual readings. Very little useable field data was obtained from the automated equipment due to repeated and prolonged periods of electrical and mechanical failures. Additional manual readings were made after major precipitation events. The NRCS conducted a soil characterization study in 1998, and thirteen profiles were described and sampled in nonponded, transition, and ponded areas for complete chemical and physical analysis by the NRCS National Soil Survey Laboratory. Additional transects and field investigations were conducted during the length of the study.

Soil Temperature

A four-year study was initiated in 2001 by the USDA-NRCS National Soil Survey Center (NSSC) in Lincoln, Nebraska, to investigate soil temperature regimes in the southern United States. Two soil temperature sites selected in Texas were in the vicinity of the Columbia Bottomlands and the Dance Bayou and Phillips Plant Unit bottomland hardwood study area. One site was approximately 37 km northwest of the bottomland hardwood study area in Wharton County near the town of Pierce on upland Telferner soils. The other site was approximately 27 km southeast of the bottomland hardwood study in Brazoria County near the town of Brazoria on bottomland Norwood soils.

In May 2002 two additional data loggers for soil temperature studies were installed at the Dance Bayou bottomland hardwood study area. Temperature data was gathered from May 2002 until May 2004. The average January coldest soil temperatures at 50 cm for Site 1 nonponded and Site 3 ponded were 14.1°C for both sites. Daily temperature readings from the data loggers showed that the coldest recorded temperatures were mainly in January, and ranged from about 12° to 13°C. Coldest temperatures lasted from periods of less than 24 hours (several consecutive 5-hour readings) to a maximum of 3 days.

The average January soil temperature at 50 cm near the town of Pierce in Wharton County was 14.4°C, and near the town of Brazoria in Brazoria County it was 13.7°C. Daily temperature readings from the data loggers showed that the coldest recorded temperatures were mainly in January, and ranged from about 9° to 14°C. Coldest temperatures lasted from periods of less than 24 hours (several consecutive 5-hour readings) to a maximum of 4 days.

A brief analysis of other soil temperature monitoring sites (in the Texas Gulf Coast Prairie MLRA that were part of the National NRCS Thermic-Hyperthermic Study for the Southern U.S.) near Victoria, Texas, to Beaumont, Texas, revealed similar trends to soil temperatures at the Brazoria County bottomland hardwood study sites. Two soil temperature monitoring sites were near Victoria, Texas, and the coldest temperatures at these two sites were in the month of January. Average soil temperature in the month of January was about 13.5°C, and coldest recorded temperatures ranged from 8.8° to 11.3°C for periods of 1 to 4 days. Coldest soil temperature at the monitoring site near Beaumont, Texas, was during the month of January. Average soil temperature for the month was 12.1°C. Coldest recorded temperatures during January at the monitoring site near Beaumont, Texas, ranged from 9.2° to 10.4°C for periods of 2 to 4 days.

The results of the bottomland hardwood study part of the Thermic-Hyperthermic Study for the Southern U.S. soil temperature study were similar to other studies in Texas and in the southeastern United States (Miller, 1986; Megonigal et al., 1996; Slabaugh, J.D., 2006). These four studies indicated that soil temperatures at 50 cm seldom reach 10°C. When soil temperature at 50 cm did reach 10°C or lower, the lower temperatures lasted for very brief periods usually in the month of January.

Current regulatory guidance for identifying wetlands uses frost-free days listed in county soil survey reports to estimate growing season in the absence of local soil temperature data (Environmental Laboratory, 1987). Four formal soil temperature studies in this part of the United States documented that the growing season, as currently defined, is for a full 12 months each year. Current regulatory guidance for estimating growing season in these regions based on frost dates in the absence of local temperature measurements is technically incorrect, and should be changed to reflect the findings of these studies.

Precipitation

During the 6-year bottomland hardwood study, on a calendar year basis, there were 4 years with normal precipitation, and 2 years (1999, 2000) with below-normal precipitation. In the 4 years with normal precipitation, 35% of the months had above-normal precipitation (average 3 with a range of 3 to 5 months), 31% of the months had normal monthly precipitation (average 3 with a range of 3 to 5 months), and 33% of the months had below-normal precipitation (average 3 with a range of 3 to 5 months).

On a water-year basis (dry-wet-dry season, September of one year to August of following year) there were 5 water-years with normal precipitation, and 1 water-year (1999-2000) with below normal precipitation. In the 5 water-years with normal precipitation, 29% of the months had above normal precipitation (average 3 with a range of 2 to 4 months), 35% of the months had normal monthly precipitation (average 3 with a range of 3 to 6 months), and 35% of the months had below normal precipitation (average 3 with a range of 3 to 5 months).

Ponding and Soil Water

Ponding

During the bottomland hardwood study there were 10 storm events with precipitation amounts of approximately 4.8 to 53.4 cm over periods of 1 to 9 days. From very dry field conditions in August, one event of 13.61 cm of precipitation over a period of 3 days caused 25-cm-deep ponding at Site 3 ponded and 10-cm-deep ponding at Site 4 ponded. Sites 1 and 5 nonponded and Site 1 ponded did not pond water. Ponding was predominately from runoff from surrounding areas. Overbank flooding from Dance Bayou occurred only during major above-normal storm events, such as tropical storms.

The storm events in the fall months (5 events) had precipitation amounts ranging from about 6 to 53 cm over periods of 2 to 9 days and caused ponding at all of the bottomland hardwood study monitoring sites. Storm events in the winter and spring months (5 events) indicated precipitation amounts ranging from about 5 to 8 cm over periods of 1 to 4 days caused similar ponding at most of the bottomland hardwood study monitoring sites. Depending on time of year, and either continued precipitation and wet conditions, or the development of dry conditions, ponding durations lasted for less than 2-continuous-weeks to several continuous months or more.

Sites 1 and 5 nonponded microlows generally ponded only during months with above-normal precipitation. Ponding event durations were usually for less than 2-continuous-weeks. Average ponding depths in microlows were approximately the same depth as blackened leaves in the bottom of the microlows. The microlows may meet the current NRCS hydric soil standard of 7 days ponding during normal precipitation months and years. During normal precipitation months and years, Sites 1 and 5 nonponded microlows would not meet the 87 Manual minimum time of 5% of the growing season (14 days), nor 5% of the total year (18 days). Site 2 nonponded only received runoff water after above-normal precipitation events, and the site never ponded during the 6-year study.

Ponding at Site 1 ponded was mostly during months with normal precipitation (56%). Durations were mainly events of less than 2-continuous-weeks, with one event of 6-continuous-weeks. Site 1 ponded may meet the current NRCS hydric soil standard of 7 days ponding during normal precipitation months and years. During normal precipitation months and years the site would not meet the 87 Manual minimum time of 5% of the growing season (14 days), nor 5% of the total year (18 days) based on the data collected during the study. A detailed statistical analysis of precipitation events and projected ponding at Site 1 ponded might provide additional insights to ponding event durations over a longer period of time.

Sites 3 ponded edge, 3 ponded middle, and 4 ponded all ponded during most months and years with normal precipitation. Ponding event durations were for at least 4-continuous-weeks or more. These ponded sites met the current NRCS hydric soil standard of 7 days ponding during normal precipitation months and years. During normal precipitation months and years, these ponded sites all met the 87 Manual minimum time of 5% of the growing season (14 days), and 5% of the total year (18 days).

Soil water

Based on bulk density values of clay from the Pledger and Churnabog (proposed) soil characterization study, theoretical pore space of the clay in the upper 50 cm was about 58%. Gravimetric soil samples were taken during seasonal wet periods and seasonal dry periods during the bottomland hardwood study to determine if the soils were endosaturated or episaturated. Soil water states of ped interiors were recorded as soil samples were taken. Soils with enough soil water content to glisten were either near saturation, or if free water was present, were saturated (wet satiated).

All soil samples taken during prolonged seasonal wet periods with <40% gravimetric water did not glisten in soil sample ped interiors. Most soil samples with 40 to 50% gravimetric soil water also did not glisten. Almost all soil samples with ≥50% gravimetric soil water had ped interiors that glistened, indicating they were soil water class wet satiated.

Under ponded conditions, soils were wet satiated (≥50% gravimetric soil water and soil glistened) in ped interiors to depths of 30 cm within about 2 weeks. Under continued ponding the soils were wet satiated in ped interiors to depths of 50 cm within about 3 weeks. Gravimetric water content during

prolonged seasonal wet periods was highest at the surface and decreased with depth at all of the monitoring sites. The same gravimetric water content trend also occurred during prolonged seasonal dry conditions, with soil water contents higher near the surface than in subsurface horizons. Gravimetric water content differences between prolonged seasonal wet periods and prolonged seasonal dry conditions at 100 cm were relatively small.

The trends in soil water content indicated the soils at the monitoring sites wet from the surface downward, and were episaturated. Most soil water changes were in the upper 50 cm. In the nonpopnded gilgai soil areas, during prolonged periods of above-normal precipitation events, surface layers of the microhighs as well as the microlows were wet satiated.

Reducing Conditions

Strong reducing conditions based on Eh readings were observed at 10, 30, and 50 cm at Sites 3 ponded edge, 3 ponded middle, and 4 ponded within 3 to 8 days from the start of four major storm events during the study. AADP dye reaction was 100% very positive in the upper 10 cm of the (soil pH 5.5 in upper 11 cm) within 7 to 8 days from the start of two of the storm events (similar to Eh readings). After two other storm events, positive reaction to AADP dye in the upper 10 cm lagged behind reducing conditions based on Eh readings by 9 to 10 days (positive reaction after 12 to 13 days ponding).

AADP dye measurements at Site 3 ponded middle indicated that a continuous ponding period of 5 to 8 weeks passed before any positive reaction was observed at 50 cm (pH 6.7 at 38 to 64 cm). After 16 weeks continuous ponding positive AADP dye reaction at 50 cm was approximately 60% of the soil matrix. After approximately 25 weeks continuous ponding, AADP dye reaction was 100% positive in the upper 50 cm and 60% positive from 50 to 75 cm. No AADP dye reaction was observed below about 75 cm (pH 7.5 at 64 to 95 cm). On several occasions during the AADP dye field test at depths below 75 cm, sodium dithionite was sprinkled in the AADP dye areas and the reaction was an immediate, very bright red, indicating adequate levels of iron in the soil.

At Site 1 nonponded microlow site, Eh readings were very similar to the ponded sites. However, there was not a positive reaction to AADP dye in the upper part of the soil during this time. During the length of the study a few positive reactions to AADP dye (less than about 40% of the soil matrix) were observed in the upper 5 cm of the soil of the microlow during prolonged periods of above normal wet conditions. Soil reaction in the microlow was near neutral (pH 6.9 to 7.2) in the upper 81 cm. On several occasions during the AADP dye field test, sodium dithionite was sprinkled in the AADP dye areas and the reaction was immediate, very bright red, indicating adequate levels of iron in the soil.

As a ponded or episaturated condition event ended, the soil started to dry out at the surface and became oxygenated. Reducing conditions changed to aerobic conditions from the soil surface downward. This trend explains why in some cases reducing conditions last longer at deeper depths.

Field results of reducing conditions measured by Eh readings and AADP dye were not always consistent. This was especially true at sites similar to nonponded microlows, where wet, ponded, and therefore reducing conditions were infrequent and of short duration for the most part. Eh readings always showed that reducing conditions developed relatively quickly to depths of 30 to 50 cm under ponded or episaturated conditions. This trend, along with the soil water samples and field observations of soil water content, indicated the strong possibility that reducing conditions developed at those depths without the soil being wet satiated during the initial ponding and episaturated conditions.

We are not sure of the reasons for the disparity between Eh measured reducing conditions and positive AADP dye reaction (ferrous iron in the soil) with soil depth in these Vertisols. Low soil organic matter content, low iron content, high manganese content (may act as a buffer for ferrous iron formation), and low soil temperatures, the usual reasons for the lack of development of reducing conditions in soils, do not apply in this case based on the soil characterization data and other field observations. Field observations during the bottomland hardwood study indicate a possible correlation to soil water status and positive reaction to AADP dye. The correlation seemes to be that as the soil developed either near wet satiated conditions (moist, moderately sticky, surface dull) or wet satiated conditions (wet: non-satiated or wet: satiated, very sticky, surface glistens with moisture) with depth, positive reaction to AADP dye developed. Soil reaction may also play a part as previously discussed, because reaction increases with depth in all of the studied soils. Soils with near neutral pH and higher reaction must undergo stronger and possibly longer reducing conditions before ferrous iron forms. If the soil is also calcareous, the formation of ferrous iron is also more difficult even under strongly reducing conditions.

Similar observations were made in the Texas Gulf Coast Prairie MLRA during the International Committee on Aquic Soils field study (upland Vertisol and Alfisol in ponded prairie depression) (Griffin, 1991), Dr. Phillip Owens' graduate field study (several upland Alfisols and bottomland hardwood Vertisols), and study a of the Sharkey soils in the lower Mississippi Valley. These field observations seem to be reasonably well documented, and further study is needed to determine the reasons for the disparity between Eh measured reducing conditions and AADP dye reaction at depths below 15 to 30 cm under episaturated conditions.

Soils

Soil series concepts

Pledger soils (microlows) classify as very-fine, smectitic, hyperthermic Typic Hapluderts. The Pledger series concept is nonponded, moderately well drained, mollic colored, slightly acid to moderately alkaline Vertisols with distinct gilgai microrelief on bottomland hardwood flood plains. Microlows comprise about 10% of the microrelief. Overbank flooding occurs during prolonged periods of above-normal precipitation events such as tropical storms or hurricanes. Redoximorphic features in the upper 50 cm of Pledger soils (microlow) are typically limited to a few 2 to 3 mm in diameter iron-manganese nodules.

Soil areas that pond and were previously mapped as Pledger soils (microlows) classify as very-fine, smectitic, hyperthermic Typic Epiaquerts (proposed new series, Churnabog). Churnabog series concept is poorly drained, mollic colored, slightly acid to moderately alkaline Vertisols on bottomland hardwood flood plains in abandoned channels and flats. Most ponded areas lack distinct gilgai microrelief. The abandoned channels and flats seasonally frequently pond for long to very long durations from runoff during normal precipitation events. Overbank flooding occurs during prolonged periods of above normal precipitation events such as tropical storms or hurricanes. Churnabog soils are physically and chemically similar to Pledger soils except reaction is typically more acid in the upper part. Redoximorphic features in the upper 50 cm of Churnabog soils typically are common to many masses of oxidized iron on faces of peds and on surfaces along root channels and pores, and a few 2 to 3 mm in diameter iron-manganese nodules. Some Churnabog soils lack redoximorphic features in the upper part.

Soils mapped as Pledger clay, occasionally flooded (soil map unit Pg) in the Matagorda County Soil Survey Report make up about 10,730 acres (Hyde, 1991). The soil will be re-correlated to Churnabog clay, frequently ponded, as the result of the bottomland hardwood study. Churnabog clay, frequently ponded, will be classified as a hydric soil and added to the county and state hydric soil list (C. Neitsch,

personal communication, 2006). A review of the soil profile field notes taken during the Matagorda soil survey field work (S. E. Brown and H. W. Hyde, unpublished data, 1989) in delineations of soils mapped as Pledger clay, occasionally flooded (soil map unit Pg) (Hyde, 1991), indicate that a lack of easily identifiable redox features in the upper 50 cm of these soils is a common occurrence. Churnabog soils will be mapped in other counties in the Columbia Bottomland hardwood area during the USDA-NRCS soil survey update of the Texas Gulf Coast Prairie MLRA, and will be fairly extensive in this landscape (J. Wiedenfeld, personal communication, 2006).

Redoximorphic features

Background

It is generally well documented that when soils become saturated with water (wet satiated), anaerobic conditions can develop if a readily oxidizable carbon source is present and the temperatures are warm enough for microorganisms to be active. If anaerobic conditions persist, soils may become sufficiently reducing that ferric iron oxide minerals begin to reduce to the ferrous state. The particular redox potential (Eh measurement) at which this transformation occurs is dependent on the soil pH as well as additional factors. While the solubility of ferric oxides is extremely low, ferrous iron is quite soluble. Therefore, the reduction of iron oxides in soils permits the translocation of iron in the aqueous phase. Seasonal fluctuations in saturation give rise to periods of oxidation and reduction, and these processes under most circumstances form redoximorphic features in soils.

Over the years, soil scientists working in the field have encountered circumstances where soils possessed seasonally high water tables, but did not exhibit the types of redox features typical of wet soils. The possible explanations to account for wet soils not having typical redoximorphic features usually fall into two general categories, the inherent properties of the soil itself and chemical conditions in the soil environment (Rabenhorst and Parikh, 2000).

Soil properties

Soil properties and redoximorphic features are usually related to soil color. In the case of the bottomland hardwood Vertisols, high organic matter content and the associated dark colors may mask redox features. These soils are recognized as problem soils by most wet soil standards.

Some soils contain iron oxide minerals that are more resistant to reduction than others. The most common iron oxide minerals in soils are hematite, goethite, ferrihydrite, and lepidocrocite. The solubility products of goethite and hematite are nearly the same, and significantly (orders of magnitude) greater than those for lepidocrocite and ferrihydrite. The most stable phases of iron oxides (hematite and goethite) are the most common iron oxide minerals in soils. Among wet soils most noted to be problematic as far as showing redox features, are those derived from red parent materials. These soils contain relatively high amounts of goethite and hematite (Rabenhorst and Parikh, 2000).

Chemical conditions in the soil environment

Some soils may saturate but reducing conditions do not develop. The term *oxyaquic* has been used in Soil Taxonomy (Soil Survey Staff, 1999) to describe conditions where the soil is wet but not reducing with respect to iron. Oxyaquic conditions may occur where soils contain low quantities of decomposable organic matter, soil temperatures are so low biologic activity is limited, or rapid flow of groundwater may prevent depletion of O_2 levels (Vepraskas and Sprecher, 1997). In these cases, soil redox changes are

insufficient to induce the formation of redoximorphic features (Megonigal et al., 1993; Rabenhorst and Parikh, 2000). Other soil chemical conditions that might influence formation of redoximorphic features are soil reaction (pH), kinds and amounts of iron oxides, high levels of manganese, development and duration of strong reducing conditions, and duration and frequency of saturation or ponding events.

Bottomland hardwood study

The Vertisols at the bottomland hardwood study formed in Holocene deposits of the Brazos and Colorado Rivers. The parent material deposits have characteristic brownish or reddish colors. The reddish ferric-oxide pigment is traditionally thought to be derived from the Permian Red Beds several hundred miles to the north and west (Aronow, 1978; Crenwelge, 1981). The red parent materials of the Vertisols at the bottomland hardwood study may have some influence on the formation of redox features.

Several long term field studies over the past 15 years in the Texas Gulf Coast Prairie, and numerous additional field observations during various field studies, have never documented oxyaquic conditions in the upper 30 cm of wet soils using AADP dye to test for ferrous iron (Miller et al., 2001; Miller and Owens, 2004). Positive reactions to AADP dye were always observed at the soil-water interface during ponded conditions, and also during flowing surface water conditions such as runoff or at the outer edges of moving water from overbank flooding. When the soils were ponded, or wet satiated at the surface, positive reactions to AADP dye were observed usually within several days to a few weeks after the wet soil conditions started. Positive reactions to AADP dye in the upper part of soils during wet field conditions ranged from barrier island sands on Galveston Island with organic carbon contents ranging from 0.29 to 0.46%, to the bottomland hardwood Vertisols with organic carbon contents of 2 to 3%. These observations were throughout the years, indicating that temperatures were always high enough for biologic activity, amounts of decomposable organic matter were adequate for microbial growth, and the soils contained adequate amounts of iron to potentially form redoximorphic features.

Similar observations were made at the bottomland hardwood study monitoring sites. Shortly after several above normal precipitation events, positive AADP dye reactions were observed in the surface of the soil immediately below flowing runoff water. During normal ponded events, the upper part of the soil at the soil-water interface always had positive reactions to AADP dye. Ponded water was oxygenated based on the observed presence of small fish, frog eggs, tadpoles, and water insects at all depths of the ponded water.

The three monitoring sites that had the most definitive ponding events and durations for hydric soils and wetland hydrology were Sites 3 ponded edge, 3 ponded middle, and 4 ponded. Site 3 ponded middle had the highest ponding durations of all of the sites, with at least five events that were longer than 20-continuous-weeks. Site 3 ponded edge had six events with ponding durations longer than 2-continuous-weeks, with a maximum of 14-continuous-weeks. Site 4 ponded had at least five ponding events that were longer than 4-continuous-weeks, with a maximum of 14-continuous-weeks.

Sites 3 ponded edge and 3 ponded middle had easily identifiable redoximorphic features in the upper part in the form of brownish masses of oxidized iron on faces of peds and along root channels. The soils at these two sites had enough redoximorphic features to meet current standards for hydric soils, and also met the 2005 NRCS-NTCHS Field Indicator F18 (Reducing Vertic) (USDA-NRCS 2005a). Based on field transects and numerous detailed soil profile descriptions in this study, a definite trend was not observed concerning amounts of iron coatings on calcium carbonate nodules predominating in ponded areas and iron coatings not predominating in nonponded areas. Therefore, iron coatings on calcium

carbonate nodules should not be used as a field indicator for hydric soils and wetland areas in Texas Gulf Coast Prairie bottomland hardwood Vertisols.

Easily observable redoximorphic features were less well defined or in many cases were absent at Site 4 ponded. Redoximorphic features at Site 4 ponded in most cases did not meet current standards for hydric soils. However, Site 4 did meet 2005 NRCS-NTCHS Field Indicator F18 (Reducing Vertic) (USDA-NRCS 2005a) based on positive AADP dye reactions observed during the study. A definite trend was not observed concerning amounts of iron coatings on calcium carbonate nodules predominating in ponded areas and iron coatings not predominating in nonponded areas during the 150-m transect.

Comparison of chemical properties of the upper 30 cm of the three sites reveals that percent OM is very similar. Site 3 ponded middle and 4 ponded have the highest OM content at 7%, and Site 3 ponded edge the lowest with 6%. Acid oxalate extractable iron (noncrystalline hydrous oxides of iron) is highest at Site 3 ponded at 0.65% and lowest at Site 3 ponded edge and Site 4 ponded at 0.39%. Dithionite-citrate extractable manganese (total) is highest at Site 3 ponded edge at 0.03% and lowest at Site 3 ponded middle and Site 4 ponded at 0.01%. Soil reaction (pH) ranges from the highest at Site 4 ponded at pH 7.3 (typical sample determined by Texas A&M University; at a small area sampled during the NSSL soil characterization study, pH 6.1), to pH 5.5 at Site 3 ponded edge, and to pH 5.0 at Site 3 ponded middle.

The reasons for the general lack of consistent field findings of easily identifiable redoximorphic features near Site 4 ponded are not clear and are problematic. The field observations were made over a long period of time (7 years) on five separate occasions in the summer months when soil conditions were dry, by different groups of three or more experienced soil scientists and/or wetland delineators. Therefore, the conclusion must be made that the observations were valid. On four of the five occasions, redoximorphic features were described as being in scattered isolated areas in the landscape and either not well expressed or absent. Additional field studies in similar landscapes in the Columbia Bottomland hardwoods indicated that this was not an isolated occurrence but was fairly widespread (W. L. Miller, unpublished data, 2004).

Several theories were proposed during the study for the reasons for the variability in redoximorphic features at Site 4 ponded. Some of the more practical theories were: the site did not pond for long durations and reducing conditions were not long enough or strong enough to reduce iron in the soil to form redoximorphic features; iron minerals in the soil were not readily reducing; clay content was different; manganese was acting as a buffer so that iron was never reduced during reducing conditions; iron content was too low; organic matter content was too low; soil reaction (higher pH) was preventing iron reduction; and oxygenated water was preventing reducing conditions to develop.

Laboratory data from the soil characterization study does not readily support the theories that clay content, manganese acting as a buffer, iron content, or organic matter content are major factors, since the values are very similar at all three ponded sites (Table 11). Soil reaction is generally higher in most areas around Site 4 ponded. That does affect iron solubility under reducing conditions and has an impact on the composition of iron minerals in the soil and whether or not they readily reduce and become soluble. The laboratory data and physical characteristics of the soil at 2 to 3 m indicate the parent materials of all the sites are very similar.

Field observations of the positive reaction of AADP dye at the immediate soil-ponded water interface strongly discount the theory of oxygenated water preventing soil reducing conditions. One possibility is that even though the soil at Site 4 ponded developed strongly reducing conditions relatively quickly (Eh values were substantially below the Eh-pH line for oxidized/reducing iron) under ponded conditions, ferrous iron either did not go into solution due to the soil pH, or not enough ferrous iron went

into solution to form *visible* masses of oxidized iron in the soil when the soil dried out and became aerobic.

Two other possibilities for the variability in observed redoximorphic features at Site 4 ponded are soil and seasonal variations. The soil characterization study, 150-m soil transects, and field observations during the study at Site 3 ponded edge and Site 3 ponded middle strongly documented soil variability in the amounts of redoximorphic features across a given soil landscape. Seasonal variations are more difficult to document because of soil variability.

Seasonal redoximorphic feature variability was documented in an upland Alfisol in Victoria County, Texas, during the International Committee on Aquic Soil Conditions Study in Victoria County, Texas (Miller and Owens, 2004). On three different occasions during this 10 year study, during prolonged periods of above-normal precipitation events, and after continuous reducing conditions for periods of 4 to 6 weeks in the slightly acid, fine sandy loam surface layer, the soil matrix changed color from 10YR 4/2 to 10YR 4/1. Masses of oxidized iron along root pores were observed after 4-continuous-weeks of reducing conditions. The soil matrix changed color back to 10YR 4/2 as the soil dried and became aerobic. Additional masses of oxidized iron along root pores and in the soil matrix were observed as the soil dried.

A similar instance of seasonal variability of formation of redoximorphic features was not documented at Site 4 ponded. However, the possibility does exist that a similar occurrence might happen if the site was ponded and strong reducing conditions developed for a very long duration during above normal, prolonged precipitation and ponding events.

In conclusion, we believe the most likely reasons for the lack of consistent observations of easily identifiable redoximorphic features at Site 4 ponded are soil reaction, soil variability, and possibly the form of iron oxides in the soil at higher pH.

Identifying Hydric Soils and Determining Hydrology in the Columbia Bottomland Hardwoods

Soils

Soil profile features that best identify mollic-colored hydric Vertisols in the Columbia Bottomland hardwoods are the common to many masses of oxidized iron on faces of peds and on surfaces along root channels and pores in typical ponded landscapes. Soils with near neutral reaction, or that are also calcareous, may either have very few of these features or not exhibit these features at all, even though they pond and reduce for long to very long periods.

Calcium carbonate concretions and nodules with iron coated rinds are not good indicators of hydric Vertisols based on the observations of three close-interval transects across ponded and nonponded landscapes at the Dance Bayou monitoring sites. Based on many years of field observations in the Texas Gulf Coast Prairie, there does seem to be a trend of a higher percent of iron coated carbonate concretions and nodules with iron rinds in bottomland hardwood Vertisols than in nonponded upland Vertisols (W. L. Miller, unpublished data, 2004). Iron-manganese concretions are not good indicators of hydric Vertisols in the Columbia Bottomland hardwoods due to past climate changes and wetter periods. Iron-manganese concretions are commonly found in most soil landscapes in the Texas Gulf Coast Prairie. Small masses of yellowish, brownish, and reddish clay are often observed in the upper 50 cm of the Vertisols in the Columbia Bottomland hardwoods. The masses of yellowish, brownish, and reddish clay are the result of mixing of deeper yellowish, brownish, and reddish clays with near surface layers by crayfish activity or Vertisol shrink-swell properties, and are not considered redoximorphic features.

Other characteristics to consider are landscape position and gilgai microrelief. Vertisols in nonponded landscapes generally have distinct gilgai microrelief, and Vertisols in ponded landscapes generally do not have distinct gilgai microrelief.

Hydrology

Landscape position is the major key to understanding and documenting hydrology in the Texas Gulf Coast Prairie MLRA and in Vertisols in the Columbia Bottomland hardwoods. Soils that have wetland hydrology occur in landscape positions that receive run on water from surrounding landscapes to cause wetness over and above normal precipitation. In the Columbia Bottomland hardwoods these landscapes are abandoned channels, backswamps, and flats. Digital orthophoto tonal patterns can be used to identify many of these areas. Field observations during this study indicate that the areas which consistently pond for long or very long durations during normal monthly and yearly precipitation events have to have a certain size and depth, and have a surrounding watershed area large enough to supply adequate runoff during normal precipitation events, before ponding durations occur to meet current regulatory standards.

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Glossary of Landforms, Soil Morphology, Soil Reducing Conditions and Hydrology Terms

Definition and Purpose

The purpose of this glossary is to provide a list of terms and their definitions used in the report that are based on standard terms and definitions used by USDA Natural Resource Conservation Service (NRCS) as part of the National Soil Survey Program (USDA-NRCS, 2005b), NRCS Field Indicators of Hydric Soils in the United States, Version 5.9. (USDA-NRCS, 2005a), NRCS National Technical Committee on Hydric Soils (USDA-NRCS, 2005c), 1987 Corps of Engineers Wetlands Delineation Manual (Corps of Engineers Environmental Laboratory, 1987), and technical literature and reports in reference to landforms, soil morphology, soil reducing conditions, and hydrology.

The glossary follows the format used in the NRCS National Soil Survey Handbook Part 629, Glossary of Landform and Geologic Terms (USDA-NRCS, 2005b).

Reference Codes

The source from which definitions were taken, whole or in part, are identified by a code (e.g., NSSH) at the end of each definition. Where a definition for a term or usage of a term is slightly different within the federal agencies involved in the study, both definitions are given. The reference codes are as follows:

AUMD--Sprecher, S.W., and A.G. Warne. 2000. Accessing and using meterological data to evaluate wetland hydrology. ERDC/EL TR-WRAP-00-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

COE87M--Corps of Engineers Environmental Laboratory. 1987. Corps of Engineers wetland delineation manual. U.S. Army Corps of Eng. Tech. Rep. Y-87-1. U.S. Gov. Print. Office, Washington, DC.

FBDSS--Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and W.D. Broderson. 2002. Field book for describing and sampling soils, Version 2.0. USDA-NRCS, National Soil Survey Center, Lincoln, NE.

FIHS--USDA-NRCS. 2002. Field indicators of hydric soils in the United States, version 5.0., G.W. Hurt, P.M. Whited, and R.F. Pringle (ed.). USDA-NRCS, Ft Worth, TX.

GG--Jackson, J.A. (ed.). 1997. Glossary of geology, 4th Ed. American Geological Institute, Alexandria, VA.

NSSH--USDA-NRCS. 2005b. National soil survey handbook, Part 629, glossary of landform and geologic terms.

NSSM--Soil Survey Staff. 1993. National soil survey manual. USDA. Agric. Handb. 18. US Govt. Print. Office, Washington, DC.

Reference Codes (continued)

STX75--Soil Survey Staff. 1975. Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys. USDA Agric. Handb. 436. US Govt. Print. Office, Washington, DC.

STX99--Soil Survey Staff. 1999. Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys. USDA Agric. Handb. 436. US Govt. Print. Office, Washington, DC.

Glossary Terms

abandoned channel
(a) A drainage channel along which runoff no longer occurs, as on an alluvial fan. GG
(b) Oxbow. GG

active water table - A condition in which the zone of soil saturation fluctuates, resulting in periodic anaerobic conditions. Soils with an active water table often contain bright mottles and matrix chromas of 2 or less. COE87M

aerobic - A situation in which molecular oxygen is part of the environment. COE87M

anaerobic
(a) A situation in which molecular oxygen is absent (or effectively so) from the environment. COE87M
(b) A condition in which molecular oxygen is virtually absent from the soil. FIHS

anaerobiosis - Microbiologic activity under anaerobic conditions. FIHS

anastomosing - Said of the channel pattern of a braided stream. GG

apparent (water table) - Level of stabilized water in a fresh unlined borehole. FBDSS

aquic conditions - Soils with aquic conditions are those that currently undergo continuous or periodic saturation and reduction. Elements of aquic conditions are: 1) saturation, characterized by zero or positive pressure in soil water and can be generally determined by observing free water in an unlined auger hole, 2) reduction, characterized by direct measurements of redox potential … in context of this taxonomy only a degree of reduction that results in reduced iron is considered …field test for reduced iron is… a strong reaction with alpha, alpha-dipyridyl on a freshly broken surface of a field–wet soil sample, and 3) redoximorphic features associated with wetness result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. STX99

aquic moisture regime
(a) (soil taxonomy, classes of soil moisture regimes). The aquic moisture regime implies a reducing regime that is virtually free of dissolved oxygen because the soils are saturated by ground water or by water of the capillary fringe. An aquic regime must be a reducing one. For differentiation in the highest categories of soils that have an aquic regime the whole soil must be saturated. The soil is considered to be saturated if water stands in an unlined borehole at such a shallow depth that the capillary fringe reaches the soil surface. The duration of the period that a soil must be saturated to have an aquic regime is not

known. The duration must be at least a few days, because it is implicit that dissolved oxygen is virtually absent. Because dissolved oxygen is removed from ground water by respiration of microorganisms, roots and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero (5 °C) at some time while the soil or the horizon is saturated. STX75
The aquic moisture regime is not used as either criteria or formative elements for taxa in soil taxonomy. STX99
(b) A mostly reducing soil moisture regime nearly free of dissolved oxygen due to saturation by ground water or its capillary fringe and occurring at periods when the soil temperature at 19.7 in. is greater than 5 °C. COE87M

backswamp
(a) A swampy or marshy depressed area developed on a flood plain, with poor drainage due to natural levees of the river. GG
(b) A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces. NSSH

backswamp deposits - Laminated silt and clay deposited in the flood basin behind the natural levees of a river. GG

backswamp depression - A low, usually swampy area adjacent to a leveed river. Syn: levee-flank depression. GG

backwater - A body of currentless or relatively stagnant water, parallel to a river usually fed from it through a single channel at the lower end by the back flow of the river. GG

backwater flooding - Situations in which the source of inundation is overbank flooding from a nearby stream. COE87M

bench mark - A fixed, more or less permanent reference point or object, the elevation of which is known. COE87M

biologic zero – Soil temperature of 5 °C at 19.7 inches (50 cm) below the soil surface.
Compare aquic moisture regime, growing season, and soil temperature regime. COE87M STX75

bottomland - (not recommended) use flood plain. An obsolete, informal term loosely applied to varying portions of a flood plain. NSSH

bowl (gilgai) - A cup or trough shaped subsurface feature centered under and surrounding the depressional component (microlow) of gilgai, commonly 3 to 5 m across and 1.5 to 3 m thick. A bowl contains numerous slickensides and bounded along its base by master slickensides with maximum angles of 5 to 10 degrees. Its morphology is distinct from that found in adjacent microhighs. NSSH

bypass flow (soil water) - A soil water movement condition, usually in clayey soils, where soil peds are not saturated but free water occurs in and moves along macropores between peds, and may fill an unlined borehole giving a false indication of soil saturation. STX99

channel (stream)
(a) The bed where a natural body of surface water flows or may flow; a natural passageway or depression of perceptible extent containing continuously or periodically flowing water, or forming a connecting link between two bodies of water. GG

(b) The hollow bed where a natural body of surface water flows or may flow. The deepest or central part of the bed of a stream, containing the main current and occupied more or less by continuously water. GG
(c) (Microfeature) Small trough-like, arcuate or sinuous channels separated by small bars or ridges, caused by fluvial processes; common to flood plains and young alluvial terraces, a constituent part of bar and channel topography. NSSH

chimney (gilgai) - A subsurface feature that forms a crude cone or wave-crest structure centered under a microhigh and extending at least part-way under adjacent intermediate positions, composed of substratum material that appears to upwell and reaches close to the surface. A chimney is commonly bounded by master slickensides with maximum angles of 60 to 80 degrees under the microhigh. Its morphology is distinct from the soil solum of the adjacent microlows. NSSH

circular gilgai - A type of gilgai dominated by circular closed depressions (microlows) separated by low mounds (microhighs); the prevailing type of gilgai on relatively level terrain slopes (slopes <3%) Distance from microhigh to the center of adjacent microlow is generally 4 to 8 meters. NSSH

concave landscapes - A landscape whose surface curves downward. FIHS

depression - Any relatively sunken part of the Earth's surface; especially a low-lying area surrounded by higher ground. A closed depression has no natural outlet for surface drainage (e.g., a sinkhole). An open depression has a natural outlet for surface drainage. NSSH

drift line - An accumulation of debris along a contour (parallel to the water flow) that represents the height of an inundation event. COE87M

drainageway
(a) A general term for a course or channel along which water moves in draining an area. NSSH
(b) A term restricted to relatively small, roughly linear arcuate depression that moves concentrated water at some time, and either lacks a defined channel(e.g., head slope, swale) or has a small defined channel (e.g., low order streams). NSSH

duration (inundation, soil saturation) - The length of time during which water stands at or above the soil surface (inundation), or during which the soil is saturated. As used herein, duration refers to a period during the growing season. COE87M

endosaturation (saturation) - Soil is saturated with water in all layers from upper boundary of saturation to a depth of 200 cm or more from the mineral soil surface. STX99

episaturation (saturation) - Soil is saturated in one or more layers within 200 cm of the mineral soil surface and also has one or more unsaturated layers, with an upper boundary above a depth of 200 cm, below the saturated layer. The zone of saturation, i.e., the water table, is perched on top of a relatively impermeable layer. STX99

field capacity, soil (see also soil water)
(a) Measured in bars of tension (soil water suction), 33 kPa to 1,500 kPa (field capacity to wilting point). FBDSS
(b) The percentage of water remaining in a soil after it has been saturated and after free drainage is negligible. COE87M

flat
(a) A tract of low-lying, level wetland; e.g., a marsh or swamp in a river valley.
(b) A general term for a level or nearly level surface or small area of land marked by little or no relief, as a plain, mud flat, valley flat. Also, a nearly level region that visibly displays lower relief than its surroundings. GG

flooded - A condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow form high tides, or any combination of sources. COE87M

flood plain
(a) The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regimen and covered with water when the river overflows its banks. Cf: valley flat, erosional flood plain. GG
(b) Any flat or nearly flat lowland that borders a stream and may be covered by its waters at flood stages. GG
(c) The nearly level plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of sediment deposited during overflow and lateral migration of the streams. NSSH

fluvial - Of or pertaining to a river or rivers. Produced by the action of a stream or river. See also: fluviatile. GG

fluviatile - A syn. of fluvial. Geologists tend to use the term for the results of river action and for river life. GG

free water - Soil moisture state where soil is at its maximum water retentive capacity, for practical purposes both large (macropores) and small (micropores) pores are filled with water, and matric suction is essentially zero. NSSM.

gilgai - A microfeature pattern of soil composed of a succession of microhighs and microlows on level areas, or of microtroughs and microridges parallel to the slope on sloping areas, and produced by expansion/contraction and shear/thrust processes with changes in moisture. NSSH

ground water - That portion of the water below the ground surface that is under greater pressure more than atmospheric pressure. COE87M

growing season - The portion of the year when soil temperatures at 19.7 inches (50 cm) below the soil surface are above biologic zero (5 °C). For ease of determination this period can be approximated by the number of frost-free days. Frost free days can be estimated from climatological data given in most SCS (NRCS) county soil surveys. Growing season starting and ending dates will generally be determined based on the "28 degrees F or lower" temperature at a frequency of "5 years in 10". COE87M

hydric soil
(a) A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. FIHS
(b) A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation. Hydric soils that

occur in areas having positive indicators of hydrophytic vegetation and wetland hydrology are wetland soils. COE87M

intermediate position (gilgai) - A subsurface feature that is a transition zone in soil between the chimney and bowl. Master slickensides in the intermediate position have maximum angles of 20 to 40 degrees. It is under the microslope surface feature, and immediately surrounds the bowl subsurface feature. NSSH.

limit of biological activity - With reference to soils, the zone which conditions preclude normal growth of soil organisms. This term is often used to refer to the temperature (5 °C) in a soil below which metabolic processes of soil microorganisms, plant roots, and animals are negligible. COE87M

linear gilgai – A type of gilgai dominated by parallel microlow troughs separated by low ridges (microhighs) and orientated perpendicular to the topographic contour (i.e., up and down slopes); the prevailing type of gilgai on sloping terrain. NSSH

levee (streams)
(a) Natural levee GG.
(b) A natural or man-made feature of the landscape that restricts movement of water into or through an area. COE87M See also *natural levee*.

Major Land Resource Area - Major Land Resource Areas (MLRA) are geographically associated divisions of land resource regions, defined in USDA Agriculture Handbook 296. FIHS

meander (streams) - One of a series of regular freely developing sinuous curves, bends, loops, turns or windings in the course of a stream. GG

meanderbelt - The area of the flood plain included between two lines drawn tangentially to the extreme limits of all fully developed meanders. GG

microhigh (gilgai) - A generic microfeature term applied to slightly elevated areas relative to the adjacent ground surface on gilgai or patterned ground; changes in relief range from several centimeters to several meters; cross-sectional profiles can be simple or complex and generally consist of gently rounded, convex tops with gently sloping sides. NSSH

microlow (gilgai) - A generic microrelief term applied to slightly lower areas relative to ground surface (e.g., shallow depression); changes in relief range from a few centimeters to several meters, cross-sectional profiles can be simple or complex and generally consist of subdued, concave, open or closed depressions with gently sloping sides. NSSH

microrelief (gilgai) (soil survey) - Slight variations in the height of a land surface that are too small or intricate to delineate on a topographic map or soils map at commonly used map scales (e.g., 1:24,000). NSSH

microslope (gilgai) - A gently sloping area, including the lower part (footslope) of a microhigh, that is a transition zone between the slightly elevated microhigh and the outer edge of an adjacent microlow in gilgai or other patterned ground. Where present, it can make up the majority of the ground service area in gilgai. NSSH

moist (soil) - Soil moisture at field capacity to wilting point. (FBDSS)

mottles
(a) These colors (mottles) are commonly lithochromic or lithomorphic (attributes retained from the geologic source rather than from pedogenesis; e.g., gray shale). (FBDSS).
(b) Spots or blotches of different colors or shades of color interspersed within the dominant color of a soil layer, usually resulting from the presence of periodic reducing soil conditions (not current NRCS usage, see redoximorphic features). COE87M

natural levee - A long broad low ridge or embankment of sand and coarse silt, built by a stream on its flood plain and along both banks of its channel. GG

normal year - A normal year is defined as a year that has plus or minus one standard deviation of the long-term mean annual precipitation. (Long-term refers to 30 years or more.) Also, the mean monthly precipitation during a normal year must be plus or minus one standard deviation of the long-term monthly precipitation for 8 of the 12 months. STX99

normal precipitation - The National Climatic Data Center (NCDC) defines "normal" as the arithmetic mean of a climatological element computed over three consecutive decades. Therefore, normal precipitation is the average of the precipitation amounts for the period of interest, for instance, for a particular month or year. The concept of "range of normal precipitation" is useful for grouping precipitation inputs into broad classes. The Standardized Precipitation Index (SPI) has the widest range of normal… and … the 30th to 70th percentile thresholds are used as the range of normal because those are the ones used in the only analysis that was specifically designed for wetland regulation (Food Security Act). AUMD FIHS

overbank flooding - Any situation in which inundation occurs as a result of the water level of a stream rising above bank level. COE87M.

oxbow - A closely looping stream meander resembling the U-shaped frame embracing an ox's neck, having an extreme curvature such that only a neck of land is left between two parts of the stream. The abandoned, bow- or horseshoe-shaped channel of a former meander, left when the stream formed a cutoff across a narrow meander neck. Syn: abandoned channel, oxbow lake. GG

oxbow lake - The crescent-shaped, often ephemeral, body of standing water situated by the side of a stream in the abandoned channel (oxbow) of a meander after the stream formed a neck cutoff and the ends of the original bend were silted up. GG

ponded - A condition in which water stands in a closed depression. Water may be removed only by percolation, evaporation, and/or transpiration. COE87M

puff (gilgai) - A surface exposure of an upward projection of a subsoil layer into and sometimes through a surface layer of Vertisols. Surface exposure located on microhigh or upper microslope microtopography. Exposed puff soil surface usually lighter in color and more alkaline than microhigh, microslope, or microlow soils may be calcareous and contain concretions of calcium carbonate or gypsum. NSSH

reducing environment - An environment conducive to the removal of oxygen and chemical reduction of ions in the soil. COE87M

reducing soil conditions
(a) The degree of soil reduction in a soil can be characterized by direct measurements of redox potential. In the context of this taxonomy, however, only a degree of reduction that results in reduced iron is considered, because it produces the visible redoximorphic features that are identifiable in the keys. A field test for reduced iron is… a strong reaction with alpha, alpha-dipyridyl on a freshly broken surface of a field–wet soil sample. STX99
(b**)** Soils saturated for long or very long duration will usually exhibit reducing conditions. Under such conditions, ions of iron are transformed from a ferric valence state to a ferrous valence state. This condition can often be detected in the field by a ferrous iron test. When a soil extract changes to a pink color upon addition of alpha, alpha dipyridyl, ferrous iron is present, which indicates a reducing environment. COE87M

reduced soil matrix - This is a soil matrix that has low chroma in situ but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air. STX97

redox potential - A measure of the tendency of a system to donate or accept electrons, which is governed by the nature and proportions of the oxidizing and reducing substances contained in the system. COE87M

redoximorphic features - Redoximorphic features are a color pattern due to loss (depletion) or gain (concentration) of pigment compared to the matrix color, formed by oxidation/reduction of Fe and/or Mn coupled with their removal, translocation, or accrual. Redoximorphic features include redox concentrations (masses, nodules or concretions); redox depletions (iron or clay depletions), or reduced matrix. STX99 FBDSS

perched (water table) - A water table that lies above an unsaturated zone. The water table will fall if the borehole is extended FBDSS

ponded - A condition in which water stands in a closed depression. Water may be removed only by percolation, evaporation, and/or transpiration. COE87M

relict features - Soil morphological features that do not reflect recent hydrologic conditions of saturation and anaerobiosis. FIHS

relict - Pertaining to surface landscape features e.g., landforms, geomorphic surfaces, and paleosols that have never been buried and yet are predominantly products of past environments. NSSH

relief - A term used loosely for the physical shape, configuration, or general unevenness of a part of the Earth's surface, considered with reference to variations of height and slope or irregularities of the land surface. A region showing a great variation in elevation has "high relief," and one showing little variation has "low relief." GG

saturation (soil water) **-** Saturation is characterized by zero or positive pressure in the soil water and can be generally be determined by observing free water in an unlined bore hole. Problems may arise, however, in clayey soils with peds, where an unlined auger hole may fill with water flowing along faces of peds while the soil matrix is and remains unsaturated (bypass flow). Three types of saturation are defined, endosaturation, episaturation, and anthric saturation. STX99

saturated soil conditions (soil water) - A condition in which all easily drained voids (pores) between soil particles in the root zone are temporarily or permanently filled with water to the soil surface at pressures greater than atmospheric. COE87M

slickensides (pedogenic) - Shrink swell produced shear slip faces on pedo-structure faces (e.g., wedges, bowls); groves, striations, glossy sheen. Most evident in Vertisols. NSS

soil temperature regimes (soil taxonomy). Within limits, temperature controls the possibilities for plant growth and soil formation. Below the freezing point there is no biotic activity, … time stands still for the soil. Between the temperatures of 0 °C and 5 °C, root growth of most plants and germination of most seeds is impossible. A horizon as cold as 5 °C is a thermal pan to roots of most plants. Daily changes in air temperature have a significant effect on the temperature of soil horizons to a depth of about 50 cm. STX75

soil water - Soil water state, the water regime, is evaluated from water suction, quantity of water, whether the water is liquid or frozen, and occurrence of free water within the soil and on the land surface. Three classes are defined, dry, moist, and wet. Dry is separated from moist at 1500 kPa suction (wilting point), and moist is separated from wet at 1 kPa suction (field capacity) and when water films are readily apparent. NSSM

soil water, wet class - Wet soil water class has nonsatiated and satiated subclasses distinguished on the basis of absence or presence of free water. Satiation is the condition from the first appearance of free water through saturation (satiation implies minor amounts of entrapped air in the smallest pores, and saturation implies no entrapped air, FBDSS). Wet is indicated by the occurrence of prominent water films on surfaces of sand grains and structural units that cause the soil material to glisten. If free water is absent, the term wet nonsatiated is used. If free water is

present, the term wet satiated is used. The position of the upper field boundary of the satiated wet class, in a formal sense, is the top of the water in an unlined bore hole after equilibrium has been reached. NSSM

surface water - Water present above the substrate or soil surface. COE87M

transition zone - The area in which a change from wetlands to nonwetlands occurs. The transition zone may be narrow or broad. COE87M

tree-throw - (not preferred) see tree-tip, tree-tip mound, tree-trip pit. NSSH

tree-tip - The process of uprooting and tipping over of trees by strong winds, commonly resulting in a small depression which the root ball is displaced and an adjacent mound from the sediments subsequently sloughed from the root ball. Most prevalent in shallow forested soils over a restrictive layer (e.g., bedrock); also called tree-throw, windthrow. NSSH

t**ree-tip pit and tree-tip mound topography** - A local-scale topography composed of irregularly spaced, small, closed depressions and adjacent mounds caused by displacement of root balls from trees knocked down by wind (i.e., tree-tip; also called tree-throw). The result is a subdued, irregularly pocked-marked or undulating surface; most common in forested areas overlying shallow rooting conditions (e.g., lithic contact, water table) Micro-elevational differences generally range from 0.5 to < 2 m. Sometimes also referred to as (not preferred) cradle and knoll, or pit and mound topography. NSSH

upland

(a) The higher ground of a region, in contrast with a low-lying, adjacent land such as a valley or plain. NSSH
(b) land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum. NSSH
(c) As used herein, any area that does not qualify as a wetland because of the associated hydrologic regime is not sufficiently wet to elicit development of vegetation, soils, and/or hydrologic characteristics associated with wetlands. Such areas occurring within *flood plains* are more appropriately termed *nonwetlands.* COE87M

watermark - A line on a tree or other upright structure that represents the maximum static water level reached during an inundation event. COE87M

water-year - A period of time marking the hydrologic period of a particular area, to include the dry-wet-dry cycle. FIHS

water table - The upper surface of ground water or that level below which the soil is saturated with water. It is at least 6 inches thick and persists in the soil for more than a few weeks. COE87M

wet nonsatiated - refer to soil water, wet class.

wet satiated – refer to soil water, wet class

wilting point - That soil moisture content (1,500 kPa bars of tension) at which most annual, agriculture row-crops start to wilt due to lack of soil water. FBDSS.

APPENDIX A. USACE-CEWES-ER-W, MEMORANDUM FOR RECORD (1996)
and
INTERAGENCY, MEMORANDUM OF AGREEMENT FOR THE INTERAGENCY "SOIL CHARACTERIZATION AND HYDROLOGICAL MONITORING PROJECT, BRAZORIA COUNTY, TEXAS, BOTTOMLAND HARDWOODS" (1997)

This appendix contains;

a) WRAP 96-10. USACE-CEWES-ER-W, Memorandum for Record, Interagency forum on delineation of wetlands in bottomland hardwood forests in Brazoria County (Wakely, J.S. June 7, 1996) U.S. Army Engineer Research and Development Center, Vicksburg, MS.; and

b) Memorandum of Agreement for the Interagency "SOIL CHARACTERIZATION AND HYDROLOGICAL MONITORING PROJECT, BRAZORIA COUNTY, TEXAS, BOTTOMLAND HARDWOODS" (1997)

24 JUN 1996

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

REPLY TO
ATTENTION OF

CEWES-EP-W (1110-2-1150a) 19 June 1996

MEMORANDUM FOR Commander, U.S. Army Engineer District, Galveston, ATTN: Mr. Marcos De La Rosa, Regulatory Branch, P.O. Box 1229, Galveston, TX 77553-1229

SUBJECT: Wetlands Regulatory Assistance Program (WRAP) Request 96-10

1. Enclosed is a memorandum (encl 1) in response to your request to participate in an interagency workshop to review complex upland forest-wetland mosaic habitats of the "Columbia Bottomland ecosystems" and establish criteria for designating "special case" areas within this ecosystem. Emphasis will be placed on wetlands hydrology and hydric soil indicators, as described in the Corps 1987 Delineation Manual. This memorandum was developed by Dr. Jim Wakeley of the Environmental Laboratory at the Waterways Experiment Station.

2. We appreciate the opportunity of assisting you through the WRAP, and if you have any questions please call Dr. Wakeley at (601) 634-3702.

FOR THE DIRECTOR, ENVIRONMENTAL LABORATORY:

Russell Theriot

RUSSELL F. THERIOT, PhD
Manager, Wetlands Regulatory
Assistance Program

Encl

CF:
Dr. Wakeley

CEWES-ER-W June 7, 1996

MEMORANDUM FOR RECORD

SUBJECT: Interagency Forum on Delineation of Wetlands in Bottomland Hardwood Forests in Brazoria County, TX (WRAP 96-10)

Background

On 14-16 May 1996, at the request of the Regulatory Branch of the U.S. Army Corps of Engineers Galveston District (CESWG-CO-RC), I participated in a meeting and field investigation in Brazoria County, TX, involving personnel from the U.S. Environmental Protection Agency (EPA), Natural Resources Conservation Service (NRCS), Fish and Wildlife Service (FWS), National Biological Service (NBS), Texas Parks and Wildlife Department (TPWD), and the Galveston District (see attached participant list). The meeting was convened by EPA to address concerns of FWS that the Galveston District was not identifying critical forested wetland habitats as jurisdictional under the Clean Water Act, thereby contributing to the inexorable destruction of the remaining bottomland hardwood (BLH) resource of the Columbia Bottomlands in Texas. FWS asked EPA to consider designating BLH forested areas of coastal Texas as a "Special Case," which would shift authority for wetland determinations from the Corps of Engineers to EPA, at least until further guidance could be developed to guide delineations in this region.

The current standard for wetland jurisdictional delineations nationwide is the 1987 *Corps of Engineers Wetlands Delineation Manual* (hereafter called the 1987 Manual) and subsequent guidance memoranda from Headquarters, U.S. Army Corps of Engineers. In their request to the Wetland Regulatory Assistance Program, the Galveston District asked that a representative of the U.S. Army Engineer Waterways Experiment Station participate in the interagency forum and give an opinion as to whether the District has been interpreting and applying the 1987 Manual correctly in this environment. Over a 2.5-day period, the interagency group discussed the issues involved and visited typical field sites in Brazoria County. We collected standard wetland delineation data at five sites in two BLH tracts at Peach Point and Dance Bayou (see attached copies of data forms), and examined a number of other sites at which no data were recorded.

Basic Findings

In my opinion, based on data gathered at the five sites described above plus the candid discussions among all participants, the disagreements between FWS and the Galveston District are not due to improper interpretation or application of the 1987 Manual by District Regulatory personnel. I found District personnel to be well trained, experienced, and sincerely interested in making the most accurate wetland delineations possible. They exhibited thorough understanding

of the 1987 Manual and its proper use. However, environmental conditions in this region make wetland identification and delineation unusually difficult, particularly with regard to soils and hydrology. In my opinion, areas meeting jurisdictional wetland criteria could potentially be overlooked because of the difficulty of identifying hydric soils and wetland hydrology in these systems.

On the other hand, FWS is mistaken in their interpretation that Clean Water Act wetland jurisdiction must be extended to any areas that exhibit recognized wetland functions. Although wetland functions (e.g., floodwater storage, sediment trapping, nutrient transformation, and provision of habitat for animals) are an important consideration in permit review, wetlands are delineated on the basis of *physical* attributes (i.e., soils, vegetation, and hydrology), not functional ones. Therefore, the functional limits of a wetland may not coincide with the jurisdictional boundary.

Future efforts to improve the accuracy of jurisdictional delineations in BLH forests of coastal Texas should focus on the difficult problem of identifying areas that are frequently ponded or flooded for long duration during the growing season and that may, nonetheless, lack easily recognizable indicators of hydric soils or wetland hydrology. Because Corps of Engineers wetland determinations must be defendable in a court of law, development and use of any new or modified methods for identifying wetlands in the region must be supported by rigorous scientific study and testing. The following is a brief review of technical issues involved in identification of wetlands in this region.

Hydrophytic Vegetation Determinations

Hydrophytic vegetation determinations are relatively straightforward in coastal Texas BLH forests and do not present a problem for wetland delineations. The five sites that we evaluated (see attached data forms) all met hydrophytic vegetation criteria, although most of the dominant species were facultative (FAC). We recorded several facultative wetland (FACW) species as dominants, one facultative upland (FACU) species, two wetland obligate (OBL) species, and no upland (UPL) species. Communities meeting hydrophytic vegetation criteria appeared to extend well above any recognizable wetland boundaries. Therefore, during our field investigations, wetland boundaries were identified mainly on the basis of hydric soil and/or wetland hydrology indicators.

Hydric Soil Determinations

Soils in the area are mainly Vertisols. Many of the problem sites we visited were in Pledger clay map units. According to Wes Miller, state hydric soil specialist with the NRCS, local Vertisols, such as Pledger, that are located above about 15 ft elevation dry out and crack to considerable depths during dry periods. They quickly absorb water after rainfall events causing the clays to swell, sealing the cracks and soil surfaces. After that, any additional rainfall moves as runoff to low areas in the landscape, where water may pond for long periods. These soils may never fully saturate and, therefore, they may not exhibit typical hydric soil indicators. However,

the Corps of Engineers recognizes soils as hydric if they meet criteria for flooding and ponding, whether or not hydric soil indicators are present.

Another problem affecting the presence of hydric soil indicators in these soils is the relatively high pH (above pH 7), which inhibits the formation of redoximorphic features by lowering the threshold redox potential required to reduce and mobilize iron and manganese. Therefore, other factors being equal, these soils must be saturated for longer periods than soils with more neutral or acid pH to exhibit similar hydric soil indicators. Furthermore, these Vertisols have the thick dark surfaces (value/chroma of 3/2 or less) recognized as a problem in the 1987 Manual due to the potential for organic matter to mask the presence of redoximorphic features near the soil surface. According to Wes Miller, soils in the very wettest landscape positions in the region are black (2/1 or N 2/), but even these may not exhibit redox features. Some of the soils we examined contained ferromanganese concretions but, for the most part, these had hard, smooth boundaries and lacked the diffuse corona that would indicate a contemporary feature. Short of long-term monitoring studies that may help to identify new hydric soil indicators for these problem soils, perhaps the only way to identify many hydric Vertisols in this region is to demonstrate that the soils in question meet hydric soil criteria for ponding or flooding.

Wetland Hydrology

The interagency group generally agreed that most of the BLH areas in question were not subject to overbank flooding from rivers and streams frequently enough or for long enough duration to meet wetland hydrology criteria due to flooding. Except at lower elevations closer to the coast, these soils also do not appear to be influenced by shallow water tables. The main source of wetland hydrology apparently is ponding in low landscape positions after heavy rains.

Wetland hydrology indicators were present, but not strongly expressed, at most of the sites we visited. Observed indicators included water marks on trees (salt lines, dark staining, or abrupt moss lines), drifted leaf litter and debris, occasional water-stained leaves, one instance of oxidized rhyzospheres, and a plant community that passed the FAC-neutral test. Indicators of ponding that could not be tied clearly to those listed in the 1987 Manual included matted leaves on the soil surface, very sparse cover of ground-layer plants, and low landscape position.

In general, in areas that have not been disturbed recently, vegetation composition and soil morphology are the most reliable indicators of the long-term hydrology of a site. Therefore, most wetland delineations focus on soils and vegetation. Indicators of wetland hydrology generally play a secondary role; they provide evidence that the site still gets wet and that vegetation and soil characteristics are not relics of a previous hydrologic regime. However, evidence of wetland hydrology takes on added importance in areas, such as coastal Texas, where either soils or vegetation are problematic.

In coastal Texas, for reasons given previously, identification of areas that pond water for long periods during the growing season may be the key to wetland identification and delineation. Unfortunately, presence of wetland hydrology indicators listed in the 1987 Manual (e.g., water

marks, debris lines, sediment deposits) provide very little evidence that wetland hydrology cri for timing, frequency, and duration of inundation are met. The Corps has always accepted *documented* direct evidence of inundation (e.g., gage data; aerial photographs showing repeated long-duration ponding or flooding; systematically recorded observations by reliable observers) as strong evidence for wetland hydrology. However, anecdotal observations and undocumented impressions could not be defended in court and are unacceptable evidence of wetland hydrology. NRCS has also used satellite data to identify areas meeting the required inundation criteria for farmed wetlands. Such data are acceptable if they lead to the strong likelihood that the site is inundated or saturated continuously for at least 5% of the growing season in most years (50% probability of recurrence). The growing season is usually approximated as the period between the average date of last occurrence of 28° F air temperatures in spring and the average first occurrence of 28° F temperatures in fall, based on local weather station data.

Recommendations

There are no easy solutions to the problem of wetland identification in the Texas coastal region. Some technical steps that can be taken include the following:

- Attempt to identify more reliable indicators of hydric soils by initiating long-term studies of soil hydrology and morphology within important problem soil units, such as Pledger. Studies should use methods similar to those developed in Texas and Louisiana during the 1980's for studies of aquic moisture regimes in relation to soil taxonomy. Similar studies are in progress in many parts of the United States under the general direction of Dr. Warren Lynn, NRCS Soil Survey Center, Lincoln, NE. Studies should focus on soil catenas or gradients to provide information useful in delineating hydric soil boundaries. At a minimum, monitoring should involve both surface water and shallow groundwater; additional useful data might include ferrous iron tests, redox potentials, and tensiometer data.

- Identify reliable indicators of frequent, long-duration ponding by monitoring depth and extent of surface water at selected sites, and correlating with observed environmental features, such as various types of water marks, leaf litter color or distribution, or soil surface characteristics.

- Develop methods for direct identification and mapping of areas subject to long-duration ponding, such as use of aerial photography or satellite multispectral data.

James S. Wakeley, Ph.D.
Wetlands Branch

Participant List

Interagency Forum on Delineation of Wetlands
in Bottomland Hardwood Forests in Brazoria County, TX
14-16 May 1996

Army Corps of Engineers

Fred Anthamatten (CESWG-CO-RC)
Casey Cutler (CESWG-CO-RC)
Kenny Jaynes (CESWG-CO-RC)
Jim Wakeley (CEWES-ER-W)
Paula Rankin Wise (CESWG-CO-RC)

Environmental Protection Agency

Bill Kirchner
Richard Prather
Norm Sears

Fish and Wildlife Service

Steve Arey
Phil Glass
Mike Lange
Fred Werner

National Biological Service

Ronnie Best
Carroll Cordes

Natural Resources Conservation Service

Glen Chervenka
Larry Goertz
Wes Miller

Texas Parks and Wildlife Department

Brent Ortego

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: DANCE BAYOU Plot 1 Applicant/Owner: Investigator:	Date: 5-15-96 County: BRAZORIA State: TX
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes No (If needed, explain on reverse.) (VERTISOL)	Community ID: Transect ID: Plot ID: 1

MOSTLY BARE AREA, DENSE SABAL MINOR.

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. FRAXINUS PENNSYLVANICA	T	FACW-	9.		
2. TOXICODENDRON RADICANS	V	FAC	10.		
3. TOXICODENDRON RADICANS	H	FAC	11.		
4. SABAL MINOR	H	FACW	12.		
5. ILEX DECIDUA	S	FACW-	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 5/5 = 100%

Remarks: SOME CELTIS LAEVIGATA, ULMUS AMERICANA, CAREX CHEROKEENSIS, AMPELOPSIS ARBOREA, ILEX VOMITORIA, VITIS SP., CARYA ILLINOISENSIS MODERATE BUTTRESSING ON SOME TREES.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: NONE (in.)

Depth to Free Water in Pit: NONE (in.)

Depth to Saturated Soil: NONE (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ✓ Water Marks
- ✓ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: MOSS LINES START ~ 4-6" FROM SOIL SURFACE (IN LOW AREAS). DARKENED BASES ON TREES. EXTENSIVE BARE SOIL. MATTED LEAVES. DEPRESSION.

DANCE BAYOU – PLOT 1

SOILS

Map Unit Name (Series and Phase): PLEDGER MAP UNIT

Drainage Class:

Field Observations Confirm Mapped Type? Yes No

Taxonomy (Subgroup):

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10YR3/1	2.5Y5/4 2.5Y5/4	2-5% $CaCO_3$ CONC. HARD PITTED. <1% Fe/Mn CONC. (2-3 mm) <2% Fe MASSES	C
4-18		10YR3/1		2% $CaCO_3$ CONC. 1 Fe/Mn CONC. w/ DISTINCT BDY. NONCALCAREOUS.	C

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime w/ REDOX CONC.
- ___ Reducing Conditions
- ✓ Gleyed or Low-Chroma Colors
- ✓ Concretions (RARE)
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks: pH 7.5 (SOME INHIBITION ON FORMATION OF REDOX FEATURES.) SOILS NOT DEFINITIVE. MEETS 1987 MANUAL, NOT NRCS INDICATORS.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? (Yes) No (Circle)

Wetland Hydrology Present? (Yes) No

Hydric Soils Present? (Yes) No (MARGINAL)

(Circle)

Is this Sampling Point Within a Wetland? (Yes) No

Remarks:

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: DANCE BAYOU Plot 2 Applicant/Owner: Investigator:	Date: 5-15-96 County: BRAZORIA State: TX
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes No (If needed, explain on reverse.) (VERTISOL)	Community ID: Transect ID: Plot ID: 2

DRAINAGE SWALE BELOW (SOUTHWEST) OF ROAD BERM. DENSE SABAL. NOT AS MUCH BARE GROUND AS PLOT 1.

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. CELTIS LAEVIGATA	T	FAC	9.		
2. CARYA AQUATICA	T	OBL	10.		
3. CELTIS LAEVIGATA	S	FAC	11.		
4. ILEX DECIDUA	S	FACW-	12.		
5. SABAL MINOR	H	FACW	13.		
6. TOXICODENDRON RADICANS	H	FAC	14.		
7. UNKNOWN FORB	H	—	15.		
8. TOXICODENDRON RAD	V	FAC	16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 7/8 = 87.5 %

Remarks: SOME BOEHMERIA CYLINDRICA, AMPELOPSIS ARBOREA, CAREX CHEROKEENSIS. FAIRLY DENSE GROUND LAYER. APPEARS DRIER THAN PLOT 1.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: NONE (in.)

Depth to Free Water in Pit: NONE (in.)

Depth to Saturated Soil: NONE (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ✓ Drift Lines (AROUND TREES)
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands (IN BROAD SWALE)

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: DARKENED TREE BASES. IN SWALE. MAY BE DRIER THAN HISTORICALLY DUE TO INTERCEPTION BY ROAD BERM. INDICATORS NOT OBVIOUS.

DANCE BAYOU – PLOT 2

SOILS

Map Unit Name (Series and Phase): PLEDGER MAP UNIT

Drainage Class: _____

Field Observations Confirm Mapped Type? Yes No

Taxonomy (Subgroup): _____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10YR2/1		2% $CaCO_3$ conc. 3-5 mm.	C
3-12		10YR2/1	BLACK 10YR3/3+3/4	1% Fe/Mn MASSES 1% Fe MASSES	1-2 mm 1-2 mm C
12-18		10YR3/1		5% $CaCO_3$ conc.	5-10 mm C

Hydric Soil Indicators: (MARGINALLY MEETS NRCS F6.)

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime w/ REDOX CONC.
- ___ Reducing Conditions
- ✓ Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks: ABUNDANCE OF REDOX CONCENTRATIONS VARIES CONSIDERABLY OVER SHORT DISTANCES. GENERALLY MORE IN LOWER POSITIONS (5-10%). (pH = 7.5.)

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes No (Circle)	(Circle)
Wetland Hydrology Present?	Yes No (MARGINAL)	
Hydric Soils Present?	Yes No (MARGINAL)	Is this Sampling Point Within a Wetland? Yes No

Remarks: Hydric soil & Wetland hydrology indicators marginally met.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: DAUCE BAYOU ("WILLOW SWAMP") Plot 3 Applicant/Owner: Investigator:	Date: 5-15-96 County: BRAZORIA State: TX
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes No (If needed, explain on reverse.) (VERTISOL)	Community ID: Transect ID: Plot ID: 3

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. CARYA AQUATICA	T	OBL	9.		
2. ULMUS AMERICANA	T	FAC	10.		
3. FRAXINUS PENNSYLVANICA	S	FACW-	11.		
4. CRATEGUS VIRIDUS	S	FAC	12.		
5. SABAL MINOR	H	FACW	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 5/5 = 100 %

Remarks: SOME TOXICODENDRON RADICANS, GALIUM SP.,

HYDROLOGY

___ Recorded Data (Describe in Remarks): ___ Stream, Lake, or Tide Gauge ___ Aerial Photographs ___ Other ✓ No Recorded Data Available Field Observations: Depth of Surface Water: NONE (in.) Depth to Free Water in Pit: NONE (in.) Depth to Saturated Soil: NONE (in.)	Wetland Hydrology Indicators: Primary Indicators: ___ Inundated ___ Saturated in Upper 12 Inches ✓ Water Marks (DARK BASES, NOT WELL DEFINED) ___ Drift Lines ___ Sediment Deposits ___ Drainage Patterns in Wetlands Secondary Indicators (2 or more required): ✓ Oxidized Root Channels in Upper 12 Inches ✓ Water-Stained Leaves ___ Local Soil Survey Data ✓ FAC-Neutral Test ___ Other (Explain in Remarks)

Remarks: DARKENED TREE BASES. LOW PART OF LANDSCAPE.

DANCE BAYOU – PLOT 3

SOILS

Map Unit Name (Series and Phase): _____ Drainage Class: _____

Field Observations Confirm Mapped Type? Yes No

Taxonomy (Subgroup): _____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.	pH
0–2		10YR 3/1	7.5 YR 4/4 10 YR 4/4	2% PORE LININGS 2% Fe MASSES NOT CALCAREOUS.	C	6.7
2–10		60% 10YR4/1 40% 10YR3/3 3/4 4/3	N 5/	2% $CaCO_3$ CONC. 5-10 mm MASSES 3-10 mm DIAMETER. 1% DEPLETIONS ALONG ROOT CHANNELS. NOT CALCAREOUS.	C	7.5
10–15		10 YR 4/2	N 5/	5% $CaCO_3$ CONC. 5-10 mm 1% DEPLETIONS ALONG ROOT CHANNELS. (WEAKLY CALCAREOUS)	C	8.0

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ✓ Gleyed or Low-Chroma Colors w/ REDOX CONC.
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

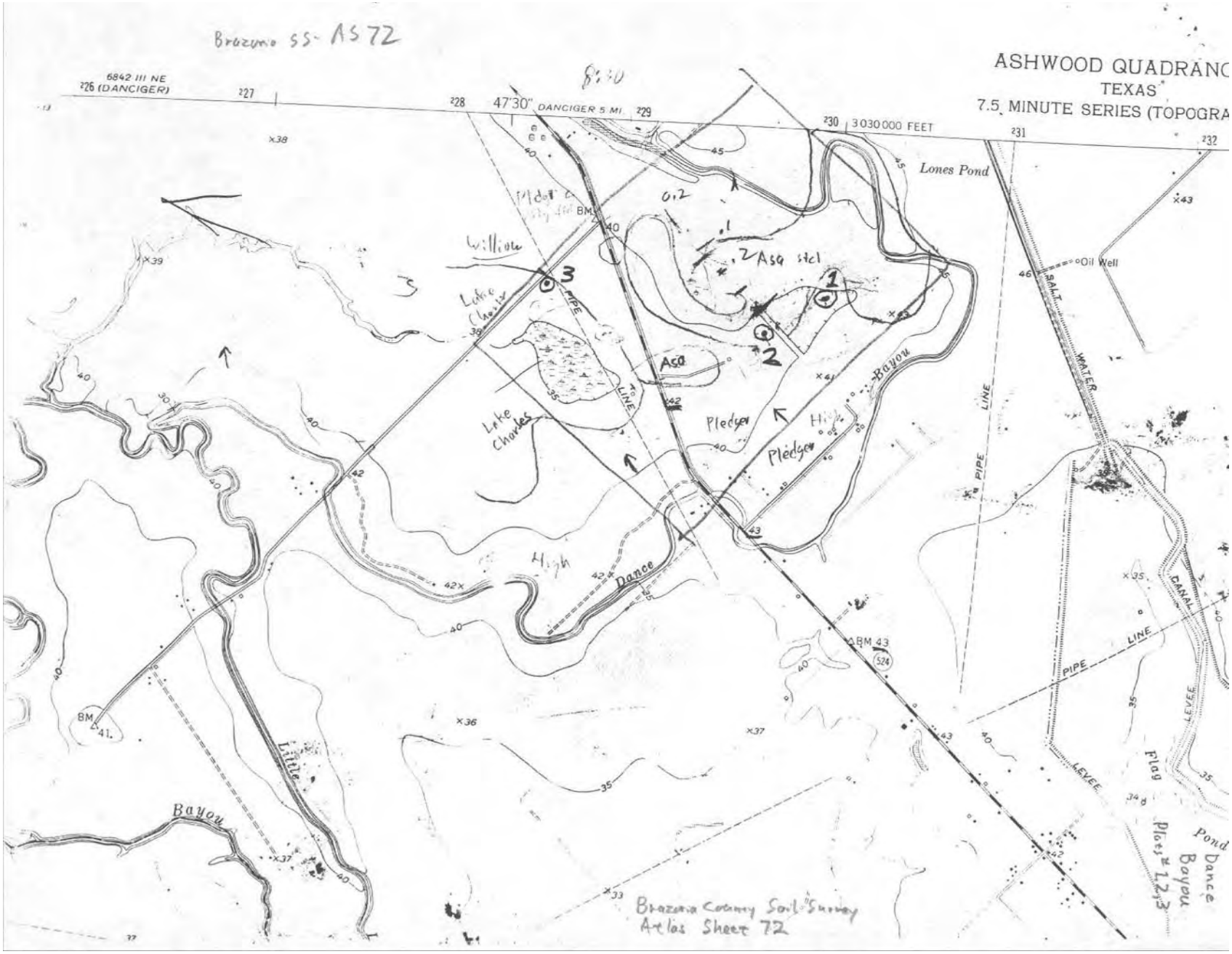
Remarks: NON-CALCAREOUS (EXCEPT CONCRETIONS) AT SURFACE. GLEYED COLORS (N 4/) IN NEARBY HOLES IN DEPRESSIONS.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes (circled) No	(Circle)
Wetland Hydrology Present?	Yes (circled) No	
Hydric Soils Present?	Yes (circled) No	
Is this Sampling Point Within a Wetland?	Yes (circled) No	

Remarks:

Approved by HQUSACE 2/92


Brazoria SS- AS72
ASHWOOD QUADRANC
TEXAS
7.5 MINUTE SERIES (TOPOGRA
6842 III NE
226 (DANCIGER)
227
228
47'30"
DANCIGER 5 MI.
229
230
3030000 FEET
231
232
Lones Pond
Oil Well
Willow
Lake Chester
Lake Charles
Asa
Asa stcl
Pledger
High
Dance
Bayou
Little
Bayou
PIPE LINE
WATER
CANAL
LEVEE
Flag
Pond
Dance Bayou
Plots # 1,2,3
BM 41
BM 43
Brazoria County Soil Survey
Atlas Sheet 72

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: PEACH POINT Plot 1 Applicant/Owner: Investigator:	Date: 5-14-96 County: BRAZORIA State: TX
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes No (If needed, explain on reverse.) (THICK DARK SOIL SURFACE)	Community ID: Transect ID: Plot ID: 1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. CELTIS LAEVIGATA	T	FAC	9.		
2. ULMUS AMERICANA	T	FAC	10.		
3. CARYA ILLINOISENSIS	S	FAC+	11.		
4. SAPIUM SEBIFERUM	S	FACU+	12.		
5. TOXICODENDRON RADIC.	V	FAC	13.		
6. CAREX CRUS-CORVI	H	OBL	14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 5/6 = 83 %

Remarks: BUTTRESSED BASES, FLUTED ROOTS ON TREES, SPARSE MIDSTORY.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: NONE (in.)

Depth to Free Water in Pit: NONE TO 18" (in.)

Depth to Saturated Soil: NONE (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ✓ Water Marks (SALT LINES AT 3")
- ✓ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ✓ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: AREA OBVIOUSLY PONDS WATER. SPARSE GROUND COVER. MATTED, DARKENED LEAVES.

PEACH POINT – PLOT 1

SOILS

WITHIN PLEDGER RANGE OF CHARACTERISTICS, BUT WETTER POSITION THAN TYPICAL.

Map Unit Name (Series and Phase): SURFSIDE MAPPING UNIT

Drainage Class:

Field Observations Confirm Mapped Type? Yes No

Taxonomy (Subgroup):

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-8		10YR 3/1	10YR 5/6 10YR 5/8 10YR 3/3 10YR 3/4	5% $CaCO_3$ CONC. 2-5 mm SIZE 5% 5-10 mm SOFT MASSES, MOSTLY ON PED INTERIORS, SOME ON PED EXTERIORS.	CLAY
8-18		10YR 2/1	10YR 5/6 10YR 5/8 10YR 3/3 10YR 3/4	2% $CaCO_3$ ACCUMULATIONS 2-5 mm SIZE 2% IRON MASSES 2-5 mm	CLAY

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ✓ Gleyed or Low-Chroma Colors w/ IRON MASSES
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks: CALCAREOUS MATRIX (WEAK REACTION). REDOX CONCENTRATIONS IN DARK SURFACE.

(MEETS NRCS INDICATOR F6)

WETLAND DETERMINATION

Hydrophytic Vegetation Present? (Yes) No (Circle)
Wetland Hydrology Present? (Yes) No
Hydric Soils Present? (Yes) No

(Circle)
Is this Sampling Point Within a Wetland? (Yes) No

Remarks:

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: PEACH POINT Plot 2 Applicant/Owner: Investigator:	Date: 5-14-96 County: BRAZORIA State: TX
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes No (If needed, explain on reverse.) (DARK SOILS)	Community ID: Transect ID: Plot ID: 2

~50' UP GRADIENT FROM PLOT 1. ~6" ELEVATION GAIN.

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. CELTIS LAEVIGATA	T	FAC	9.		
2. SAPIUM SEBIFERUM	S	FACU+	10.		
3. LONICERA JAPONICA	V	FAC	11.		
4. ILEX VOMITORIA	S	FAC-	12.		
5. TOXICODENDRON RADICANS	H	FAC	13.		
6. CAREX CHEROKEENSIS	H	FACW-	14.		
7. AMPELOPSIS ARBOREA	H	FAC	15.		
8. IVA ANNUA	H	FAC	16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 6/8 = 75%

Remarks: NO OBSERVED MORPHOLOGICAL ADAPTATIONS.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: NONE (in.)

Depth to Free Water in Pit: NONE TO 18" (in.)

Depth to Saturated Soil: NONE (in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
___ Saturated in Upper 12 Inches
NONE ___ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
NONE ___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

PEACH POINT — PLOT 2

SOILS (PROBABLE PLEDGER SOIL)

Map Unit Name (Series and Phase): SURFSIDE MAP UNIT

Drainage Class:

Field Observations Confirm Mapped Type? Yes No

Taxonomy (Subgroup):

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10YR 3/2	10YR 5/8	2% $CaCO_3$ HARD PITTED ACCUM. 2-5 mm	CL
3-8		10 YR 3/2 — PED INTERIORS 10 YR 3/1 — PED EXTERIORS		5-10% $CaCO_3$ ACCUMULATIONS	10YR 5/8 C
8-18		10YR 2/1	5% 10YR4/3 PED INTERIORS	<2% $CaCO_3$ ACCUM.	ONE IRON CONCRETION WITH SHARP BOUNDARY. C

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ___ Gleyed or Low-Chroma Colors

NONE

- ___ Concretions (LACKED DIFFUSE BOUNDARY)
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

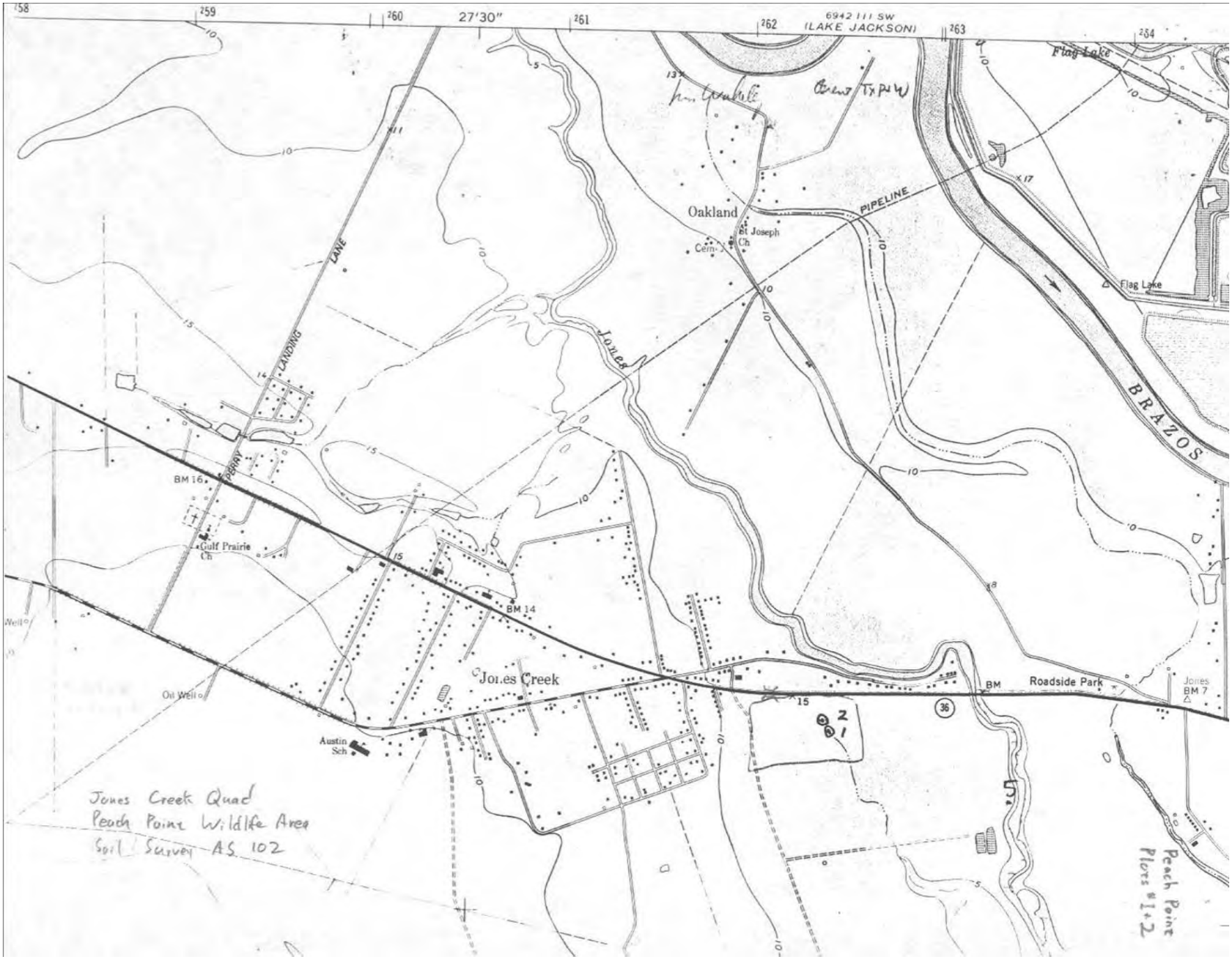
Remarks: NO REDOX FEATURES TO 18."

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes (Circled) No	(Circle)
Wetland Hydrology Present?	Yes (No)	
Hydric Soils Present?	Yes (No)	Is this Sampling Point Within a Wetland? Yes (No)

Remarks:

Approved by HQUSACE 2/92


27'30"
6942 III SW
(LAKE JACKSON)
Flag Lake
Oakland
St Joseph Ch
Cem
PIPELINE
Flag Lake
BRAZOS
Jones
LANDING
LANE
BM 16
Gulf Prairie Ch
BM 14
Jones Creek
Oil Well
Austin Sch
BM
Roadside Park
Jones BM 7
36
Jones Creek Quad
Peach Point Wildlife Area
Soil Survey AS 102
Peach Point Plots #1+2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

OCT 17 1997

Wes Miller
Natural Resources Conservation Service
312 South Main
Federal Bldg, RM 310
Victoria, Texas 77901-8122

Dear Mr. Miller:

Please find enclosed your copy of the final, signed Memorandum of Agreement- Soil Characterization and Hydrological Monitoring Project - Brazoria County Bottomland Hardwoods (MOA). The field work for the study is well under way. We appreciate your patience and cooperation in this endeavor.

Sincerely,

Becky Weber

Becky Weber
Chief
Marine & Wetlands Section

Enclosure

Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Recycled Paper (40% Postconsumer)

MEMORANDUM OF AGREEMENT

SOIL CHARACTERIZATION AND
HYDROLOGICAL MONITORING PROJECT
BRAZORIA COUNTY
BOTTOMLAND HARDWOODS

BACKGROUND

The United States Department of the Army (Army) and the United States Environmental Protection Agency (EPA) established the policy and procedures pursuant to which they will determine the geographic jurisdictional scope of waters of the United States for the purpose of Section 404 of the Clean Water Act (CWA). On January 19, 1989, the Army and EPA signed a Memorandum of Agreement (MOA) which sets forth an appropriate allocation of responsibilities for the effective administration of the 404 program. In the January 6, 1994 MOA, the Army, the EPA, the U.S. Department of Agriculture and the U.S. Department of Interior jointly agreed to the appropriate allocation of responsibilities on jurisdictional scope of waters of the United States for the purpose of Section 404 of the CWA and the Swampbuster provisions of the Food Security Act. Nothing in this document is intended to diminish, modify, or otherwise affect the statutory or regulatory authorities of any of these agencies.

PURPOSE

The purpose of this document is to establish an agreement between the U.S. Environmental Protection Agency, Region 6 (EPA), the U.S. Army Corps of Engineers, Galveston District (District), The U.S. Fish and Wildlife Service (FWS), the Natural Resource Conservation Service (NRCS), and the Texas Parks and Wildlife Department (TPWD) on procedures to identify and develop reliable field indicators for delineating wetlands in forested bottomlands in the lower Brazos and San Bernard River basins in Brazoria, Fort Bend, Wharton, and Matagorda Counties, Texas.

These field indicators will be based on the soil, hydrology and vegetation parameters as described in the Corps of Engineers Wetlands Delineation Manual (1987 Manual) which is used to determine the geographic extent of the waters of the United States with respect to Section 404 of the Clean Water Act.

PROBLEM

The FWS has requested that EPA make jurisdictional determinations under the "special case" provision of the 1989 MOA between the Army and EPA Concerning the Determination of the Geographic Jurisdiction of the Section 404 Program in bottomland hardwoods of the Lower Brazos and San Bernard River basins. The EPA has not invoked this special case provision. However, in response to the concerns of FWS, an interagency field workshop

was held May 14-16, 1996 in Lake Jackson, Texas, to jointly explore the scope of jurisdiction for these bottomland hardwood systems.

The consensus of that workshop was that soil and landscape features of these bottomlands are complex, and application of current field indicators for identifying wetland hydrology and hydric soils for wetland determinations warrant further study.

These areas represent a difficult area for wetland delineation and the best approach toward a solution would be to implement a long term study to better characterize the soil and to perform hydrological and other monitoring in these forested bottomlands. After compilation and evaluation of the data, a determination will be made as to whether additional field indicators would be developed for use in making wetland determinations in these specific situations.

The soil series of primary concern is Pledger clay. The Pledger clay map unit, as currently mapped, covers large areas of the San Bernard and Brazos river watersheds, and is a Vertisol which developed in red clayey fluvial deposits. Pledger has morphological and chemical features which make identification of hydric soil features very difficult. There are also difficulties in determining the presence of hydrology indicators. Additional data is needed to establish the frequency and duration of ponding and saturation in soils mapped as Pledger clay.

We believe that the additional information gained from the proposed study will further advance scientifically sound wetland delineations.

PROPOSED STUDY

An outline of the study, provided by NRCS, is given below; details are found in the formal project proposal for the study of Pledger soil in Brazoria County which may be extended into Fort Bend, Wharton, and Matagorda Counties.

* Conduct hydrological monitoring study to determine actual frequency and duration of soil saturation and inundation, and presence of reducing conditions.

* Measure soil temperature to establish true growing season of native wetland vegetation.

* Conduct field studies of vegetative communities to correlate vegetation with soil hydrology and morphological features.

* Update soil survey of area and establish new soil series as needed.

It is proposed that 5 sites will be selected for study:

* One site that represents Pledger series concept.

* Three sites across a relatively short distance hydrologic catina; one site would be relatively dry, one site intermediate, and one site at a wet landscape position.

* One site at another intermediate landscape elevation.

Sites will be selected jointly by participating agencies based on landscape position, vegetation, and soils.

The following parameters will be measured:

* Water tables

* Ponding depth and duration

* Soil and air temperature, precipitation.

* Soil reduction

* Soil characterization (redoximorphic features, etc.)

* Vegetation (correlate with soil and hydrology)

Initial estimates of cost are $5,000 per site, assuming complete automation. If sufficient funding is not available, the project will be scaled back by reducing number of sites or using less sophisticated equipment.

AGENCY ROLES

The proposed study will require specialized equipment such as piezometers, platinum electrodes, and automated data recorders. The cost of the project is estimated to exceed $35,000, which is more than any single agency can contribute. There is also a need for a commitment of manpower to install and monitor the equipment and perform other field work.

It is agreed that the participating agencies will, according to their abilities, contribute financial, technical, and human resources, as resources allow, to ensure a successful project.

* EPA will provide administrative leadership as well as technical and financial assistance for the study. EPA has provided $10,000 towards project costs, and will provide an additional $15,000 if needed. EPA will also develop any supplementary guidance that may be needed for delineations in bottomland hardwood.

* The NRCS will provide technical leadership in obtaining and installing monitoring equipment, as well as financial support for the project. As funds become available, the NRCS will contribute $5,000 for purchase of initial equipment, and will maintain the equipment during the study.

* The FWS and TPWD will assist in selection of field sites, vegetation analysis of sites, and provide other field and technical work as needed. The FWS has provided $8,000 as their financial contribution. TPWD will provide as much financial assistance as possible if funds become available.

* The Corps of Engineers, Galveston District has offered to provide field and technical assistance as needed and as resources allow. They are also seeking technical assistance in an amount up to $10,000 from the Corps of Engineers, Waterways Experiment Station, Vicksburg.

INTERIM ACTIVITIES

It is anticipated that the monitoring study would continue for at least three years. After the initial 3 years, the monitoring study will be reevaluated. Additionally, since considerable time will pass before definitive results are available, there may be several occasions when jurisdictional determinations (JD's) are needed in these or similar areas. Pursuant to the 1989 MOA it is the District's responsibility to conduct these JD's. The District may consult or coordinate the results of these JD's with the participating agencies as needed (e.g., NRCS on agricultural land). In all cases, the District will retain authority to make the final jurisdictional determination.

GENERAL

This monitoring study will be conducted in a scientifically rigorous manner such that the results will be publishable in refereed professional journal. We believe the results of this study would help others with similar delineation problems which may exist in other parts of the country. We believe that seeking a solution to these problems is to each agency's mutual interest as we seek to improve management and regulation of our wetland resources through better decision-making.

This agreement may be amended at the request of any signatory if approved by all the other signatories.

SIGNATURES for the SOIL CHARACTERIZATION AND HYDROLOGICAL MONITORING PROJECT BRAZORIA COUNTY BOTTOMLAND HARDWOODS MEMORANDUM OF AGREEMENT

W B Hathaway — 4/8/97

William B. Hathaway, Director,
Water Quality Protection Division
Environmental Protection Agency, Region 6, Dallas

Eric R. Potts — 05 SEP 1997

Colonel Eric R. Potts, District Engineer,
U.S. Army Corps of Engineers,
Galveston District, Galveston

Frank B. Hefferman — 4/30/97

for Conrad Fjetland, Geographic Manager-Texas
U.S. Fish and Wildlife Service,
Region 2, Albuquerque, N.M.
FWS Agreement No. 1448-20181-97-K960

John R Burt — APR 16 1997

John Burt, State Conservationist
U.S. Natural Resources Conservation Service,
Temple, TX

5/28/97

Larry McKinney, Director,
Resource Protection Division,
Texas Parks and Wildlife Department, Austin, TX

APPENDIX B. SOIL CHARACTERIZATION STUDY, SOIL MORPHOLOGY DESCRIPTIONS

This appendix contains soil morphology descriptions for each pedon of the August, 1998 NRCS-NSSL soil characterization study.

Sampled as Pledger microlow. 039-001. Pedon taken from a microlow in area near monitoring Site 1 nonponded. Distinct gilgai with isolated microlows 1 to 2 meters in diameter surrounded by interconnected microhighs.

Classification: Very-fine, smectitic, hyperthermic Typic Hapluderts

A--0 to 14 centimeters; black (2.5Y 2.5/1) clay; moderate fine and medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; many fine, common medium and coarse roots; common fine tubular pores; 1 percent fine nodules of calcium carbonate; neutral; clear smooth boundary.

Bw--14 to 36 centimeters; black (2.5Y 2.5/1) clay; moderate medium prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm,, very sticky and very plastic; common fine and medium and few coarse roots; few fine tubular pores; common distinct pressure faces; 1 percent fine nodules of calcium carbonate; neutral; gradual smooth boundary.

Bss1--36 to 57 centimeters; black (2.5Y 2.5/1) clay; moderate medium and coarse prismatic structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium and coarse roots; few fine tubular pores; common distinct pressure faces; common distinct slickensides; neutral; gradual wavy boundary.

Bss2--57 to 81 centimeters; very dark gray (N 3/) clay; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium roots; few fine tubular pores; few crayfish krotovinas filled with reddish brown (5YR 5/4) clay; many distinct pressure faces; many distinct slickensides; neutral; gradual wavy boundary.

Bss3--81 to 117 centimeters; very dark gray (N 3/) clay; moderate medium and coarse angular blocky structure; extremely hard, extremely firm; very sticky and very plastic; few fine roots in krotovinas; few fine tubular pores; few crayfish krotovinas filled with reddish brown (5YR 5/4) and black (10YR 2/1) clay; many distinct pressure faces; many distinct slickensides; 1 percent fine masses of calcium carbonate with hard-pitted centers; slightly effervescent; slightly alkaline; clear wavy boundary.

Bkss1--117 to 132 centimeters; brown (7.5YR 4/2) silty clay; weak medium and coarse angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few distinct reddish brown (5YR 5/4) masses of clay; common distinct brown (7.5YR 5/3) slickensides; few cracks 1 to 5 centimeters wide filled with very dark gray (N 3/) clay; 10 percent nodules of calcium carbonate 5 to 20 millimeters in diameter; violently effervescent; moderately alkaline; gradual wavy boundary.

Bkss2--132 to 148 centimeters; reddish brown (5YR 4/3) silty clay; weak medium and coarse prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct slickensides; few cracks 1 to 4 millimeters wide filled with very dark gray (N 3/) clay; 4 percent nodules of calcium carbonate 5 to 20 millimeters in diameter; strongly effervescent; moderately alkaline; clear wavy boundary.

Sampled as Pledger microlow. 039-001. Pedon taken from a microlow in area near monitoring Site 1 nonponded (continued).

B'ss1--148 to 163 centimeters; reddish brown (5YR 4/3) silty clay; weak coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few reddish brown (5YR 5/4) masses of clay 1 to 2 millimeters in diameter; common distinct reddish brown (5YR 5/3) slickensides; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions on slickensides and in interiors of peds; 1 percent medium and coarse iron-manganese masses; strongly effervescent; moderately alkaline; gradual wavy boundary.

B'ss2--163 to 173 centimeters; reddish brown (5YR 4/3) silty clay; moderate medium prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct reddish brown (5YR 5/3) slickensides; 2 percent fine threads of calcium carbonate; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries in interiors of peds; moderately alkaline; clear wavy boundary.

2B'ss3—173 to 181 centimeters; reddish yellow (7.5YR 6/6) silty clay; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical surfaces of peds; 1 percent fine threads of calcium carbonate; common distinct reddish brown (5YR 5/3) slickensides; 1 percent fine distinct light brownish gray (10YR 6/2) iron depletions with sharp boundaries in interiors of peds; strongly effervescent; moderately alkaline; abrupt smooth boundary.

2BC1--181 to 187 centimeters; light brown (7.5YR 6/4) silty clay loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC2--187 to 196 centimeters; reddish brown (5YR 4/3) clay; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; common distinct pressure faces; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on pressure faces; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC3--196 to 200 centimeters; light brown (7.5YR 6/4) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC4--200 to 211 centimeters; reddish brown (5YR 4/3) clay; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; common distinct pressure faces; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on pressure faces; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC5--211 to 213 centimeters; light brown (7.5YR 6/4) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

Sampled as Pledger microlow. 039-001. Pedon taken from a microlow in area near monitoring Site 1 nonponded (continued).

2BC6--213 to 218 centimeters; reddish brown (5YR 4/3) clay; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; common distinct pressure faces; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on pressure faces; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC7--218 to 222 centimeters; light brown (7.5YR 6/4) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

2C1--280 to 318 centimeters; strong brown (7.5YR 5/6) fine sandy loam; massive; soft, very friable; common fine mica flakes; violently effervescent; moderately alkaline.

2C2--318 to 333 centimeters; reddish yellow (7.5YR 6/6) clay loam; massive; firm, friable; few thin strata of reddish brown (5YR 5/4) clay and reddish yellow (7.5YR 6/6) fine sandy loam, which were mixed together to get the reddish yellow clay loam matrix; common fine mica flakes; violently effervescent; moderately alkaline.

2C3--333 to 358 centimeters; strong brown (7.5YR 5/6) loam; massive; soft, friable; common fine mica flakes; violently effervescent; moderately alkaline.

2C4--358 to 376 centimeters; brown (7.5YR 5/4) fine sandy loam; massive; soft, very friable; common fine mica flakes; violently effervescent; moderately alkaline.

Sampled as Pledger microhigh. 039-001A. Pedon taken from a microhigh in area near monitoring Site 1 nonponded. Distinct gilgai with isolated microlows 1 to 2 meters in diameter surrounded by interconnected microhighs.

Classification: Very-fine, smectitic, hyperthermic Chromic Hapluderts

A--0 to 10 centimeters; black (10YR 2/1) clay; weak fine and medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic: many fine and medium and common coarse roots; few fine interstitial pores; few faint pressure faces; 1 percent nodules of calcium carbonate 2 to 5 millimeters in diameter; slightly effervescent; slightly alkaline; clear smooth boundary.

Bw1--10 to 20 centimeters; very dark gray (10YR 3/1) clay; moderate medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium roots; few fine tubular pores; few wormcasts; common distinct pressure faces; 2 percent nodules of calcium carbonate 2 to 5 millimeters in diameter; strongly effervescent; slightly alkaline; clear smooth boundary.

Bw2--20 to 46 centimeters; 70 percent dark grayish brown (10YR 4/2) and 30 percent dark gray (10YR 4/1) clay; moderate medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; few distinct slickensides; common distinct pressure faces; 3 percent nodules of calcium carbonate 2 to 5 millimeters in diameter; strongly effervescent; slightly alkaline; clear wavy boundary.

Bkss1--46 to 78 centimeters; brown (7.5YR 4/3) clay; moderate medium prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few distinct brown (7.5YR 5/4) masses of clay 1 to 3 millimeters in diameter; few cracks 1 to 3 millimeters wide filled with black (10YR 2/1) clay and few cracks 1 to 5 millimeters wide filled with very dark gray (N 3/) clay; many distinct slickensides; 15 percent nodules of calcium carbonate 1 to 5 millimeters in diameter; strongly effervescent; slightly alkaline; abrupt wavy boundary.

Bkss2--78 to 106 centimeters; reddish brown (5YR 4/3) silty clay; moderate medium and coarse prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few cracks 2 to 7 millimeters wide filled with black (10YR 2/1) clay; many distinct slickensides; 5 percent nodules of calcium carbonate 2 to 5 millimeters in diameter; 1 percent fine prominent grayish brown (10YR 5/2) iron depletions lining pores and on slickensides; strongly effervescent; moderately alkaline; abrupt wavy boundary.

Bss1--106 to 121 centimeters; brown (7.5YR 5/3) silty clay; weak coarse prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct slickensides; few cracks 1 to 7 millimeters wide filled with very dark gray (N /3) clay; 2 percent nodules of calcium carbonate 2 to 5 millimeters in diameter; 1 percent fine prominent grayish brown (10YR 5/2) iron depletions lining pores and on slickensides; strongly effervescent; slightly alkaline; gradual wavy boundary.

Sampled as Pledger microhigh. 039-001A. Pedon taken from a microhigh in area near monitoring Site 1 nonponded (continued).

Bss2--121 to 142 centimeters; reddish brown (5YR 4/3) silty clay; weak medium and coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct reddish brown slickensides; few cracks 1 to 4 millimeters wide filled with very dark gray (10YR 3/1) clay; 5 percent nodules of calcium carbonate 2 to 5 millimeters in diameter; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss3--142 to 163 centimeters; reddish brown (5YR 4/3) clay; weak coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct reddish brown (5YR 5/3) slickensides; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on slickensides; 1 percent medium and coarse iron-manganese masses with sharp boundaries; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss4--163 to 173 centimeters; reddish brown (5YR 4/3) clay; moderate medium prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine tubular pores; common distinct reddish brown (5YR 5/3) slickensides; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on slickensides; 2 percent fine threads of calcium carbonate; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries in interiors of peds; strongly effervescent; moderately alkaline; clear wavy boundary.

2BC1--173 to 181 centimeters; reddish yellow (7.5YR 6/6) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; 1 percent fine threads of calcium carbonate; 1 percent fine distinct light brownish gray (10YR 6/2) iron depletions with sharp boundaries in interiors of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC2--181 to 187 centimeters; light brown (7.5YR 6/4) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC3--187 to 196 centimeters; reddish brown (5YR 4/3) clay; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; common distinct pressure faces; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on pressure faces; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC4--196 to 200 centimeters; light brown (7.5YR 6/4) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC5--200 to 211 centimeters; reddish brown (5YR 4/3) clay; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; common distinct pressure faces; violently effervescent; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on pressure faces; moderately alkaline; abrupt smooth boundary.

Sampled as Pledger microhigh. 039-001A. Pedon taken from a microhigh in area near monitoring Site 1 nonponded (continued).

2BC6--211 to 213 centimeters; light brown (7.5YR 6/4) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC7--213 to 218 centimeters; reddish brown (5YR 4/3) clay; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; common distinct pressure faces; 1 percent fine prominent light brownish gray (10YR 6/2) iron depletions with sharp boundaries on pressure faces; violently effervescent; moderately alkaline; abrupt smooth boundary.

2BC8--218 to 222 centimeters; light brown (7.5YR 6/4) silt loam; weak medium prismatic structure; hard, firm, sticky and plastic; few fine tubular pores; few distinct reddish brown (5YR 4/3) clay films on vertical faces of peds; violently effervescent; moderately alkaline; abrupt smooth boundary.

Sampled as Churnabog (field name) microlow. 039-002. Pedon taken from microlow in area near monitoring Site 1 ponded. Indistinct gilgai microrelief

Classification: Very-fine, smectitic, hyperthermic Typic Epiaquerts

Ag--0 to 19 centimeters; very dark gray (N 3/) clay; moderate medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; many fine and common medium roots; few fine tubular pores; less than 1 percent fine strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries lining pores in the upper 5 centimeters of the horizon; strongly effervescent to H_2O_2 ; neutral; gradual smooth boundary.

Bg--19 to 27 centimeters; black (N 2.5/) clay; strong medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and medium roots; few fine tubular pores; few prominent reddish brown (2.5YR 4/3) masses of clay 1 to 5 centimeters in diameter; slightly effervescent to H_2O_2; neutral; gradual smooth boundary.

Bssg--27 to 99 centimeters; black (2.5Y 2.5/1) clay; moderate medium and coarse prismatic structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few prominent reddish brown (2.5YR 4/3) masses of clay 1 to 5 centimeters in diameter; many distinct slickensides; slightly alkaline; gradual wavy boundary.

Bkss1--99 to 112 centimeters; brown (7.5YR 4/4) clay; weak medium and coarse prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many distinct slickensides; common nodules of calcium carbonate 1 to 3 millimeters in diameter, with a few nodules having brownish yellow (10YR 6/8) iron-manganese coatings; strongly effervescent; moderately alkaline; clear smooth boundary.

Bkss2--112 to 127 centimeters; reddish brown (5YR 4/3) silty clay; weak medium and coarse prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct slickensides; common nodules of calcium carbonate 1 to 3 millimeters in diameter, with a few nodules having brownish yellow (10YR 6/8) iron-manganese coatings; common fine threads of calcium carbonate; strongly effervescent; moderately alkaline; clear smooth boundary.

2BC1--127 to 138 centimeters; brown (7.5YR 5/4) silty clay loam; moderate medium prismatic structure parting to moderate medium angular blocky; very hard, very firm, sticky and plastic; few fine roots; common fine tubular pores; 3 percent fine distinct light brownish gray (10YR 6/2) iron depletions with sharp boundaries lining pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

2BC2--138 to 170 centimeters; reddish yellow (7.5YR 6/6) silty clay loam; moderate medium prismatic structure; very hard, very firm, sticky and plastic; few fine roots; common fine and few medium tubular pores; common prominent brown (7.5YR 5/3) clay films on vertical surfaces of peds; 5 percent fine distinct light brownish gray (10YR 6/2) iron depletions with clear boundaries lining pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

Sampled as Churnabog (field name) microlow. 039-002. Pedon taken from microlow in area near monitoring Site 1 ponded. Indistinct gilgai microrelief (continued).

2BC3--170 to 195 centimeters; yellowish red (5YR 5/6) loam; moderate medium prismatic structure; hard, firm, sticky and plastic; few fine roots; common fine tubular pores; common prominent brown (7.5YR 5/3) clay films on vertical surfaces of peds; 3 percent fine distinct light brownish gray (10YR 6/2) iron depletions with clear boundaries lining pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

2BC4--195 to 220 centimeters; brown (7.5YR 5/4) loam; weak coarse prismatic structure; soft, very friable, slightly sticky and nonplastic; few fine roots; few fine tubular pores; common distinct reddish brown (5YR 5/3) clay films on vertical faces of peds; 3 percent fine distinct light brownish gray (10YR 6/2) iron depletions with clear boundaries lining pores; strongly effervescent; moderately alkaline.

Sampled as Churnabog (field name) microhigh. 039-002A. Pedon taken from microhigh in area near monitoring Site 1 ponded. Indistinct gilgai microrelief.

Classification: Very-fine, smectitic, hyperthermic Aeric Calciaquert

Ag--0 to 14 centimeters; black (2.5Y 2.5/1) clay; moderate medium subangular blocky structure; extremely hard, extremely firm, very sticky, very plastic; many fine and medium and common coarse roots; common fine interstitial and tubular pores; common faint pressure faces; 1 percent nodules of calcium carbonate 3 to 5 millimeters in size; neutral; clear sharp boundary.

Bg--14 to 44 centimeters; black (2.5Y 2.5/1) clay; moderate medium prismatic structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium roots; few fine tubular pores; few faint slickensides; common distinct pressure faces; 1 percent nodules of calcium carbonate 3 to 5 millimeters in size; neutral; gradual smooth boundary.

Bkss1--44 to 64 centimeters; brown (7.5YR 4/2) clay; moderate medium and coarse wedge structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few reddish brown (5YR 5/4) masses of clay 1 to 2 millimeters in size; few vertical cracks 2 to 10 millimeters wide filled with dark gray (10YR 4/1) clay; common distinct intersecting slickensides tilted at 40 to 60 degrees from the horizontal; common distinct pressure faces; 2 percent nodules of calcium carbonate 3 to 5 millimeters in size; strongly effervescent; slightly alkaline; clear wavy boundary.

Bkss2--64 to 112 centimeters; reddish brown (5YR 5/3) clay; weak medium and coarse wedge structure parting to moderate medium angular blocky; extremely hard; extremely firm; very sticky, very plastic; few fine roots; few fine tubular pores; common prominent slickensides tilted 40 to 60 degrees from the horizontal; common distinct pressure faces; 5 percent nodules of calcium carbonate 3 to 5 millimeters in size; strongly effervescent; slightly alkaline; clear smooth boundary.

Bkss3--112 to 130 centimeters; reddish brown (5YR 4/3) clay; weak medium and coarse wedge structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct slickensides tilted 40 to 50 degrees from the horizontal; 2 percent nodules of calcium carbonate 1 to 3 millimeters in size; common threads of calcium carbonate; strongly effervescent; moderately alkaline; clear smooth boundary.

2Bk--130 to 138 centimeters; brown (7.5YR 5/4); silty clay loam; moderate medium prismatic structure parting to moderate medium angular blocky; very hard, very firm, sticky and plastic; few fine roots; common fine tubular pores; 3 percent fine distinct light brownish gray (10YR 6/2) iron depletions with sharp boundaries on surfaces along root channels and pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

2BC1--138 to 170 centimeters; reddish yellow (7.5YR 6/6) silty clay loam; moderate medium prismatic structure; very hard, very firm, sticky and plastic; few fine roots; common fine and few medium tubular pores; common prominent brown (7.5YR 5/3) clay films on vertical faces of peds; 3 percent fine distinct light brownish gray (10YR 6/2) iron depletions with clear boundaries on surfaces along root channels and pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

Sampled as Churnabog (field name) microhigh. 039-002A. Pedon taken from microhigh in area near monitoring Site 1 ponded (continued).

2BC2--170 to 195 centimeters; yellowish red (5YR 5/6) loam; moderate medium prismatic structure; hard, firm, sticky and plastic; few fine roots; common fine tubular pores; common prominent brown (7.5YR 5/3) clay films on vertical faces of peds; 3 percent fine distinct light brownish gray (10YR 6/2) iron depletions with clear boundaries on surfaces along root channels and pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

2BC3--195 to 220 centimeters; brown (7.5YR 5/4) loam; weak coarse prismatic structure; soft, very friable, slightly sticky and nonplastic; few fine roots; few fine tubular pores; common distinct reddish brown (5YR 5/3) clay films on vertical faces of peds; 3 percent fine distinct light brownish gray (10YR 6/2) iron depletions on surfaces along root channels and pores; strongly effervescent; moderately alkaline.

Sampled as Pledger microlow. 039-003. Pedon taken from microlow in area near monitoring Site 2 nonponded. Distinct gilgai with isolated microlows 1 to 2 meters in diameter surrounded by interconnected microhighs.

Classification: Very-fine, smectitic, hyperthermic, Typic Hapluderts

A1--0 to 20 centimeters; black (10YR 2/1) clay; moderate fine subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium roots; many very fine and few fine pores; less than 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries in interiors of peds; neutral; clear smooth boundary.

A2--20 to 44 centimeters; black (10YR 2/1) clay; moderate fine subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium roots; many very fine and few fine pores; less than 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries in interiors of peds; neutral; clear smooth boundary.

Bss1--44 to 88 centimeters; black (10YR 2/1) clay; moderate fine subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium roots; many very fine and few fine pores; common prominent slickensides; common wedge-shaped peds tilted at 35 to 45 degrees to the horizontal; less than 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries in interiors of peds; neutral; gradual smooth boundary.

Bss2--88 to 133 centimeters; black (10YR 2/1) clay; moderate medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine and medium roots; common very fine and few fine pores; common prominent slickensides; many distinct pressure faces; common wedge-shaped peds tilted at 40 to 45 degrees to the horizontal; less than 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries in interiors of peds and lining pores ; slightly alkaline; gradual wavy boundary.

Bkss1--133 to 171 centimeters; yellowish red (5YR 4/6) clay; moderate medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; common prominent slickensides; many prominent pressure faces; common wedge-shaped peds tilted at 50 to 60 degrees to the horizontal; 2 percent hard, pitted concretions of calcium carbonate 1 to 5 millimeters in diameter; 2 percent fine prominent grayish brown (10YR 5/2) iron depletions on faces of peds and lining pores; less than 1 percent fine and medium distinct strong brown (7.5YR 5/8) masses of oxidized iron with clear boundaries on faces of peds and lining pores; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bkss2--171 to 182 centimeters; yellowish red (5YR 4/6) silty clay; weak medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; common prominent slickensides; few prominent pressure faces; common wedge-shaped peds tilted at 50 to 60 degrees to the horizontal; 2 percent hard, pitted concretions of calcium carbonate 1 to 5 millimeters in diameter; 1 percent fine and medium prominent gray (10YR 6/1) iron depletions with clear boundaries on faces of peds; 1 percent fine and medium weakly cemented iron-manganese nodules; strongly effervescent; slightly alkaline; gradual wavy boundary.

Sampled as Pledger microlow. 039-003. Pedon taken from microlow in area near monitoring Site 2 nonponded (continued).

BCk--182 to 220 centimeters; red (2.5YR 4/6) clay; weak medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; few pressure faces; 1 percent hard, pitted concretions of calcium carbonate 1 to 5 millimeters in diameter; 3 percent fine and medium prominent gray (10YR 6/1) iron depletions on faces of peds and pore linings; 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; 1 percent fine prominent black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; strongly effervescent; slightly alkaline; gradual smooth boundary.

BC1—220 to 265 centimeters; red (2.5YR 4/6) silty clay; massive; extremely hard, extremely firm, very sticky and very plastic; common very fine and few fine pores; few fine threads of calcium carbonate lining pores; few crayfish krotovinas; few fine weakly cemented iron-manganese nodules with diffuse boundaries; 1 percent fine prominent black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 3 percent fine and 1 percent medium prominent brown (7.5YR 5/2) iron depletions with clear boundaries lining pores; strongly effervescent; slightly alkaline; clear smooth boundary.

BC2—265 to 304 centimeters; yellowish red (5YR 4/6) silty clay; massive; extremely hard, extremely firm, very sticky and very plastic; common very fine and few fine pores; 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; 1 percent fine prominent black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 1 percent fine and 1 percent medium brown (7.5YR 5/2) iron depletions with clear boundaries lining pores; strongly effervescent; slightly alkaline; clear smooth boundary.

2BC3—304 to 345 centimeters; brown (7.5YR 5/4) loam; massive; very hard, very firm, very sticky and plastic; common very fine and few fine pores; 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; 1 percent fine prominent black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 3 percent fine and 1 percent medium distinct light brownish gray (10YR 6/2) iron depletions in the matrix and lining pores; few fine mica flakes; strongly effervescent; slightly alkaline; clear smooth boundary.

2BC4—345 to 365 centimeters; brown (7.5YR 5/4) fine sandy loam; massive; slightly hard; friable, nonsticky and nonplastic; common very fine and few fine pores; few fine weakly cemented iron-manganese nodules with diffuse boundaries; 1 percent fine distinct black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 5 percent fine and 1 percent medium distinct light brownish gray (10YR 6/2) iron depletions with clear boundaries in the matrix and lining pores; common fine mica flakes; strongly effervescent; moderately alkaline.

The masses of oxidized iron in the upper 133 cm were only visible in interiors of peds and were less than 1 mm in diameter. The peds were shaved with a knife blade to identify these masses. Due to the sharp boundaries and the occurrence of these features in interiors of peds, these features were considered relict.

Sampled as Pledger microhigh. 039-003A. Pedon taken from microhigh in area near monitoring Site 2 nonponded. Distinct gilgai with isolated microlows 1 to 2 meters in diameter surrounded by interconnected microhighs.

Classification: Fine, smectitic, hyperthermic, Chromic Hapluderts

A--0 to 18 centimeters; very dark gray (10YR 3/1) clay; moderate fine subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and medium roots; many very fine and fine pores; few hard, pitted concretions of calcium carbonate 1 to 3 millimeters in diameter; few crayfish krotovinas; less than 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries lining pores; slightly effervescent; slightly alkaline; clear smooth boundary.

A/Bk--18 to 33 centimeters; 85 percent brown (7.5YR 4/2) and 15 percent yellowish red (5YR 5/6) clay; moderate fine subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine and medium roots; many very fine and fine pores; 3 percent hard, pitted concretions of calcium carbonate 1 to 3 millimeters in diameter; few crayfish krotovinas; less than 1 percent fine distinct strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries lining pores; strongly effervescent; slightly alkaline; clear wavy boundary.

Bk--33 to 55 centimeters; brown (7.5YR 4/4) clay; moderate fine angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine and few medium roots; many very fine and few fine pores; common distinct pressure faces; 3 percent cracks 3 to 10 millimeters wide filled with black (10YR 2/1) clay from the A horizon; 3 percent hard, pitted concretions of calcium carbonate 1 to 4 millimeters in diameter; few crayfish krotovinas; less than 1 percent fine faint strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries lining pores; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bkss1--55 to 102 centimeters; brown (7.5YR 4/4) clay; moderate fine angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine and few medium roots; common very fine and few fine pores; common prominent slickensides; many distinct pressure faces; common cracks 3 to 10 millimeters wide filled with black (10YR 2/1) clay from the A horizon; common wedge-shaped peds tilted at 50 to 60 degrees from the horizontal; 3 percent hard, pitted concretions of calcium carbonate 1 to 4 millimeters in diameter; few crayfish krotovinas; 1 percent fine faint strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries lining pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bkss2--102 to 130 centimeters; brown (7.5YR 4/3) clay; moderate medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; common prominent slickensides; many distinct pressure faces; common cracks 3 to 10 millimeters wide filled with black (10YR 2/1) clay from the A horizon; common wedge-shaped peds tilted at 50 to 60 degrees from the horizontal; 3 percent hard, pitted concretions of calcium carbonate 1 to 4 millimeters in diameter; few crayfish krotovinas; 5 percent masses of red (2.5YR 4/6) clay 1 to 5 millimeters in diameter intruding from the C horizon; 1 percent fine distinct strong brown (7.5YR 5/6) masses of oxidized iron with sharp boundaries on faces of peds; strongly effervescent; moderately alkaline; gradual wavy boundary.

Sampled as Pledger microhigh. 039-003A. Pedon taken from microhigh in area near monitoring Site 2 nonponded (continued).

Bss--130 to 179 centimeters; reddish brown (5YR 4/4) silty clay; weak medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; common prominent slickensides; many distinct pressure faces; common wedge-shaped peds tilted at 45 to 55 degrees from the horizontal; 1 percent hard, pitted concretions of calcium carbonate 1 to 5 millimeters in diameter; few crayfish krotovinas; 5 percent masses of red (2.5YR 4/6) clay 1 to 5 millimeters in diameter intruding from the C horizon; 1 percent fine distinct strong brown (7.5YR 5/6) masses of oxidized iron with diffuse boundaries on surfaces of peds and lining pores; 1 percent fine and less than 1 percent medium gray (10YR 5/1) iron depletions on faces of peds and lining pores; strongly effervescent; slightly alkaline; gradual wavy boundary

BC1--179 to 185 centimeters; red (2.5YR 4/6) clay; weak medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; few distinct pressure faces; 1 percent hard, pitted concretions of calcium carbonate 1 to 5 millimeters in diameter; few crayfish krotovinas; 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with diffuse boundaries on faces of peds and pore linings; 1 percent fine and medium prominent gray (10YR 5/1) iron depletions on surfaces of peds and pore linings; strongly effervescent; slightly alkaline; gradual smooth boundary.

BC2--185 to 198 centimeters; reddish brown (5YR 4/4) silty clay; weak medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; few distinct pressure faces; 1 percent hard-pitted concretions of calcium carbonate 1 to 5 millimeters in diameter; few crayfish krotovinas; less than 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; less than 1 percent fine distinct black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 1 percent fine and medium prominent gray (10YR 6/1) iron depletions on faces of peds and lining pores; strongly effervescent; slightly alkaline; gradual smooth boundary.

BC3--198 to 220 centimeters; red (2.5YR 4/6) silty clay; weak medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; common very fine and few fine pores; few distinct pressure faces; 1 percent hard, pitted concretions of calcium carbonate 1 to 5 millimeters in diameter; few crayfish krotovinas; less than 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; less than 1 percent fine distinct black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 1 percent fine and medium prominent gray (10YR 6/1) iron depletions on faces of peds and lining pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

C1--220 to 265 centimeters; red (2.5YR 4/6) silty clay; massive; extremely hard, extremely firm, very sticky and very plastic; common very fine and few fine pores; few fine threads of calcium carbonate as linings of pores; few crayfish krotovinas; less than 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; 1 percent fine distinct black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 3 percent fine and few medium prominent brown (7.5YR 5/2) iron depletions on faces of peds and lining pores; strongly effervescent; slightly alkaline; clear smooth boundary.

Sampled as Pledger microhigh. 039-003A. Pedon taken from microhigh in area near monitoring Site 2 nonponded (continued).

C2--265 to 304 centimeters; yellowish red (5YR 4/6) silty clay; massive; extremely hard, extremely firm, very sticky and very plastic; common very fine and few fine pores; less than 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; less than 1 percent fine distinct black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 3 percent fine and medium distinct brown (7.5YR 5/2) iron depletions in matrix and lining pores; strongly effervescent; slightly alkaline; clear smooth boundary.

2C3--304 to 345 centimeters; brown (7.5YR 5/4) loam; massive; very hard, very sticky and plastic; common very fine and few fine pores; less than 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; less than 1 percent fine distinct black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 5 percent fine and medium distinct light brownish gray (10YR 6/2) iron depletions in matrix and lining pores; common fine mica flakes; strongly effervescent; slightly alkaline; clear smooth boundary.

2C4--345 to 365 centimeters; brown (7.5YR 5/4) fine sandy loam; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and few fine pores; less than 1 percent fine weakly cemented iron-manganese nodules with diffuse boundaries; 1 percent fine distinct black (10YR 2/1) iron-manganese masses with diffuse boundaries lining pores; 5 percent fine and medium distinct light brownish gray (10YR 6/2) iron depletions in ped interiors and lining pores; common fine mica flakes; strongly effervescent; moderately alkaline;

The masses of oxidized iron were only visible in ped interiors and were less than 1mm in diameter. The ped was shaved with a knife blade to identify these masses. Due to the sharp boundaries and the occurrence of these features in ped interiors, these features were considered relict.

Sampled as Churnabog (field name) microlow. 039-004. Pedon taken from a microlow in edge of ponded area near monitoring Site 3 ponded edge. Distinct gilgai microrelief

Classification: Very-fine, smectitic, hyperthermic Typic Epiaquerts

Ag--0 to 13 centimeters; black (10YR 2/1) clay; moderate medium and coarse subangular blocky structure; extremely hard, very firm, very sticky and very plastic; common fine and medium and few coarse roots; common fine and medium tubular pores; few faint pressure faces; common cracks 10 to 20 millimeters in width; 1 percent fine prominent yellowish red (5YR 5/8) masses of oxidized iron with clear boundaries lining pores; less than 1 percent fine prominent brown (7.5YR 4/4) iron-manganese masses with clear boundaries lining pores; moderately acid; clear wavy boundary.

Bg--13 to 34 centimeters; black (2.5Y N/) clay; moderate medium prismatic structure parting to moderate medium and coarse angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; few wormcasts; few faint slickensides; common distinct pressure faces; common cracks 8 to 20 millimeters in width; less than 1 percent rounded iron-manganese nodules 1 millimeter in diameter; 1 percent fine prominent brown (7.5YR 4/4) masses of oxidized iron with clear boundaries lining pores; moderately acid; gradual wavy boundary.

Bssg1--34 to 61 centimeters; black (2.5Y N/) clay; moderate medium wedge structure parting to moderate medium and coarse angular blocky; extremely hard; extremely firm, very sticky and very plastic; few fine roots; few very fine tubular pores; many prominent slickensides tilted 30 to 60 degrees from the horizontal; common cracks 5 to 15 millimeters in width; neutral; gradual wavy boundary.

Bssg2--61 to 94 centimeters; black (2.5Y N/) clay; moderate medium wedge structure parting to moderate medium and coarse angular blocky; extremely hard; extremely firm, very sticky and very plastic; few fine roots; few very fine tubular pores; many prominent slickensides tilted 45 to 60 degrees from the horizontal; common cracks 5 to 10 millimeters in width; neutral; gradual wavy boundary.

Bss--94 to 126 centimeters; very dark gray (2.5Y 3/1) clay; weak medium and coarse wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few very fine and fine roots; few very fine tubular pores; few masses of yellowish red (5YR 4/6) clay; many prominent intersecting slickensides tilted 20 to 45 degrees from the horizontal; slightly alkaline; clear smooth boundary.

Bkss--126 to 140 centimeters; yellowish red (5YR 4/6) silty clay; weak coarse wedge structure parting to moderate medium and coarse subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few very fine and fine roots on slickensides; few very fine tubular pores; few masses of yellowish red (5YR 5/6) clay; common distinct intersecting slickensides tilted 10 to 20 degrees from the horizontal; few cracks 2 to 4 millimeters wide filled with very dark gray (2.5Y 3/1) clay; 8 percent concretions of calcium carbonate 2 to 6 millimeters in diameter; strongly effervescent; slightly alkaline; abrupt wavy boundary.

Sampled as Churnabog (field name) microlow. 039-004. Pedon taken from a microlow in edge of ponded area near monitoring Site 3 ponded edge. Distinct gilgai microrelief (continued)

2BC1--140 to 146 centimeters; 65 percent yellowish red (5YR 5/6), 20 percent grayish brown (10YR 5/2), and 15 percent yellowish red (5YR 4/6) silty clay loam; weak medium prismatic structure; hard, firm, sticky and plastic; few very fine and fine roots; common fine tubular pores; few masses of calcium carbonate 3 to 5 millimeters in diameter and mostly at contact with the upper horizon; very few fine threads of calcium carbonate; grayish brown (10YR 5/2) matrix color is mostly iron depletions on faces of peds and on surfaces along root channels and pores; violently effervescent; moderately alkaline; clear wavy boundary.

2BC2--146 to 158 centimeters; 75 percent yellowish red (5YR 5/8) and 25 percent gray (10YR 5/1) silty clay loam; weak medium and coarse prismatic structure; hard, firm, sticky and plastic; few very fine and fine roots; common fine tubular pores; few distinct reddish brown (5YR 5/4) clay films on vertical faces of peds; gray (10YR 5/1) matrix color is mostly an iron depletion on faces of peds and on surfaces along root channels and pores; violently effervescent; moderately alkaline; clear wavy boundary.

2BC3--158 to 182 centimeters; yellowish red (5YR 5/8) silty clay loam; moderate medium and coarse prismatic structure parting to moderate medium and coarse angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; common fine tubular pores; 5 percent fine to coarse prominent gray (7.5YR 5/1) iron depletions with diffuse boundaries on vertical faces of peds, and on surfaces along root channels and pores; violently effervescent; moderately alkaline; clear smooth boundary.

2BC4--182 to 194 centimeters; brown (7.5YR 5/4) silty clay loam; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; very few layers of red (2.5YR 5/6) clay up to 5 centimeters thick, with common fine threads of calcium carbonate; 5 percent fine to coarse prominent gray (7.5YR 5/1) iron depletions with diffuse boundaries on vertical faces of peds, and on surfaces along root channels and pores; 1 percent very pale brown (10YR 7/3) very fine sand along root channels and pores; violently effervescent; moderately alkaline; clear wavy boundary.

2BC5—194 to 210 centimeters; brown (7.5YR 5/4) loam; weak coarse prismatic structure parting to moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine decayed roots; common fine tubular pores; violently effervescent; 5 percent fine distinct gray (10YR 5/1) iron depletions on surfaces along root channels and pores; 1 percent very pale brown (10YR 7/3) very fine sand on surfaces along root channels and pores; few fine mica flakes; violently effervescent; moderately alkaline.

Sampled as Churnabog (field name) microhigh. 039-004A Pedon taken from a microhigh in an area near monitoring Site 3 ponded edge. Distinct gilgai microrelief.

Classification: Very-fine, smectitic, hyperthermic Aeric Calciaquerts

Ag--0 to 15 centimeters; very dark gray (2.5Y 3/1) clay; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; many fine, medium, and few coarse roots; common fine and medium tubular pores; 2 percent fine yellowish red (5YR 5/6) masses of clay; 1 percent fine concretions of calcium carbonate; less than 1 percent fine prominent yellowish red (5YR 4/6) masses of oxidized iron with sharp boundaries on faces of peds; moderately acid; clear smooth boundary.

Bg--15 to 30 centimeters; black (2.5Y 2.5/1) clay; moderate medium angular blocky structure; very hard, very firm, very sticky and very plastic; common fine and few medium roots; few fine tubular pores; few faint slickensides; common distinct pressure faces; less than 1 percent rounded iron-manganese nodules 1 millimeter in diameter; neutral; clear smooth boundary.

Bss1--30 to 66 centimeters; dark grayish brown (10YR 4/2) clay; weak medium wedge structure parting to weak coarse angular blocky; very hard, very firm, very sticky and very plastic; common fine and few medium roots; few fine tubular pores; common distinct intersecting slickensides tilted 20 to 40 degrees from the horizontal; 5 percent fine nodules of calcium carbonate; slightly effervescent; slightly alkaline; clear wavy boundary.

Bss2--66 to 84 centimeters; brown (7.5YR 4/3) clay; moderate medium and coarse wedge structure parting to moderate medium and coarse angular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent dark grayish brown (10YR 4/2) slickensides tilted 30 to 60 degrees from the horizontal; very few vertical columns 2 to 5 millimeters wide filled with yellowish brown (5YR 5/6); few vertical cracks 1 to 5 millimeters wide filled with very dark gray (10YR 3/1) clay; 3 percent nodules of calcium carbonate 3 to 7 millimeters in diameter; strongly effervescent; slightly alkaline; clear wavy boundary.

Bkss1--84 to 103 centimeters; reddish brown (5YR 5/4) clay; weak coarse wedge structure parting to moderate coarse angular blocky; very hard, very firm, very sticky and very plastic; few fine roots; many prominent slickensides tilted 20 to 60 degrees from the horizontal; few vertical cracks 1 to 5 millimeters in width filled with black (2.5Y 2.5/1) clay; 5 percent nodules of calcium carbonate 3 to 7 millimeters in diameter; 3 percent fine prominent gray (10YR 5/1) iron depletions on slickensides; strongly effervescent; moderately alkaline; clear smooth boundary.

Bkss2--103 to 135 centimeters; reddish brown (5YR 4/4) silty clay; weak coarse wedge structure parting to moderate medium and coarse subangular blocky; very hard, very firm, very sticky and very plastic; few fine roots; common prominent slickensides tilted 30 to 60 degrees from the horizontal; few rounded iron-manganese masses 1 millimeter in diameter; 5 percent fine masses of calcium carbonate with few having fine nodules of calcium carbonate in the center; 3 percent fine prominent gray (10YR 5/1) iron depletions on slickensides and on surfaces along root channels; strongly effervescent; moderately alkaline; clear smooth boundary.

Sampled as Churnabog (field name) microhigh. 039-004A Pedon taken from a microhigh in an area near monitoring Site 3 ponded edge (continued).

Bkss3--135 to 141 centimeters; 60 percent reddish brown (5YR 4/4) and 40 percent gray (10YR 6/1) clay; weak coarse wedge structure parting to moderate medium and coarse subangular blocky; very hard, very firm, very sticky and very plastic; few fine roots; common prominent slickensides tilted 30 to 60 degrees from the horizontal; few rounded iron-manganese masses 1 millimeter in diameter; 8 percent fine masses of calcium carbonate with few having fine nodules of calcium carbonate in the center; gray (10YR 6/1) matrix color is mostly an iron depletion on faces of peds; 3 percent fine prominent gray (10YR 5/1) iron depletions on slickensides and on surfaces along root channels and pores; strongly effervescent; slightly alkaline; clear smooth boundary.

2BC1--141 to 158 centimeters; strong brown (7.5YR 5/6) loam; weak coarse prismatic structure parting to weak medium and coarse subangular blocky hard, firm, sticky and plastic; few very fine and fine roots; common fine tubular pores; few distinct reddish brown (5YR 5/4) clay films on vertical faces of peds; 2 percent fine prominent gray (10YR 5/1) iron depletions with diffuse boundaries on surfaces along root channels and pores; violently effervescent; moderately alkaline; clear wavy boundary.

2BC2--158 to 195 centimeters; reddish brown (5YR 5/4) clay loam; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; very few strata 1 to 5 centimeters in width of red (2.5YR 5/6) clay, with common fine threads of calcium carbonate; common distinct gray (7.5YR 5/1) clay films on vertical faces of peds and along roots and pores; 1 percent very pale brown (10YR 7/3) very fine sand along pores and root channels; 2 percent fine prominent gray (10YR 5/1) iron depletions with diffuse boundaries on surfaces along root channels and pores; violently effervescent; moderately alkaline; clear wavy boundary.

2BC3--195 to 210 centimeters; brown (7.5YR 5/4) loam; weak coarse prismatic structure parting to moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine decayed roots; common fine tubular pores; 1 percent very pale brown (10YR 7/3) very fine sand along roots and pores; 5 percent fine distinct gray (10YR 5/1) iron depletions with diffuse boundaries on surfaces along root channels and pores; few fine mica flakes; violently effervescent; moderately alkaline.

Sampled as Churnabog (field name) microlow. 039-005. Pedon taken from microlow in ponded area near monitoring Site 3 ponded middle. Indistinct gilgai microrelief.

Classification: Very-fine, smectitic, hyperthermic Aeric Epiaquerts

Ag--0 to 11 centimeters; black (2.5Y 2.5/1) clay; moderate medium subangular structure; extremely hard, extremely firm, very sticky and very plastic; many fine and common fine and medium roots; common fine and medium tubular pores; less than 1 percent fine prominent yellowish red (5YR 5/8) masses of oxidized iron with sharp boundaries on faces of peds; 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with clear boundaries on surfaces along root channels and pores; less than 1 percent fine prominent brownish yellow (10YR 6/8) masses of oxidized iron with diffuse boundaries on surfaces along root channels and pores; strongly acid; clear smooth boundary.

Bg--11 to 38 centimeters; very dark gray (N 3/) clay; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and medium roots; common fine and medium tubular pores; common distinct pressure faces; few distinct slickensides; less than 1 percent fine prominent red (2.5YR 4/6) masses of oxidized iron with sharp boundaries on faces of peds; 1 percent fine prominent yellowish red (5YR 4/6) masses of oxidized iron with clear boundaries on surfaces along root channels and pores; 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with clear boundaries on surfaces along root channels and pores; slightly acid; clear wavy boundary.

Bssg--38 to 64 centimeters; very dark gray (N 3/) clay; moderate medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and medium roots; few fine tubular pores; many prominent slickensides tilted at 30 to 45 degrees from horizontal in the lower 10 centimeters; 2 percent fine and medium prominent dark grayish brown (2.5Y 4/2) iron depletions with diffuse boundaries on slickensides; slightly effervescent to H_2O_2; neutral; clear wavy boundary.

Bss--64 to 105 centimeters; 60 percent brown (7.5YR 5/4) and 40 percent very dark gray (2.5Y 3/1) clay; moderate medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few old roots channels filled with reddish brown (5YR 5/4), black (2.5Y 2.5/1), and very dark gray (N 3/) clay; common prominent slickensides; 2 percent fine and medium hard, pitted calcium carbonate nodules, with few nodules having brownish yellow (10YR 6/8) iron-manganese coatings; strongly effervescent; slightly alkaline; clear wavy.

Bkss--105 to 125 centimeters; reddish brown (5YR 5/4) clay; moderate medium and coarse subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few old roots channels filled with reddish brown (5YR 5/4), black (2.5Y 2.5/1), and very dark gray (N 3/) clay; common distinct slickensides; 8 percent nodules of calcium carbonate 5 to 7 millimeters in diameter; 2 percent fine distinct gray (7.5YR 5/1) iron depletions on slickensides; strongly effervescent; slightly alkaline; clear wavy boundary.

Bss1--125 to 145 centimeters; reddish brown (5YR 5/4) clay; moderate medium and coarse subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent slickensides; 2 percent nodules of calcium carbonate 5 to 7 millimeters in diameter; 4 percent fine distinct gray (7.5YR 5/1) iron depletions with diffuse boundaries on slickensides; strongly effervescent; slightly alkaline.

Sampled as Churnabog (field name) microlow. 039-005. Pedon taken from microlow in ponded area near monitoring Site 3 ponded middle. Indistinct gilgai microrelief (continued).

Bss2--145 to 175 centimeters; reddish brown (5YR 5/4) silty clay; weak medium and coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent slickensides; 1 percent nodules of calcium carbonate 5 to 7 millimeters in diameter; 6 percent fine distinct gray (7.5YR 5/1) iron depletions with diffuse boundaries on slickensides; strongly effervescent; slightly alkaline.

Bss3--175 to 200 centimeters; reddish brown (5YR 5/3) silty clay; weak medium and coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent slickensides; 1 percent nodules of calcium carbonate 5 to 7 millimeters in diameter; 10 percent fine distinct gray (7.5YR 5/1) iron depletions with diffuse boundaries on slickensides; strongly effervescent; slightly alkaline.

Sampled as Churnabog (field name) microhigh. 039-005A. Pedon taken from microhigh in ponded area near monitoring Site 3 ponded middle. Indistinct gilgai microrelief.

Classification: Fine, smectitic, hyperthermic Aeric Calciaquerts

A--0 to 11 centimeters; black (2.5Y 2.5/1) clay; weak medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; many fine and common fine and medium roots; few fine tubular pores; 1 percent fine prominent yellowish brown (10YR 5/8) masses of oxidized iron with diffuse boundaries on faces of peds; less than 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with diffuse boundaries on surfaces along root channels and pores; moderately acid; clear smooth boundary.

Bg--11 to 20 centimeters; black (2.5Y 2.5/1) clay; weak medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine roots; few fine tubular pores; common distinct pressure faces; few distinct slickensides; few masses of yellowish brown (10YR 5/4) clay 1 to 2 centimeters in size; 2 percent fine nodules of calcium carbonate 1 to 2 millimeters in diameter with a yellowish brown (10YR 5/8) iron coating; 1 percent fine prominent yellowish red (5YR 5/6) masses of oxidized iron with clear boundaries on slickensides; neutral; clear smooth boundary.

Bkss1--20 to 50 centimeters; 60 percent dark gray (10YR 3/1) and 40 percent brown (7.5YR 5/4) clay; weak medium wedge structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine roots; few fine tubular pores; common prominent slickensides tilted 40 to 60 degrees from the horizontal; few masses of yellowish brown (10YR 5/4) clay 1 to 2 centimeters in size; 20 percent fine and medium nodules of calcium carbonate 5 to 7 millimeters in diameter; 1 percent fine and medium prominent brown (7.5YR 4/4) masses of oxidized iron with sharp boundaries on surfaces along root channels and pores in dark gray matrix; strongly effervescent; slightly alkaline; clear wavy boundary.

Bkss2--50 to 75 centimeters; brown (10YR 5/3) clay; weak medium wedge structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent dark gray (10YR 4/1) slickensides tilted at 40 to 60 degrees from the horizontal; common cracks 1 to 5 millimeters wide filled with dark gray (10YR 4/1) clay; 15 percent fine and medium nodules of calcium carbonate 5 to 7 millimeters in diameter; 1 percent fine and medium faint brown (7.5YR 4/4) masses of oxidized iron with sharp boundaries on faces of peds; strongly effervescent; slightly alkaline; clear wavy boundary.

Bkss3--75 to 100 centimeters; brown (7.5YR 5/4) silty clay; moderate medium wedge structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; few old root channels filled with dark gray (10YR 4/1) clay; 1 percent fine prominent red (2.5YR 5/6) masses of clay; many prominent slickensides tilted at 40 to 60 degrees from the horizontal; 5 percent fine and medium nodules of calcium carbonate 5 to 7 millimeters in diameter; 10 percent fine distinct gray (10YR 5/1) iron depletions on faces of peds; strongly effervescent; slightly alkaline; clear wavy boundary.

Sample as Churnabog (field name) microhigh. 039-005A. Pedon taken from microhigh in ponded area near monitoring Site 3 ponded middle (continued).

Bss1--100 to 130 centimeters; reddish brown (5YR 5/4) silty clay; moderate medium and coarse wedge structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent slickensides tilted at 20 to 40 degrees from the horizontal; 5 percent fine and medium nodules of calcium carbonate 5 to 10 millimeters in diameter; 15 percent fine prominent gray (10YR 5/1) iron depletions with diffuse boundaries on faces of peds and lining pores; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bss2--130 to 153 centimeters; reddish brown (5YR 5/4) silty clay; moderate medium prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few very fine roots; common prominent slickensides tilted at 20 to 40 degrees from the horizontal; 1 percent fine nodules of iron-manganese; 2 percent fine nodules of calcium carbonate 5 to 10 millimeters in diameter; strongly effervescent; 10 percent fine prominent gray (10YR 5/1) iron depletions with diffuse boundaries on faces of peds and on surfaces along root channels; moderately alkaline; gradual wavy boundary.

Bss3--153 to 200 centimeters; reddish brown (5YR 5/3) silty clay; weak medium and coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent slickensides tilted at 15 to 30 degrees from the horizontal; 1 percent fine nodules of calcium carbonate 5 to 7 millimeters in diameter; 10 percent fine distinct gray (7.5YR 5/1) iron depletions with diffuse boundaries on slickensides; strongly effervescent; moderately alkaline.

Sampled as Churnabog (field name). 039-006. Pedon taken in ponded area near monitoring Site 4 ponded. Indistinct gilgai microrelief. Soil trench about 10 m long. This profile located in a very shallow microlow 1 to 2 m in diameter. Only soil area exposed (1 to 2 m wide) in trench with masses of oxidized iron on faces of peds in upper part

Classification: Fine, smectitic, hyperthermic Typic Epiaquerts

A--0 to 14 centimeters; very dark gray (2.5Y 3/1) clay; moderate fine and medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; many fine and medium and few coarse roots; common fine and medium interstitial and tubular pores; few cracks 1 to 2 centimeters wide; less than 1 percent fine prominent strong brown (7.5YR 5/6) masses of oxidized iron with clear boundaries on faces of peds; less than 1 percent fine prominent brownish yellow (10YR 6/6) masses of oxidized iron with diffuse boundaries lining pores; slightly acid; clear smooth boundary.

Bg--14 to 44 centimeters; very dark gray (10YR 3/1) clay; moderate medium and coarse prismatic structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and medium and few coarse roots; common fine tubular pores; few faint slickensides; common distinct pressure faces; few cracks 1 to 2 centimeters wide; less than 1 percent black (10YR 2/1) iron-manganese nodules 2 to 3 millimeters in diameter with a brownish yellow (10YR 6/8) calcareous rind; iron-manganese nodules react violently to H_2O_2; 1 percent very fine black iron-manganese nodules without rinds; less than 1 percent fine prominent yellowish red (5YR 5/6) iron-manganese masses with clear boundaries that react violently to H_2O_2 on faces of peds; less than 1 percent fine prominent yellowish brown (10YR 5/6) masses of oxidized iron with diffuse boundaries lining pores; slightly alkaline; clear smooth boundary.

Bssg1--44 to 82 centimeters; dark gray (10YR 4/1) clay; moderate medium and coarse prismatic structure parting to weak medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and medium roots; few fine tubular pores; common distinct slickensides; many distinct pressure faces; few cracks 1 to 2 centimeters wide; 1 percent black (10YR 2/1) iron-manganese nodules 2 to 3 millimeters in diameter with a brownish yellow (10YR 6/8) calcareous rind; iron- manganese nodules react violently to H_2O_2; less than 1 percent very fine black iron-manganese nodules without rinds; 1 percent fine distinct light olive brown (2.5Y 5/3) masses of oxidized iron with diffuse boundaries lining pores; moderately alkaline; gradual wavy boundary.

Bssg2--82 to 129 centimeters; dark gray (10YR 4/1) clay; moderate medium and coarse prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; 3 percent crayfish krotovinas; few krotovinas filled with a mixture of calcareous reddish brown (5YR 5/4) and brown (10YR 5/3) clay; 1 percent fine masses and nodules of calcium carbonate; few cracks 1 to 2 centimeters wide; slightly alkaline; gradual wavy boundary.

Bkss--129 to 152 centimeters; 70 percent dark gray (10YR 4/1) and 30 percent brown (10YR 5/3) clay; moderate medium and coarse prismatic structure parting to moderate medium angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine pores; 5 percent crayfish krotovinas filled with a mixture of calcareous reddish brown (5YR 5/4) and brown (10YR 5/3) clay; 1 percent fine masses of calcium carbonate; 8 percent nodules of calcium carbonate 5 to 10 millimeters in diameter; slightly effervescent; slightly alkaline; gradual wavy boundary.

Sampled as Churnabog (field name). 039-006. Pedon taken in ponded area near monitoring Site 4 ponded. Indistinct gilgai microrelief (continued).

2Bk1--152 to 178 centimeters; 45 percent brownish yellow (10YR 6/6) and 30 percent light brownish gray (10YR 6/2) silty clay loam; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; very hard, very firm, sticky and plastic; few fine roots; 5 percent crayfish krotovinas filled with a mixture of calcareous reddish brown (5YR 5/4) and 10YR 5/3 clay; 10 percent fine and medium masses of calcium carbonate with a few having fine nodules in the center; 1 percent fine and medium distinct weak red (7.5YR 5/4) masses of oxidized iron with sharp boundaries on faces of peds; light brownish gray (10YR 6/2) matrix is mostly iron depletions on faces of peds; strongly effervescent; few very fine mica flakes; moderately alkaline; gradual wavy boundary.

2Bk2--178 to 196 centimeters; 35 percent pale brown (10YR 6/3), 35 percent light brownish gray (10YR 6/2), and 30 percent red (7.5YR 5/8) silty clay loam; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; very hard, very firm, sticky and plastic; few fine roots between peds; 3 percent crayfish krotovinas filled with a mixture of calcareous reddish brown (5YR 5/4) and (10YR 5/3) clay ; 10 percent fine and medium masses and nodules of calcium carbonate; common prominent clay films on vertical faces of peds;; light brownish gray (10YR 6/2) matrix is mostly iron depletions on faces of peds; few very fine mica flakes, violently effervescent; moderately alkaline; gradual wavy boundary.

3B'ss--196 to 220 centimeters; reddish brown (5YR 4/3) clay; moderate medium prismatic structure parting to moderate medium angular blocky; extremely hard, extremely firm; very sticky and very plastic; few fine roots; common faint slickensides; common pressure faces; 1 percent fine strong brown (7.5YR 5/8) masses of oxidized iron with sharp boundaries on faces of peds; 3 percent fine prominent gray (10YR 6/1) iron depletions with clear boundaries on pressure faces; 1 percent fine masses of calcium carbonate with hard, pitted centers; violently effervescent; moderately alkaline.

Sampled as Pledger microlow. 39-007. Pedon taken from a microlow near monitoring Site 5 nonponded. Distinct gilgai microrelief with isolated microlows 1 to 2 meters in diameter surrounded by interconnected microhighs.

Classification: Very-fine, smectitic, hyperthermic Typic Hapluderts

A--0 to 23 centimeters; black (10YR 2/1) clay; moderate very coarse granular structure; extremely hard, extremely firm, very sticky and very plastic; many fine and common medium and coarse roots; few fine tubular and interstitial pores; 1 percent fine irregularly shaped nodules of calcium carbonate; slightly effervescent to H_2O_2; slightly effervescent to HCl; slightly alkaline; clear smooth boundary.

Bw--23 to 43 centimeters; black (7.5YR 2.5/1) clay; moderate medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine to coarse roots; few fine vesicular and tubular pores; common distinct pressure faces; few faint slickensides; 1 percent fine irregularly shaped nodules of calcium carbonate; slightly effervescent to H_2O_2; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bss1-- 43 to 65 centimeters; very dark gray (7.5YR 3/1) clay; moderate medium wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct pressure faces; many distinct slickensides; 1 percent fine irregularly shaped nodules of calcium carbonate; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bss2--65 to 88 centimeters; very dark gray (7.5YR 3/1) clay; moderate medium wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many distinct slickensides; 1 percent fine irregularly shaped nodules of calcium carbonate; few snail shell fragments; few cracks 1 to 8 mm wide filled with black (10YR 2/1) clay; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bss3--88 to 119 centimeters; very dark gray (7.5YR 3/1) clay; strong medium and coarse wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent slickensides; 1 percent fine irregularly shaped nodules of calcium carbonate; few snail shell fragments; few cracks 1 to 5 mm wide filled with black (10YR 2/1) clay; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss4--119 to 147 centimeters; very dark gray (7.5YR 3/1) clay; strong medium and coarse wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots on slickensides; few fine tubular pores; many prominent slickensides; 1 percent fine irregularly shaped nodules of calcium carbonate; few snail shell fragments; few masses 3 to 10 mm wide of irregularly shaped reddish brown (5YR 5/4) clay; few cracks 1 to 5 mm wide filled with black (10YR 2/1) clay; strongly effervescent; slightly alkaline; gradual wavy boundary.

Sampled as Pledger microlow. 39-007. Pedon taken from a microlow near monitoring Site 5 nonponded (continued).

Bss5--147 to 163 centimeters; brown (7.5YR 4/4) clay; strong medium and coarse wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; less than 1 percent fine roots on slickensides; less than 1 percent fine tubular pores; many prominent slickensides; 1 percent fine irregularly shaped nodules of calcium carbonate; 1 percent fine masses of calcium carbonate; few snail shell fragments; few masses 3 to 10 mm wide of irregularly shaped reddish brown (5YR 5/4) clay; few cracks 1 to 5 mm wide filled with black (10YR 2/1) and very dark gray (10YR 3/1) clay; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss6--163 to 190 centimeters; reddish brown (5YR 4/4) clay; strong coarse wedge structure parting to strong coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; less than 1 percent fine roots on slickensides; less than 1 percent fine tubular pores; many prominent slickensides; 2 percent fine irregularly shaped nodules of calcium carbonate; 1 percent fine masses of calcium carbonate; few snail shell fragments; few cracks 2 to 10 mm wide filled with black (10YR 2/1) and very dark gray (10YR 3/1) clay; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bkss--190 to 212 centimeters; reddish brown (5YR 5/4) clay; few fine faint yellowish red (5YR 5/6) mottles on surfaces of peds; strong coarse wedge structure parting to strong coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; many prominent slickensides; few fine irregularly shaped nodules of calcium carbonate; common fine masses of calcium carbonate; few snail shell fragments; few cracks 2 to 10 mm wide filled with black (10YR 2/1) and very dark gray (10YR 3/1) clay; strongly effervescent; moderately alkaline; gradual wavy boundary.

Sampled as Pledger microhigh. 37-007A. Pedon taken from a microhigh near monitoring Site 5 nonponded. Distinct gilgai microrelief with isolated microlows 1 to 2 meters in diameter surrounded by interconnected microhighs.

Classification: Fine, smectitic, hyperthermic Chromic Hapluderts

A--0 to 12 centimeters; black (7.5YR 2.5/1) clay; moderate medium and coarse granular structure; extremely hard, extremely firm, very sticky and very plastic; many fine, common medium and coarse roots; common fine tubular pores; 1 percent fine irregularly shaped nodules of calcium carbonate; few snail shell fragments; slightly effervescent; slightly alkaline; clear smooth boundary.

Bw--12 to 28centimeters; dark brown (7.5YR 3/2) clay; moderate medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and medium roots; few fine tubular pores; common faint pressure faces; 1 percent fine irregularly shaped nodules of calcium carbonate; few snail shell fragments; slightly effervescent to H_2O_2; strongly effervescent to HCl; moderately alkaline; clear smooth boundary.

Bk-- 28 to 63 centimeters; brown (7.5YR 4/2) clay; moderate medium subangular blocky structure; extremely hard; extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct pressure faces; few faint slickensides; 5 percent fine irregularly shaped nodules of calcium carbonate; 1 percent fine masses of calcium carbonate; few snail shell fragments; strongly effervescent; moderately alkaline; gradual smooth boundary.

Bkss1--63 to 97 centimeters; dark reddish gray (5YR 4/2) clay; moderate medium wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; common distinct slickensides; 2 percent fine irregularly shaped nodules of calcium carbonate; 3 percent fine masses of calcium carbonate; few snail shell fragments; 1 percent fine distinct yellowish red (5YR 5/6)masses of oxidized iron with sharp boundaries on faces of peds; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bkss2--97 to 123 centimeters; reddish brown (5YR 4/3) clay; moderate medium and coarse wedge structure parting to moderate medium and coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots; few fine tubular pores; many prominent slickensides; 2 percent fine irregularly shaped nodules of calcium carbonate; 3 percent fine masses of calcium carbonate; few snail shell fragments; 1 percent fine distinct yellowish red (5YR 5/6) masses of oxidized iron with sharp boundaries on faces of peds; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss1--123 to 146 centimeters; reddish brown (5YR 4/3) clay; strong coarse wedge structure parting to strong coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine roots on slickensides; few fine tubular pores; many prominent slickensides; few snail shell fragments; less than 1 percent fine distinct gray (5YR 5/1) iron depletions with clear boundaries on slickensides; 1 percent fine distinct yellowish red (5YR 5/6) masses of oxidized iron with sharp boundaries on faces of peds; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bss2--146 to 183 centimeters; reddish brown (5YR 5/3) clay; strong coarse wedge structure parting to strong coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; very few fine roots on slickensides; very few fine tubular pores; many prominent

slickensides; less than 1 percent fine distinct gray (5YR 5/1) iron depletions with clear boundaries on slickensides; strongly effervescent; slightly alkaline; gradual wavy boundary.

Bss3--183 to 212 centimeters; reddish brown (5YR 4/3) clay; strong coarse wedge structure parting to strong coarse angular blocky; extremely hard, extremely firm, very sticky and very plastic; many prominent slickensides; 2 percent fine distinct gray (5YR 5/1) iron depletions with clear boundaries on slickensides; strongly effervescent; slightly alkaline.

APPENDIX C. SOIL CHARACTERIZATION STUDY, SOIL CHEMICAL AND PHYSICAL ANALYSIS

This appendix contains soil chemical and physical analysis of each pedon of the August 1998 NRCS-NSSL soil characterization study.

/UNITED STATES DEPARTMENT OF AGRICULTURE
SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 576, SAMPLES 98P 3412- 3427
- GENERAL METHODS 1B1A, 2A1, 2B

NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) CLAY LT .002	SILT .002 -.05	SAND .05 -2	FINE LT .0002	CO3 LT .002	(- -CLAY- -) FINE .002 -.02	COARSE .02 -.05	(- -SILT- -) VF .05 -.10	F .10 -.25	(- - - - - -SAND- - - - - -) M .25 -.50	C .5 -1	VC 1 -2	(-COARSE FRACTIONS(MM)-) 2 -5	5 -20	20 -75	(>2MM) .1- 75	WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - - PCT OF <2MM						(3A1) - - - - - - - - - - - - - - - ->						<- PCT OF <75MM(3B1)->		
98P3412S	0- 14	A	73.8	24.7	1.5	53.8		22.6	2.1	0.7	0.4	0.2	0.1	0.1	--	--	--	1	--
98P3413S	14- 36	Bw	74.7	24.2	1.1	56.0		22.2	2.0	0.4	0.4	0.2	0.1	TR	--	--	--	1	--
98P3414S	36- 57	Bss1	73.2	25.2	1.6	52.0		23.0	2.2	0.8	0.4	0.2	0.1	0.1	--	--	--	1	--
98P3415S	57- 81	Bss2	74.2	24.6	1.2	52.2		22.3	2.3	0.7	0.4	0.1	TR	TR	--	--	--	TR	--
98P3416S	81-117	Bss3	76.3	22.4	1.3	31.1		21.3	1.1	0.6	0.4	0.2	0.1	TR	--	--	--	1	--
98P3417S	117-132	Bkss	56.6	40.5	2.9	27.4		37.3	3.2	0.3	0.5	0.4	0.4	1.3	3	5	--	10	8
98P3418S	132-148	B'ss1	55.2	43.5	1.3	26.8	4.6	39.6	3.9	0.3	0.3	0.3	0.2	0.2	1	7	--	9	8
98P3419S	148-163	B'ss2	49.6	47.8	2.6	23.8	5.4	41.0	6.8	0.3	0.4	0.4	0.6	0.9	--	--	--	2	--
98P3420S	163-173	B'w	48.6	49.5	1.9	22.4	4.9	42.7	6.8	0.1	0.2	0.3	0.4	0.9	TR	1	--	3	1
98P3421S	173-181	2Bw1	48.8	49.2	2.0	22.7	3.8	39.4	9.8	0.4	0.3	0.4	0.5	0.4	--	TR	--	2	TR
98P3422S	181-222	2Bw2	41.9	55.7	2.4	19.8	2.9	34.8	20.9	1.9	0.2	0.1	0.1	0.1	--	--	--	TR	--
98P3423S	181-222	2Bw2	31.0	64.7	4.3	17.3	2.1	33.3	31.4	3.6	0.4	0.2	0.1	TR	--	TR	--	1	TR

DEPTH (CM)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g	MN 6D2g	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1	PI 4F	(- BULK DENSITY -) FIELD MOIST 4A5	1/3 BAR 4A1d	OVEN DRY 4A1h	COLE WHOLE SOIL 4D1	(- - -WATER CONTENT - -) FIELD MOIST 4B4	1/10 BAR 4B1c	1/3 BAR 4B1c	15 BAR 4B2a	WRD WHOLE SOIL 4C1
				<- PERCENT	OF <2MM -->					PCT <0.4MM		<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->				CM/CM
0- 14		0.345			1.9	0.2	0.1	0.88	0.51			1.34	1.03	1.78	0.200	29.4		51.2	37.8	0.14
14- 36		0.237			2.1	0.2	0.1	0.83	0.58			1.38	1.06	1.79	0.191	28.5		49.6	43.4	0.07
36- 57		0.192			2.0	0.2	0.1	0.84	0.46			1.68	1.03	1.77	0.198	15.9		52.3	33.9	0.19
57- 81		0.166			1.8	0.2	TR	0.86	0.45			1.69	1.02	1.78	0.204	16.2		51.9	33.6	0.19
81-117		0.137			1.8	0.2	TR	0.81	0.45			1.69	1.03	1.79	0.202	16.8		51.8	34.0	0.18
117-132					1.5	0.1	0.1	0.61	0.40			1.81	1.32	1.90	0.123	11.8		32.7	22.5	0.13
132-148					1.5	0.1	TR	0.58	0.40			1.86	1.38	1.92	0.110	11.2		30.3	21.8	0.11
148-163					1.3	0.1	0.1	0.58	0.42			1.83	1.40	1.88	0.103	8.7		28.9	20.6	0.12
163-173					1.2	0.1	TR	0.57	0.42			1.80	1.41	1.86	0.096	8.4		28.5	20.6	0.11
173-181					1.3	0.1	TR	0.61	0.42			1.89	1.36	1.96	0.129	8.7		31.7	20.4	0.15
181-222					1.2	0.1	TR	0.61	0.45			1.82	1.41	1.93	0.110	8.8		29.1	18.7	0.15
181-222					0.9	0.1	TR	0.66	0.49			1.70	1.46	1.70	0.052	5.4		26.5	15.2	0.17

AVERAGES, DEPTH 25-100: PCT CLAY 75 PCT .1-75MM 1

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-001 PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-LOA ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 576, SAMPLE 98P 3412- 3427

DEPTH (CM)	-1-- CA 5B5a 6N2i	-2-- MG 5B5a 6O2h	-3-- NA 5B5a 6P2f	-4-- K 5B5a 6Q2f	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7--	-8-- SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- NA 5D2	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- BASE SATURATION NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- CARBONATE AS CACO3 <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- CASO4 AS GYPSUM <20MM 6F4	-18- PH SAT PASTE 8C1b	-19- PH CACL2 .01M 8C1f	-20- PH H2O 8C1f
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->									PCT		<- -PCT- >		<- -PCT ->		<- -PCT ->			1:2	1:1
0- 14		5.0	0.2	2.2		3.8			64.8	TR	TR		100	1		--		6.6	7.1	7.2
14- 36	56.6	4.8	0.3	1.8	63.5	6.2		69.7	61.7	TR	TR	91	100					6.5	6.7	6.9
36- 57	60.3	5.4	0.4	1.7	67.8	7.0		74.8	61.6	1	TR	91	100					6.8	6.9	7.0
57- 81	59.8	6.6	0.5	1.3	68.2	4.2		72.4	63.5	1	1	94	100	--				6.9	7.0	7.1
81-117		8.1	0.7	1.3		2.7			62.0	1	1		100	1				7.2	7.3	7.5
117-132		7.3	0.8	0.5					34.6	2		100	100	18					7.6	7.9
132-148		7.5	0.7	0.8					31.9	2	1	100	100	21				7.7	7.7	7.9
148-163		7.4	1.0	0.7					29.0	3	2	100	100	26				7.7	7.7	7.9
163-173		7.1	0.9	0.7					27.7	3	1	100	100	24				7.7	7.6	7.9
173-181		7.5	1.1	0.7					29.6	3	2	100	100	20				7.5	7.6	7.8
181-222		6.7	1.0	0.7					25.7	3	2	100	100	1		--		7.6	7.6	7.9
181-222		5.7	0.9	0.5					20.4	3	2	100	100	17				7.7	7.7	8.0

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	PRED. ELEC. COND. 8A3a MMHOS /cm	PRED. ELEC. COND. 8I MMHOS /cm
	(- - - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - - - -)														
	< - - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - - ->											<- -PCT- ->			
0- 14	10.3	1.4	0.2	0.4	--	8.8	TR	0.3	0.7	TR	TR	108.3	0.1	1.09	0.58
14- 36	5.7	1.0	0.2	0.3	--	4.6	TR	0.4	0.9	TR	TR	106.3	TR	0.71	0.27
36- 57	5.1	0.8	0.3	0.2	--	4.6	TR	0.4	1.0	--	TR	110.4	TR	0.64	0.32
57- 81	2.9	0.6	1.0	0.2	--	2.5	TR	0.8	0.9	--	0.1	109.1	TR	0.51	0.30

81-117	2.9	0.7	0.7	0.1	--	2.7	TR	0.4	0.9	--	0.1	115.0	TR	0.45	0.32
117-132															0.18
132-148	2.1	0.7	0.9	0.1	--	1.7	0.1	0.7	1.3	--	TR	82.2	TR	0.41	0.26
148-163	2.4	1.1	2.0	0.2	--	1.6	0.2	1.4	2.0	--	TR	77.6	TR	0.58	0.32
163-173	3.2	1.0	1.8	0.1	--	1.6	0.2	2.1	2.1	--	TR	78.3	TR	0.66	0.38
173-181	4.2	1.9	2.9	0.2	--	2.0	0.1	3.7	2.8	TR	0.1	77.0	TR	0.90	0.41
181-222	6.3	2.7	3.5	0.1	--	1.9	0.1	7.2	3.3	--	0.1	78.6	0.1	1.31	0.58
181-222	4.9	2.2	3.1	0.2	--	1.7	0.1	4.6	3.5	--	0.1	62.5	TR	1.06	0.43

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 6,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-001 (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : PLEDGER-LOA ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 576, SAMPLES 98P 3412- 3427
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) CLAY LT .002	SILT .002 -.05	SAND .05 -2	FINE LT .0002	CO3 LT .002	(- -CLAY- -) FINE .002 -.02	COARSE .02 -.05	(- -SILT- -) VF .05 -.10	F .10 -.25	(- - - - -SAND- - - - - -) M .25 -.50	C .5 -1	VC 1 -2	(-COARSE FRACTIONS(MM)-)(>2MM) - - - - WEIGHT - - - - 2 -5	5 -20	20 -75	.1- 75	WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
98P3424S	280-318	2C1	15.3	28.5	56.2	9.4	0.7	9.9	18.6	44.1	11.8	0.2	0.1	TR	--	--	--	12	--
98P3425S	318-333	2C2	34.1	43.8	22.1	16.5	1.8	22.9	20.9	18.9	2.1	0.3	0.3	0.5	--	3	--	6	3
98P3426S	333-358	2C3	17.2	35.5	47.3	9.5	0.7	11.5	24.0	42.0	4.6	0.3	0.2	0.2	1	TR	--	6	1
98P3427S	358-376	2C4	11.4	25.9	62.7	6.7		6.8	19.1	48.5	14.0	0.1	0.1	TR	TR	TR	--	14	--

DEPTH (CM)	ORGN TOTAL C	N	EXTR TOTAL P	S	(- - DITH-CIT - -) EXTRACTABLE FE	AL	MN	CEC	(RATIO/CLAY) 15 BAR	(ATTERBERG) - LIMITS - LL	PI	(- BULK DENSITY -) FIELD MOIST	1/3 BAR	COLE OVEN DRY	WHOLE SOIL	(- - -WATER CONTENT - -) FIELD MOIST	1/10 BAR	1/3 BAR	15 BAR	WRD WHOLE SOIL
	6A1c	6B4a	6S3b	6R3c	6C2h	6G7g	6D2g	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1

	PCT <2MM	PPM	<- PERCENT OF <2MM -->			PCT <0.4MM	<- - G/CC - - ->	CM/CM	<- - -PCT OF <2MM - ->	CM/CM
280-318		0.6	TR	TR	0.65	0.48			7.4	
318-333		1.2	TR	TR	0.59	0.44			14.9	
333-358		0.7	TR	TR	0.64	0.43			7.4	
358-376		0.6	0.1	TR	0.74	0.53			6.0	

AVERAGES, DEPTH 25-100: PCT CLAY 15 PCT .1-75MM 12

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-001 PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-LOA ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 576, SAMPLE 98P 3412- 3427

DEPTH (CM)	-1-- CA 5B5a 6N2i	-2-- MG 5B5a 6O2h	-3-- NA 5B5a 6P2f	-4-- K 5B5a 6Q2f	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7--	-8-- SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- EXCH NA 5D2	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- <20MM 6F4	-18- (- - - -PH - - -) SAT PASTE 8C1b	-19- CACL2 .01M 8C1f	-20- H2O 8C1f
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->									PCT		<- -PCT- >		<- -PCT ->		<- -PCT ->			1:2	1:1
280-318		2.4	0.4	0.3					10.0	4	1	100	100	6				7.8	7.7	8.2
318-333		4.6	0.8	0.7					20.2	3	1	100	100	2				7.6	7.7	7.9
333-358		2.7	0.6	0.3					11.0	5	1	100	100	13				7.7	7.7	8.0
358-376		2.2	0.5	0.1					8.4	5	1	100	100	11				7.8	7.7	8.1

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	PRED. ELEC. COND. 8A3a MMHOS /cm	PRED. ELEC. COND. 8I MMHOS /cm
	(- - - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - - - - -)														
	< - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - ->											<- -PCT- ->			
280-318	4.9	1.4	1.9	0.2	--	1.5	0.1	5.8	1.2	TR	TR	42.5	TR	0.92	0.25
318-333	6.8	2.2	2.7	0.1	--	1.6	TR	9.3	1.3	0.1	TR	61.1	TR	1.30	0.46
333-358	5.7	1.9	2.1	0.1	--	1.4	0.1	7.6	0.9	--	TR	46.9	TR	1.09	0.33
358-376	5.8	1.9	1.8	0.2	--	1.4	0.1	7.4	0.9	--	TR	39.4	TR	1.05	0.26

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-001 PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-LOA ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 576, SAMPLE 98P 3412- 3427

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

--- CLAY MINERALOGY (<.002mm) ---
FRACT --- X-RAY --- THERMAL --- ELEMENTAL --- EGME INTER
SAMPLE ION --- DTA --- TGA --- SiO2 AL2O3 Fe2O3 MgO CaO K2O Na2O --- RETN PRETA
--- 7A2i --- 7A6b --- 7A4c --- 7C4a --- 7D2 TION
NUMBER --- peak size --- Percent --- Percent ---

98P3414	TCLY	MT 3	MI 2	KK 2	QZ 2	
98P3416	TCLY	MT 3	MI 2	KK 2	QZ 2	
98P3417	TCLY	MT 3	CA 3	MI 2	KK 2	QZ 2
98P3420	TCLY	MT 3	CA 3	MI 2	KK 2	QZ 1
98P3420	TCLY	HE 1				
98P3421	TCLY	MT 3	MI 3	CA 2	KK 2	QZ 1
98P3421	TCLY	HE 1				

FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm

MINERAL INTERPRETATION:

MT montmorillon MI mica KK kaolinite QZ quartz CA calcite HE hematite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:

BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-001 PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-LOA ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 576, SAMPLE 98P 3412- 3427

```
            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- ------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - - - - -><- - - THERMAL - - - -><- - - - - - - - ELEMENTAL - - - - - - - -><- -> EGME  INTER
SAMPLE      ION <                          ><- DTA - -><- TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
              < - - - - - -  7A2i - - - - - -><- 7A6b - ><- 7A4c - ><- - - - - - - - - - 7C4a- - - - - - - - -><    >  7D2   TION
NUMBER    <- - ><- - - - - peak size - - - - -><- - - Percent - - - -><- - - - - - - - - Percent - - - - - - - -><- -><- - ->

98P3424     TCLY  MT 3  MI 3  KK 2  CA 2  QZ 1
98P3427     TCLY  MT 3  MI 3  KK 2  CA 2  VR 1
98P3427     TCLY  QZ 1

--------- ------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - - - SAND - SILT MINERALOGY (2.0-0.002mm) - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - -><- - - THERMAL - - - -><- - - - - - - -  OPTICAL - - - - - - - - -><                > INTER
SAMPLE      ION <                      ><- DTA - -><- TGA - ->TOT RE< - - - - - GRAIN COUNT - - - - - -><                > PRETA
              < - - - - - 7A2i - - - - -><- 7A6b - ><- 7A4c - ><- - - - - - - - -  7B1a - - - - - - - - -><                >  TION
NUMBER    < - -><- - - Peak Size - - -><- - - Percent - - - -><- - - - - - - - - Percent - - - - - - - -><- - - - - - - -><- ->

98P3424     VFS                                                   60  QZ57  FK17  CA16  FP 4  HN 2  OP 2
98P3424     VFS                                                       BT 1  MS 1  FE 1  PRtr  TMtr  GNtr
98P3424     VFS                                                       CDtr
98P3424     GRVL                                                  34  CA62  QZ33  FK 2  BT 1  OP 1  HN 1
98P3424     GRVL                                                      MS 1  FPtr  ZRtr  CLtr

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FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm VFS Very Fine Sand, 0.05-0.10mm

MINERAL INTERPRETATION:

MT montmorillon MI mica KK kaolinite CA calcite QZ quartz FK potas feldsp

BT	biotite	OP	opaques	HN	hornblende	MS	muscovite	FP	plag-feldspa	ZR	zircon
CL	chlorite	FE	iron oxides	PR	pyroxene	TM	tourmaline	GN	garnet	CD	chalcedony
VR	vermiculite										

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-001A (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : PLEDGER-HIGH ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC HAPLUDERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 577, SAMPLES 98P 3428- 3434
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM)	HORIZON	-1-- CLAY LT .002	-2-- SILT .002 -.05	-3-- SAND .05 -2	-4-- FINE LT .0002	-5-- CO3 LT .002	-6-- FINE .002 -.02	-7-- COARSE .02 -.05	-8-- VF .05 -.10	-9-- F .10 -.25	-10- M .25 -.50	-11- C .5 -1	-12- VC 1 -2	-13- 2 -5	-14- 5 -20	-15- 20 -75	-16- .1- 75	-17- PCT OF WHOLE SOIL	-18-	-19-	-20-
			(- - -TOTAL - - -)				(- -CLAY- -)	(- -SILT- -)		(- - - - - -SAND- - - - - -)				(-COARSE FRACTIONS(MM)-)(>2MM)								
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - - ->											<- PCT OF <75MM(3B1)->								
98P3428S	0- 10	A	67.2	27.1	5.7	34.6		24.3	2.8	0.7	0.9	1.1	1.6	1.4	--	--	--	5	--			
98P3429S	10- 20	Bw1	67.8	26.5	5.7	31.6	3.0	24.0	2.5	0.9	1.0	1.0	1.5	1.3	TR	1	--	6	1			
98P3430S	20- 46	Bw2	68.5	26.2	5.3	26.2	3.8	24.3	1.9	0.8	0.9	1.0	1.5	1.1	TR	--	--	4	TR			
98P3431S	46- 78	Bkss1	60.0	32.7	7.3	21.5	4.1	30.5	2.2	0.5	0.7	0.9	2.2	3.0	TR	1	--	8	1			
98P3432S	78-106	Bkss2	54.7	40.5	4.8	23.9	4.3	36.2	4.3	0.4	0.5	0.7	1.1	2.1	TR	2	--	6	2			
98P3433S	106-121	Bss	55.4	40.4	4.2	26.3	4.6	36.6	3.8	0.3	0.5	0.6	1.3	1.5	TR	1	--	5	1			
98P3434S	121-142	B'ss	52.8	44.6	2.6	24.7	6.5	38.1	6.5	0.3	0.3	0.5	0.7	0.8	TR	1	--	3	1			

	ORGN C	TOTAL N	EXTR TOTAL P	S	(- - DITH-CIT - -) EXTRACTABLE		(RATIO/CLAY) 15	(ATTERBERG) - LIMITS -	(- BULK DENSITY -) FIELD	1/3	OVEN	COLE WHOLE	(- - -WATER CONTENT - -) FIELD	1/10	1/3	15	WRD WHOLE

DEPTH (CM)	6A1c PCT	6B4a <2MM	6S3b PPM	6R3c <- PERCENT	FE 6C2h	AL 6G7g OF	MN 6D2g <2MM -->	CEC 8D1	BAR 8D1	LL 4F1 PCT	PI 4F <0.4MM	MOIST 4A5 <- -	BAR 4A1d G/CC -	DRY 4A1h - ->	SOIL 4D1 CM/CM	MOIST 4B4 <- -	BAR 4B1c -PCT OF	BAR 4B1c <2MM -	BAR 4B2a ->	SOIL 4C1 CM/CM
0- 10		0.316			2.1	0.1	0.1	0.72	0.60			1.37	0.96	1.58	0.181	19.4		49.3	40.3	0.09
10- 20		0.206			2.0	0.1	TR	0.67	0.44			1.55	1.20	1.82	0.148	20.6		38.2	29.6	0.10
20- 46		0.117			2.0	0.1	TR	0.64	0.41			1.58	1.21	1.82	0.146	20.9		39.4	28.4	0.13
46- 78		0.083			1.8	0.1	TR	0.60	0.39			1.65	1.27	1.87	0.136	18.3		35.2	23.4	0.15
78-106		0.067			1.5	0.1	TR	0.60	0.39			1.79	1.41	1.92	0.107	15.2		29.7	21.5	0.11
106-121					1.6	0.1	0.1	0.58	0.38			1.74	1.42	1.93	0.107	17.0		29.1	21.1	0.11
121-142					1.4	0.1	TR	0.56	0.40			1.75	1.41	1.90	0.104	16.0		29.5	21.2	0.12

AVERAGES, DEPTH 25-100: PCT CLAY 57 PCT .1-75MM 7

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-001A PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-HIGH ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 577, SAMPLE 98P 3428- 3434

DEPTH (CM)	-1-- CA 6N2i	-2-- MG 6O2h	-3-- NA 6P2f	-4-- K 6Q2f	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7-- SUM CATS 5A3a	-8-- NH4-OAC 5A8b	-9-- EXCH NA 5D2 PCT	-10- EXCH 5E	-11- SAR	-12- BASE SATURATION SUM 5C3	-13- BASE SATURATION NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- CARBONATE AS CACO3 <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- CASO4 AS GYPSUM <20MM 6F4	-18- (- - - -PH - - -) SAT PASTE 8C1b	-19- CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->											<- -PCT- >		<- -PCT ->		<- -PCT ->				
0- 10		4.4	0.4	1.7		0.8		48.1	1	TR			100	13		--		6.7	7.3	7.4
10- 20		4.4	0.5	1.4				45.3	1	TR		100	100	7				6.9	7.4	7.5
20- 46		4.9	0.5	1.1				44.0	1	TR		100	100	14				7.4	7.5	7.6
46- 78		7.1	0.8	0.7				36.0	2	1		100	100	19				7.5	7.8	7.8
78-106		7.9	1.0	0.7				32.7	3	1		100	100	21				7.6	7.6	7.9
106-121		8.6	1.0	0.8				32.3	3	1		100	100	22				7.5	7.6	7.8
121-142		8.6	1.1	0.8				29.4	3	2		100	100	26				7.6	7.7	7.8

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	(- - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - -) TOTAL SALTS EST. 8D5	PRED. ELEC. COND. 8A3a MMHOS	PRED. ELEC. COND. 8I MMHOS

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          < - - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - -> <- -PCT- ->   /cm   /cm

  0- 10     12.6   1.8   0.4   0.5    --  10.3    --   0.4   0.6    TR    TR  99.8   0.1  1.25  0.53
 10- 20      8.6   1.3   0.4   0.3    --   7.5    TR   0.3   0.5    TR    TR  88.6    TR  0.91  0.38
 20- 46      3.9   0.8   0.7   0.2    --   3.4    TR   0.4   0.5    --    TR  93.4    TR  0.51  0.30
 46- 78      3.0   1.0   1.3   0.1    --   2.9   0.1   0.5   1.2    --    TR  87.1    TR  0.50  0.26
 78-106      2.8   1.2   1.8   0.2    --   2.6   0.1   0.7   1.9    --    TR  81.5    TR  0.57  0.29
106-121      3.1   1.5   2.2   0.1    --   2.2   0.1   1.4   2.5    --    TR  79.4    TR  0.66  0.36
121-142      3.8   2.0   2.7   0.2    --   2.1   0.1   2.1   3.8    --    TR  79.3    TR  0.83  0.43

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        ANALYSES:  S= ALL ON SIEVED <2mm BASIS

                              ***   P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A   ***

S98TX-039-001A                                                                                              PRINT DATE 12/06/99
SAMPLED AS    : PLEDGER-HIGH          ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 577, SAMPLE 98P 3428- 3434

            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- -----------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - - - CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - - - - - -><  - - - THERMAL - - - -><  - - - - - - - - ELEMENTAL - - - - - - - - -><  - -> EGME  INTER
SAMPLE      ION <                         ><  - DTA - -><  - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                < - - - - - -  7A2i - - - - - -><  - 7A6b - ><  - 7A4c - ><  - - - - - - - - - - - 7C4a- - - - - - - - - -><    >  7D2   TION
NUMBER    <- - ><  - - - - - peak size - - - - - -><  - - - Percent - - - -><  - - - - - - - - - - Percent - - - - - - - - -><  - -><  - ->

98P3430    TCLY  MT 2  CA 2  KK 2  QZ 2  MI 1
98P3432    TCLY  MT 2  CA 2  KK 2  MI 2  QZ 2

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FRACTION INTERPRETATION:

    TCLY  Total Clay, <0.002mm

MINERAL INTERPRETATION:

    MT  montmorillon     CA  calcite          KK  kaolinite        QZ  quartz           MI  mica

RELATIVE PEAK SIZE:   5 Very Large   4 Large   3 Medium   2 Small   1 Very Small   6 No Peaks
```

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-002 (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SUMPF-LIKE-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 578, SAMPLES 98P 3435- 3443
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM)	HORIZON	-1-- CLAY LT .002	-2-- SILT .002 -.05	-3-- SAND .05 -2	-4-- FINE LT .0002	-5-- CO3 LT .002	-6-- FINE .002 -.02	-7-- COARSE .02 -.05	-8-- VF .05 -.10	-9-- F .10 -.25	-10- M .25 -.50	-11- C .5 -1	-12- VC 1 -2	-13- 2 -5	-14- 5 -20	-15- 20 -75	-16- .1- 75	-17- PCT OF WHOLE SOIL
			(- - -TOTAL - - -)			(- -CLAY- -)		(- -SILT- -)		(- - - - - -SAND- - - - - -)				(-COARSE FRACTIONS(MM)-)					(>2MM) WT
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - - ->											<- PCT OF <75MM(3B1)->					
98P3435S	0- 19	A	65.1	32.9	2.0	46.8		26.2	6.7	1.3	0.4	0.1	0.1	0.1	--	--	--	1	--
98P3436S	19- 27	Bw	62.8	35.3	1.9	43.3		27.4	7.9	1.1	0.6	0.2	TR	TR	--	--	--	1	--
98P3437S	27- 99	Bss	70.1	28.3	1.6	47.5		24.1	4.2	1.0	0.3	0.2	0.1	--	--	--	--	1	--
98P3438S	99-112	Bkss1	60.8	34.8	4.4	24.3	3.5	29.2	5.6	1.0	0.7	0.7	0.9	1.1	TR	TR	--	3	TR
98P3439S	112-127	Bkss2	42.2	49.6	8.2	19.4	3.7	30.8	18.8	1.1	0.9	1.4	2.9	1.9	TR	TR	--	7	TR
98P3440S	127-138	2Bk	32.1	58.0	9.9	15.5	2.1	25.9	32.1	7.8	0.6	0.6	0.4	0.5	2	4	--	8	6
98P3441S	138-170	2Bw1	28.8	54.5	16.7	14.7	1.5	21.1	33.4	13.9	1.1	0.6	0.5	0.6	TR	TR	--	3	TR
98P3442S	170-195	2Bw2	24.2	38.3	37.5	13.9	1.0	14.2	24.1	31.9	5.2	0.3	0.1	TR	1	1	--	7	2
98P3443S	195-220	2Bw3	19.7	35.4	44.9	11.7	1.0	10.5	24.9	38.6	5.8	0.2	0.1	0.2	1	1	--	8	2

DEPTH (CM)	ORGN TOTAL C	N	EXTR TOTAL P	S	(- - DITH-CIT - -) EXTRACTABLE FE	AL	MN	CEC	(RATIO/CLAY) 15 BAR	(ATTERBERG) - LIMITS - LL	PI	(- BULK DENSITY -) FIELD MOIST	1/3 BAR	OVEN DRY	COLE WHOLE SOIL	(- - -WATER CONTENT - -) FIELD MOIST	1/10 BAR	1/3 BAR	15 BAR	WRD WHOLE SOIL
	6A1c	6B4a	6S3b	6R3c	6C2h	6G7g	6D2g	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT OF <2MM -->						PCT <0.4MM		<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->				CM/CM

0- 19	0.303	1.8	0.1	TR	0.80	0.65	1.53	1.15	1.73	0.146	19.3	39.2	42.2				
19- 27	0.154	1.6	0.1	TR	0.78	0.47	1.61	1.19	1.83	0.154	19.6	39.4	29.3	0.12			
27- 99	0.126	1.8	0.2	TR	0.73	0.44	1.51	1.14	1.84	0.173	25.5	45.8	30.6	0.17			
99-112	0.085	1.7	0.1	TR	0.62	0.39	1.64	1.31	1.91	0.134	19.5	34.8	23.7	0.15			
112-127		1.3	0.1	TR	0.59	0.41	1.76	1.43	1.99	0.116	15.3	28.6	17.1	0.16			
127-138		1.0	0.1	TR	0.63	0.43	1.72	1.53	1.78	0.050	9.7	22.2	13.8	0.12			
138-170		0.9	0.1	TR	0.68	0.48	1.65	1.49	1.67	0.039	8.6	21.8	13.9	0.12			
170-195		0.9	0.1	TR	0.68	0.45	1.68	1.53	1.76	0.047	9.6	20.9	11.0	0.15			
195-220		0.8	0.1	TR	0.71	0.47	1.54	1.45	1.55	0.022	8.3	17.3	9.3	0.11			

AVERAGES, DEPTH 25-100: PCT CLAY 70 PCT .1-75MM 1

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-002 PRINT DATE 12/06/99
SAMPLED AS : SUMPF-LIKE-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 578, SAMPLE 98P 3435- 3443

	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
	(- NH4OAC EXTRACTABLE BASES -)					ACID-	(- -CEC- -)			EXCH	SAR	BASE		CARBONATE		CASO4 AS		(- - - -PH - - -)		
	CA	MG	NA	K	SUM	ITY	SUM	NH4-	NA			SATURATION		AS CACO3		GYPSUM		SAT	CACL2	H2O
DEPTH	5B5a	5B5a	5B5a	5B5a	BASES		CATS	OAC				SUM NH4OAC		<2MM	<20MM	<2MM	<20MM	PASTE	.01M	
(CM)	6N2i	6O2h	6P2f	6Q2f		6H5a	5A3a	5A8b	5D2	5E		5C3	5C1	6E1h	6E4b	6F1a	6F4	8C1b	8C1f	8C1f
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->								PCT			<- -PCT- >		<- -PCT ->		<- -PCT ->			1:2	1:1
0- 19	49.6	3.8	0.4	1.6	55.4	6.8	62.2	52.3	1	TR		89	100			--		6.5	6.7	6.8
19- 27	40.9	3.1	0.4	1.3	45.7	10.4	56.1	48.8	1			81	94						5.6	5.9
27- 99	51.8	3.8	0.5	1.4	57.5	6.4	63.9	51.1	1	TR		90	100					6.8	6.8	6.9
99-112		3.3	0.4	1.1				37.7	1			100	100	14					7.5	7.7
112-127		2.4	0.4	0.7				25.0	2			100	100	32					7.6	7.9
127-138		1.8	0.4	0.6				20.3	2			100	100	15					7.6	7.9
138-170		1.7	0.3	0.6				19.5	2			100	100	10					7.6	8.0
170-195		1.5	0.3	0.6				16.5	2			100	100	7					7.5	8.0
195-220		1.2	0.3	0.3				14.0	2			100	100	5					7.6	8.0

	(- - - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - - -)PRED.														
													TOTAL	ELEC.	ELEC.
	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O	SALTS	COND.	COND.
DEPTH													EST.	8A3a	8I
(CM)	6N1d	6O1d	6P1d	6Q1d	6I1b	6J1b	6U1c	6K1e	6L1e	6W1c	6M1e	8A	8D5	MMHOS	MMHOS

```
          < - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - -> <- -PCT- ->   /cm   /cm

  0- 19     11.0   1.7   0.7   0.5    --   8.7    --   0.4   1.0    TR    TR  93.7   0.1  1.11  0.53
 19- 27                                                                                       0.06
 27- 99      5.4   0.8   0.6   0.2    --   4.5    TR   0.4   0.7    --    TR 102.4    TR  0.62  0.36
 99-112                                                                                       0.22
112-127                                                                                       0.17
127-138                                                                                       0.14
138-170                                                                                       0.16
170-195                                                                                       0.13
195-220                                                                                       0.10

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        MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS  2,  4,  5,  6,  7,  8,  9,

        ANALYSES:  S= ALL ON SIEVED <2mm BASIS

                              ***   P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A   ***

S98TX-039-002                                                                                              PRINT DATE 12/06/99
SAMPLED AS    : SUMPF-LIKE-LOW        ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 578, SAMPLE 98P 3435- 3443

            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- -------------------------------------------------------------------------------------------------------------------
           < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - - - - -->< - - - THERMAL - - - -->< - - - - - - - - ELEMENTAL - - - - - - - -->< - -> EGME  INTER
SAMPLE       ION <                            >< - DTA - -->< - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                 < - - - - - -  7A2i - - - - - -->< - 7A6b - >< - 7A4c - >< - - - - - - - - - - 7C4a- - - - - - - - - -><    >  7D2   TION
NUMBER     <- - >< - - - - peak size - - - - -->< - - - Percent - - - -->< - - - - - - - - - Percent - - - - - - - - -->< - -->< - ->

98P3437     TCLY  MT 3  MI 2  KK 2  QZ 2  VR 1
98P3439     TCLY  MT 3  MI 3  KK 3  CA 2  VR 2
98P3439     TCLY  QZ 2
98P3440     TCLY  MT 3  MI 3  KK 2  CA 2  QZ 1
98P3442     TCLY  MT 3  MI 3  KK 2  QZ 2
98P3443     TCLY  MT 3  MI 3  KK 3  QZ 1

--------- -------------------------------------------------------------------------------------------------------------------
           < - - - - - - - - - - - - - - - - - - - - - SAND - SILT MINERALOGY (2.0-0.002mm) - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - -->< - - - THERMAL - - - -->< - - - - - - - -  OPTICAL - - - - - - - - - ><               > INTER
SAMPLE       ION <                      >< - DTA - -->< - TGA - ->TOT RE< - - - - - - GRAIN COUNT - - - - - - -><               > PRETA
```

NUMBER	7A2i Peak Size	7A6b Percent	7A4c Percent	7B1a Percent					
98P3442	VFS	66	QZ64	FK17	CA 7	FP 4	BT 3	MS 2	
98P3442	VFS		HN 1	OP 1	FE 1	GStr	GCtr	TMtr	
98P3442	VFS		GNtr	PRtr					
98P3443	VFS	65	QZ62	FK20	CA 9	BT 4	MS 2	FP 2	
98P3443	VFS		CD 1	OP 1	FE 1	HNtr	TMtr	PRtr	
98P3443	VFS		ZRtr	GNtr	FFtr				

FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm VFS Very Fine Sand, 0.05-0.10mm

MINERAL INTERPRETATION:

MT	montmorillon	MI	mica	KK	kaolinite	QZ	quartz	VR	vermiculite	CA	calcite
FK	potas feldsp	FP	plag-feldspa	BT	biotite	MS	muscovite	HN	hornblende	OP	opaques
FE	iron oxides	GS	glass	GC	glas-coat gr	TM	tourmaline	GN	garnet	PR	pyroxene
CD	chalcedony	ZR	zircon	FF	foraminifera						

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-002A (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SUMPF-LIKE-HIGH ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC EPIAQUERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 579, SAMPLES 98P 3444- 3448
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) CLAY LT .002 <- - - - - - - - - - - - -	SILT .002 -.05	SAND .05 -2	FINE LT .0002	CO3 LT .002	(- -CLAY- -) FINE .002 -.02	COARSE .02 -.05	VF .05 -.10	(- - - - - -SAND- - - - - - -) F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	(-COARSE FRACTIONS(MM)-)(>2MM) - - - - WEIGHT - - - - 2 -5	5 -20	20 -75	.1- 75	WT PCT OF WHOLE SOIL
			PCT OF <2MM (3A1) - - - - - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
98P3444S	0- 14	A	67.4	29.7	2.9	47.3		23.4	6.3	1.9	0.6	0.2	0.1	0.1	--	--	--	1	--
98P3445S	14- 44	Bw	70.3	27.6	2.1	47.4		22.8	4.8	1.3	0.6	0.2	TR	TR	TR	1	--	2	1
98P3446S	44- 64	Bss	56.5	37.9	5.6	18.8	3.8	30.7	7.2	0.6	0.8	0.9	1.4	1.9	TR	1	--	6	1
98P3447S	64-112		55.6	39.0	5.4	17.4	4.0	31.5	7.5	0.7	0.9	1.1	1.6	1.1	TR	TR	--	5	TR
98P3448S	112-130		34.3	58.0	7.7	17.0	2.4	27.8	30.2	4.2	0.7	0.9	0.9	1.0	TR	1	--	4	1

DEPTH (CM)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR TOTAL P 6S3b PPM	S 6R3c	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h <- PERCENT OF <2MM -->	AL 6G7g	MN 6D2g	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT <0.4MM	PI 4F	(- BULK DENSITY -) FIELD MOIST 4A5 <- - G/CC - - ->	1/3 BAR 4A1d	OVEN DRY 4A1h	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- - -PCT OF <2MM - ->	1/10 BAR 4B1c	1/3 BAR 4B1c	15 BAR 4B2a	WRD WHOLE SOIL 4C1 CM/CM
0- 14		0.257			1.9	0.1	0.1	0.77	0.53			1.39	1.01	1.59	0.163	20.8		43.7	35.5	0.08
14- 44		0.154			2.0	0.2	0.1	0.73	0.44			1.52	1.13	1.82	0.171	23.0		43.6	31.0	0.14
44- 64		0.079			1.9	0.1	0.1	0.61	0.41			1.65	1.33	1.92	0.129	18.7		32.7	23.0	0.13
64-112		0.078			1.7	0.1	TR	0.62	0.43			1.72	1.40	1.96	0.118	17.2		30.0	24.1	0.08
112-130					1.1	0.1	TR	0.62	0.45			1.66	1.47	1.82	0.073	13.4		23.9	15.4	0.12

AVERAGES, DEPTH 25-100: PCT CLAY 57 PCT .1-75MM 5

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-002A PRINT DATE 12/06/99
SAMPLED AS : SUMPF-LIKE-HIGH ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 579, SAMPLE 98P 3444- 3448

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	MG 5B5a 6O2h	NA 5B5a 6P2f	K 5B5a 6Q2f	SUM BASES 6H5a	ACID-ITY	(- -CEC- -) SUM CATS 5A3a	NH4-OAC 5A8b	EXCH NA 5D2 PCT	SAR 5E	BASE SATURATION SUM NH4OAC 5C3 <- -PCT- >	5C1	CARBONATE AS CACO3 <2MM 6E1h <- -PCT ->	<20MM 6E4b	CASO4 AS GYPSUM <2MM 6F1a <- -PCT ->	<20MM 6F4	(- - - -PH - - -) SAT PASTE 8C1b	CACL2 .01M 8C1f 1:2	H2O 8C1f 1:1
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->																		

```
  0- 14     51.0   3.6   0.3   1.8  56.7   6.2         62.9  51.9     1     TR     90   100                --         6.6   6.8   7.0
 14- 44     49.2   3.2   0.3   1.6  54.3   5.0         59.3  51.1     1     TR     92   100                           6.9   6.9   7.1
 44- 64            3.1   0.4   0.9                           34.4     1           100   100    18                              7.5   7.8
 64-112            3.2   0.3   1.0                           34.3     1           100   100    18                              7.4   7.7
112-130            2.1   0.3   0.5                           21.3     1           100   100    17                              7.6   7.9

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           (- - - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - - )PRED.
                                                                                  TOTAL ELEC. ELEC.
             CA    MG    NA     K    CO3  HCO3    F    CL    SO4   NO2   NO3  H2O   SALTS COND. COND.
 DEPTH                                                                              EST.  8A3a   8I
  (CM)      6N1d  6O1d  6P1d  6Q1d  6I1b  6J1b  6U1c  6K1e  6L1e  6W1c  6M1e   8A    8D5  MMHOS MMHOS
           < - - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - -> <- -PCT- ->  /cm   /cm

  0- 14     10.7   1.5   0.6   0.4    --   8.3    TR   0.4   0.9    TR    TR 104.3   0.1  1.11  0.53
 14- 44      5.3   0.7   0.5   0.3    --   4.5    --   0.7   0.5    --    TR 103.4   0.1  1.11  0.34
 44- 64                                                                                        0.19
 64-112                                                                                        0.22
112-130                                                                                        0.15

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      MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS  3,  4,  5,

      ANALYSES:  S= ALL ON SIEVED <2mm BASIS

                           ***   P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A   ***

S98TX-039-002A                                                                                                      PRINT DATE 12/06/99
SAMPLED AS    : SUMPF-LIKE-HIGH       ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 579, SAMPLE 98P 3444- 3448

            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- ------------------------------------------------------------------------------------------------------------------------------
           < - - - - - - - - - - - - - - - - - - - - - - - CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - - - - - ->< - - - THERMAL - - - -><  - - - - - - - - ELEMENTAL - - - - - - - - ->< - -> EGME  INTER
SAMPLE       ION <                             >< - DTA - -->< - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                 < - - - - - -  7A2i - - - - - -->< - 7A6b - >< - 7A4c - >< - - - - - - - - - - - 7C4a- - - - - - - - - - -><    >  7D2   TION
NUMBER     <- - >< - - - - - peak size - - - - -->< - - - Percent - - - ->< - - - - - - - - - - Percent - - - - - - - - -->< - -->< - ->

98P3445     TCLY  MT 3  MI 2  KK 2  QZ 2
98P3446     TCLY  MT 2  CA 2  KK 2  MI 2  QZ 1
```

98P3447 TCLY MT 3 MI 2 CA 2 KK 2 QZ 1

FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm

MINERAL INTERPRETATION:

MT montmorillon MI mica KK kaolinite QZ quartz CA calcite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-003 (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SND-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 580, SAMPLES 98P 3449- 3459
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

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SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -)(- -CLAY- -)(- -SILT- -)(- - - - - -SAND- - - - - -)(-COARSE FRACTIONS(MM)-)(>2MM) CLAY LT .002	SILT .002 -.05	SAND .05 -2	FINE LT .0002	CO3 LT .002	FINE .002 -.02	COARSE .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	2 -5	5 -20	WEIGHT - - - - 20 -75	.1- 75	WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
98P3449S	0- 20		69.5	28.9	1.6	48.6		23.2	5.7	0.8	0.4	0.2	0.1	0.1	--	TR	--	1	TR
98P3450S	20- 44		72.1	26.4	1.5	50.1		22.5	3.9	0.8	0.4	0.2	TR	0.1	--	--	--	1	--
98P3451S	44- 88		73.1	25.8	1.1	47.7		22.5	3.3	0.4	0.4	0.2	0.1	TR	--	TR	--	1	TR

98P3452S	88-133		71.8	26.2	2.0	29.3		22.5	3.7	0.7	0.5	0.3	0.4	0.1	1	2	--		4	3
98P3453S	133-171		52.7	45.0	2.3	23.1	5.6	36.6	8.4	0.4	0.5	0.5	0.5	0.4	2	2	--		6	4
98P3454S	171-182		58.8	39.5	1.7	24.3	4.9	34.7	4.8	0.2	0.4	0.3	0.4	0.4	--	--	--		1	--
98P3455S	182-220		55.1	44.1	0.8	22.6	5.4	36.7	7.4	0.1	0.2	0.2	0.2	0.1	--	TR	--		1	TR
98P3456S	220-265		55.5	43.3	1.2	23.7	4.8	34.2	9.1	0.9	0.1	TR	0.1	0.1	--	--	--		TR	--
98P3457S	265-304		44.7	46.4	8.9	21.1	4.0	29.7	16.7	7.3	1.4	0.1	TR	0.1	--	--	--		2	--
98P3458S	304-345		23.3	35.1	41.6	14.1	1.0	15.0	20.1	33.2	8.0	0.2	0.2	TR	--	1	--		9	1
98P3459S	345-365		16.4	26.5	57.1	9.8	0.7	9.4	17.1	34.8	21.9	0.3	0.1	--	--	TR	--		22	TR

DEPTH (CM)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR TOTAL P 6S3b PPM	S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g OF	MN 6D2g <2MM -->	(RATIO/CLAY) CEC 8D1	15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT	PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- - G/CC	1/3 BAR 4A1d - - ->	OVEN DRY 4A1h	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- - -PCT OF	1/10 BAR 4B1c <2MM	1/3 BAR 4B1c - ->	15 BAR 4B2a	WRD WHOLE SOIL 4C1 CM/CM
0- 20		0.325			1.7	0.1	0.1	0.87	0.52			1.34	1.05	1.77	0.190	27.9		47.3	36.3	0.12
20- 44		0.207			2.0	0.2	0.2	0.81	0.45			1.39	1.09	1.82	0.186	28.7		47.4	32.7	0.16
44- 88		0.141			1.7	0.2	0.1	0.80	0.43			1.40	1.11	1.84	0.183	29.3		47.8	31.7	0.18
88-133		0.117			1.6	0.2	TR	0.76	0.43			1.42	1.15	1.83	0.165	29.0		45.0	30.8	0.16
133-171					1.2	0.1	TR	0.58	0.40			1.68	1.40	1.91	0.106	18.3		30.2	21.3	0.12
171-182					1.4	0.1	TR	0.57	0.39			1.62	1.40	1.95	0.117	21.6		30.4	23.2	0.10
182-220					1.3	0.1	TR	0.57	0.40			1.54	1.31	1.86	0.124	20.9		31.5	22.2	0.12
220-265					1.3	0.1	0.1	0.58	0.41										23.0	
265-304					1.1	0.1	TR	0.59	0.45										19.9	
304-345					0.5	0.1	TR	0.63	0.40										9.3	
345-365					0.5	0.1	--	0.69	0.45										7.3	

AVERAGES, DEPTH 25-100: PCT CLAY 73 PCT .1-75MM 1

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-003 PRINT DATE 12/06/99
SAMPLED AS : SND-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 580, SAMPLE 98P 3449- 3459

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	MG 5B5a 6O2h	NA 5B5a 6P2f	K 5B5a 6Q2f	SUM BASES	ACID-ITY 6H5a	(- -CEC- -) SUM CATS 5A3a	NH4-OAC 5A8b	EXCH NA 5D2	SAR 5E	BASE SATURATION SUM 5C3	NH4OAC 5C1	CARBONATE AS CACO3 <2MM 6E1h	<20MM 6E4b	CASO4 AS GYPSUM <2MM 6F1a	<20MM 6F4	(- - - -PH - - -) SAT PASTE 8C1b	CACL2 .01M 8C1f	H2O 8C1f

	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - ->							PCT	<- -PCT- >		<- -PCT ->	<- -PCT ->		1:2	1:1
0- 20		5.1	0.3	1.7		4.9		60.6	1	TR	100	1	--	6.6	7.0	7.0
20- 44	51.1	5.5	0.4	1.3	58.3	6.6	64.9	58.7	1	90	99				6.4	6.6
44- 88	51.8	7.1	0.8	1.1	60.8	4.9	65.7	58.6	1	1	93	100	TR		6.9	7.0	7.2
88-133		9.1	1.2	1.1		2.8		54.8	2	1		100	1		7.3	7.5	7.6
133-171		7.9	1.4	0.6				30.6	3	2	100	100	24	--	7.5	7.6	7.7
171-182		8.6	1.4	0.8				33.4	3	2	100	100	20	--	7.5	7.6	7.7
182-220		8.5	1.4	0.9				31.6	3	2	100	100	19	--	7.7	7.6	7.7
220-265		9.5	1.5	0.9				32.2	3	2	100	100	18	--	7.8	7.6	7.7
265-304		7.8	1.3	0.8				26.5	3	2	100	100	16	--	7.9	7.7	7.7
304-345		4.8	1.0	0.6				14.7	5	2	100	100	12	--	8.0	7.7	7.8
345-365		3.7	1.0	0.2				11.3	5	3	100	100	11	--	8.1	7.7	8.0

DEPTH (CM)	(- - - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - - -)PRED.														
	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O	TOTAL SALTS EST.	ELEC. COND. 8A3a	ELEC. COND. 8I
	6N1d	6O1d	6P1d	6Q1d	6I1b	6J1b	6U1c	6K1e	6L1e	6W1c	6M1e	8A	8D5	MMHOS /cm	MMHOS /cm
	< - - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - - ->											<- -PCT- ->			
0- 20	8.5	1.5	0.8	0.3	--	7.1	--	0.6	0.5	TR	0.1	108.2	0.1	0.96	0.53
20- 44															0.19
44- 88	3.1	0.8	1.7	0.1	--	2.8	TR	0.9	0.7	--	0.1	110.4	TR	0.53	0.30
88-133	3.3	1.1	2.2	0.2	--	3.0	TR	1.1	1.5	--	TR	115.1	TR	0.64	0.47
133-171	7.0	3.1	4.6	0.1	--	1.3	--	6.8	5.4	--	0.1	81.0	0.1	1.46	0.76
171-182	7.2	3.3	4.8	0.2	--	1.7	--	9.0	5.0	--	0.1	92.6	0.1	1.56	0.91
182-220	7.4	2.8	4.0	0.2	--	2.0	TR	10.5	3.0	0.1	--	84.0	0.1	1.56	0.83
220-265	9.2	3.7	5.2	0.3	--	1.8	TR	16.2	1.8	--	0.1	91.0	0.1	1.94	1.08
265-304	9.5	4.1	5.6	0.4	--	1.6	TR	16.5	2.0	--	0.1	83.1	0.1	1.98	1.05
304-345	14.1	5.5	7.1	0.3	--	1.0	--	22.3	4.4	--	--	47.0	0.1	2.85	0.94
345-365	14.4	5.4	8.1	0.3	--	0.8	--	20.4	7.6	--	--	44.0	0.1	2.82	0.79

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 2,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-003 PRINT DATE 12/06/99
SAMPLED AS : SND-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT

USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 580, SAMPLE 98P 3449- 3459

```
            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

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          < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - - - - - -><- - - THERMAL - - - -><- - - - - - - - ELEMENTAL - - - - - - - -><- -> EGME  INTER
SAMPLE      ION <                            ><- DTA - -><- TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                < - - - - - -  7A2i - - - - - -><- 7A6b - ><- 7A4c - ><- - - - - - - - - 7C4a- - - - - - - - -><    >  7D2   TION
NUMBER    <- - ><- - - - - peak size - - - - -><- - - Percent - - - -><- - - - - - - - Percent - - - - - - - -><- -><- - ->

98P3450     TCLY  MT 3  MI 2  KK 2  QZ 2
98P3451     TCLY  MT 3  KK 2  MI 2  QZ 1
98P3455     TCLY  MT 3  MI 2  CA 2  KK 2  QZ 1
98P3456     TCLY  MT 3  CA 2  KK 2  MI 2  QZ 1
98P3458     TCLY  MT 3  MI 2  KK 2  CA 2  QZ 1
98P3459     TCLY  MT 3  MI 3  KK 2  CA 2  QZ 1

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          < - - - - - - - - - - - - - - - - - - - - - - SAND - SILT MINERALOGY (2.0-0.002mm) - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - -><- - - - THERMAL - - - -><- - - - - - - -  OPTICAL - - - - - - - - -><                > INTER
SAMPLE      ION <                      ><- DTA - -><- TGA - ->TOT RE< - - - - - GRAIN COUNT - - - - - -><                > PRETA
                < - - - - - 7A2i - - - - -><- 7A6b - ><- 7A4c - ><- - - - - - - - -  7B1a - - - - - - - - -><                >  TION
NUMBER    < - -><- - - - Peak Size - - -><- - - Percent - - - -><- - - - - - - - - Percent - - - - - - - -><- - - - - - - - -><- ->

98P3457     CSi                                                   41  QZ34  FK29  CA24  OP 4  FP 2  BT 2
98P3457     CSi                                                       PR 2  HN 1  MS 1  TM 1  PO 1  FE 1
98P3457     CSi                                                       FFtr  SStr  ZRtr  GNtr
98P3458     VFS                                                   62  QZ58  CA15  FK14  FP 3  BT 2  OP 2
98P3458     VFS                                                       CD 2  HN 2  MS 2  PRtr  FFtr  FEtr
98P3458     VFS                                                       ENtr  POtr  ZRtr  TMtr
98P3459     VFS                                                   63  QZ60  FK15  CA15  FP 2  OP 2  MS 2
98P3459     VFS                                                       BT 1  HN 1  CD 1  PRtr  FEtr  FFtr
98P3459     VFS                                                       TMtr

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FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm CSi Coarse Silt, 0.02-0.05mm VFS Very Fine Sand, 0.05-0.10mm

MINERAL INTERPRETATION:

MT	montmorillon	MI	mica	KK	kaolinite	QZ	quartz	CA	calcite	FK	potas feldsp
OP	opaques	FP	plag-feldspa	BT	biotite	PR	pyroxene	HN	hornblende	MS	muscovite
TM	tourmaline	PO	plant opal	FE	iron oxides	FF	foraminifera	SS	spon spicule	ZR	zircon
GN	garnet	CD	chalcedony	EN	enstatite						

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-003A (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SND-HIGH ; FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 581, SAMPLES 98P 3460- 3468
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM)	HORIZON	-1-- CLAY LT .002	-2-- SILT .002 -.05	-3-- SAND .05 -2	-4-- FINE LT .0002	-5-- CO3 LT .002	-6-- FINE .002 -.02	-7-- COARSE .02 -.05	-8-- VF .05 -.10	-9-- F .10 -.25	-10- M .25 -.50	-11- C .5 -1	-12- VC 1 -2	-13- 2 -5	-14- 5 -20	-15- 20 -75	-16- .1- 75	-17- PCT OF WHOLE SOIL	-18-	-19-	-20-
			(- - -TOTAL - - -)				(- -CLAY- -)		(- -SILT- -)		(- - - - - -SAND- - - - - - -)				(-COARSE FRACTIONS(MM)-)(>2MM)							
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->							
															- - - - WEIGHT - - - -							
98P3460S	0- 18		66.7	29.3	4.0	39.5	0.8	26.2	3.1	1.0	0.7	0.6	0.8	0.9	--	TR	--	3	TR			
98P3461S	18- 33		60.9	32.8	6.3	24.1	3.8	30.4	2.4	0.5	0.6	0.9	2.1	2.2	TR	1	--	7	1			
98P3462S	33- 55		58.0	36.3	5.7	20.4	5.2	32.9	3.4	0.3	0.7	1.0	1.3	2.4	6	1	--	12	7			
98P3463S	55-102		57.8	36.7	5.5	21.8	4.9	34.7	2.0	0.4	0.7	0.9	1.6	1.9	4	3	--	12	7			
98P3464S	102-130		59.5	37.4	3.1	23.6		34.9	2.5	0.4	0.5	0.5	0.6	1.1	3	3	--	9	6			
98P3465S	130-179		54.2	43.5	2.3	20.8	4.9	38.2	5.3	0.3	0.5	0.4	0.5	0.6	--	--	--	2	--			
98P3466S	179-185		59.8	39.0	1.2	22.9	4.3	34.7	4.3	0.2	0.3	0.2	0.2	0.3	--	2	--	3	2			
98P3467S	185-198		59.0	39.9	1.1	23.7	4.9	35.0	4.9	0.5	0.2	0.2	0.1	0.1	--	TR	--	1	TR			
98P3468S	198-210		50.8	47.2	2.0	22.2	4.3	38.3	8.9	1.6	0.3	0.1	TR	TR	--	TR	--	TR	TR			

DEPTH	ORGN C	TOTAL N	EXTR P	TOTAL S	(- - DITH-CIT - -) EXTRACTABLE FE	AL	MN	CEC	(RATIO/CLAY) 15 BAR	(ATTERBERG) - LIMITS - LL	PI	(- BULK DENSITY -) FIELD MOIST	1/3 BAR	OVEN DRY	COLE WHOLE SOIL	(- - -WATER CONTENT - -) FIELD MOIST	1/10 BAR	1/3 BAR	15 BAR	WRD WHOLE SOIL

(CM)	6A1c PCT	6B4a <2MM	6S3b PPM	6R3c <- PERCENT	6C2h OF	6G7g <2MM -->	6D2g	8D1	8D1	4F1 PCT	4F <0.4MM	4A5 <- -	4A1d G/CC -	4A1h - ->	4D1 CM/CM	4B4 <- -	4B1c -PCT	4B1c OF	4B2a <2MM - ->	4C1 CM/CM
0- 18		0.291		1.5	0.2	0.1	0.70	0.51				1.39	1.02	1.74	0.195	25.4		49.6	33.7	0.16
18- 33		0.143		1.5	0.2	0.1	0.63	0.42				1.64	1.29	1.96	0.148	17.5		33.1	25.4	0.10
33- 55		0.067		1.3	0.2	TR	0.58	0.38				1.70	1.34	1.98	0.132	17.4		31.4	22.3	0.12
55-102		0.076		1.4	0.2	TR	0.56	0.38				1.69	1.39	1.97	0.118	19.1		30.3	21.8	0.11
102-130				1.3	0.1	TR	0.56	0.38				1.72	1.39	1.93	0.111	18.9		30.8	22.5	0.11
130-179				1.2	0.1	TR	0.57	0.40				1.70	1.40	1.93	0.113	19.7		30.4	21.8	0.12
179-185				1.4	0.1	TR	0.54	0.38				1.65	1.44	1.93	0.102	21.3		29.0	22.5	0.09
185-198				1.2	0.1	TR	0.55	0.38				1.75	1.38	1.92	0.116	16.8		31.5	22.7	0.12
198-210				1.0	0.1	TR	0.57	0.41				1.72	1.40	1.88	0.103	14.2		28.9	21.0	0.11

AVERAGES, DEPTH 25-100: PCT CLAY 53 PCT .1-75MM 11

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-003A PRINT DATE 12/06/99
SAMPLED AS : SND-HIGH ; FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 581, SAMPLE 98P 3460- 3468

DEPTH (CM)	-1-- CA 5B5a 6N2i	-2-- MG 5B5a 6O2h	-3-- NA 5B5a 6P2f	-4-- K 5B5a 6Q2f	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7--	-8-- SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- EXCH NA 5D2 PCT	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- <20MM 6F4	-18- (- - - -PH - - -) SAT PASTE 8C1b	-19- CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->									PCT		<- -PCT- >		<- -PCT ->		<- -PCT ->				
0- 18		5.0	0.3	1.4					46.6	1	TR	100	100	8		--		6.9	7.2	7.4
18- 33		4.4	0.3	1.1					38.1	1	--	100	100	4				7.3	7.4	7.6
33- 55		5.8	0.6	0.9					33.7	2		100	100	24					7.6	7.8
55-102		5.9	0.6	0.7					32.5	2		100	100	23					7.6	8.0
102-130		7.5	0.9	0.7					33.3	2	1	100	100	20				8.0	7.6	7.9
130-179		7.4	1.0	0.6					30.7	3	2	100	100	21				7.9	7.6	7.8
179-185		9.1	1.4	1.0					32.2	3	2	100	100	21		--		7.9	7.6	7.8
185-198		7.8	1.2	0.9					32.2	3	2	100	100	19		--		7.8	7.6	7.6
198-210		6.9	1.1	0.9					29.2	3	2	100	100	19		--		7.8	7.6	7.9

(- - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - -)PRED.
TOTAL ELEC. ELEC.

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	SALTS EST. 8D5	COND. 8A3a MMHOS /cm	COND. 8I MMHOS /cm
	< - - - -	- - - -	- - - -	- - - -	- - - -	-MEQ / LITER	- - - -	- - - -	- - - -	- - - -	- - ->	<- -PCT-	->		
0- 18	10.5	1.5	0.1	0.4	--	9.0	--	0.4	0.6	TR	TR	92.0	0.1	1.04	0.50
18- 33	5.8	0.9	--	0.2	--	5.2	TR	0.3	0.4	TR	TR	85.4	TR	0.65	0.25
33- 55															0.21
55-102															0.21
102-130	2.8	0.9	1.4	0.1	--	2.4	0.2	1.1	1.9	--	TR	88.9	TR	0.56	0.30
130-179	3.7	1.2	2.4	0.2	--	2.1	0.1	3.4	2.7	--	TR	83.2	TR	0.79	0.45
179-185	6.9	2.8	4.5	0.2	--	1.5	0.1	10.4	3.0	0.1	0.1	84.3	0.1	1.49	0.71
185-198	7.2	2.4	3.8	0.3	--	1.6	0.1	9.2	3.4	0.1	0.1	89.0	0.1	1.42	0.71
198-210	7.1	2.3	3.5	0.3	--	1.4	0.1	11.1	2.2	0.1	0.1	85.6	0.1	1.41	0.75

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 3, 4,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A ***

S98TX-039-003A PRINT DATE 12/06/99
SAMPLED AS : SND-HIGH ; FINE, SMECTITIC, HYPERTHERMIC TYPIC HAPLUDERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 581, SAMPLE 98P 3460- 3468

```
            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-
---------  ----------------------------------------------------------------------------------------------------------------------------
           < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - - - - - ->< - - - THERMAL - - - ->< - - - - - - - - ELEMENTAL - - - - - - - - ->< - -> EGME  INTER
SAMPLE       ION <                            >< - DTA - -><  - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                 < - - - - - -  7A2i - - - - - ->< - 7A6b - >< - 7A4c - >< - - - - - - - - - - 7C4a- - - - - - - - - -><    >  7D2   TION
NUMBER     <- - >< - - - - peak size - - - - ->< - - - Percent - - - ->< - - - - - - - - - Percent - - - - - - - - ->< - -><  - ->
```

SAMPLE NUMBER	-1--	-2--	-3--	-4--	-5--	-6--
98P3461	TCLY	MT 3	MI 2	KK 2	CA 2	QZ 1
98P3463	TCLY	MT 3	CA 3	KK 2	MI 2	QZ 1
98P3465	TCLY	MT 3	CA 3	KK 2	MI 2	QZ 2
98P3468	TCLY	MT 3	KK 2	MI 2	VR 2	CA 2
98P3468	TCLY	QZ 1				

FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm

MINERAL INTERPRETATION:

MT montmorillon MI mica KK kaolinite CA calcite QZ quartz VR vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-004 (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SND-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 582, SAMPLES 98P 3469- 3479
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM)	HORIZON	-1-- CLAY LT .002	-2-- SILT .002 -.05	-3-- SAND .05 -2	-4-- FINE LT .0002	-5-- CO3 LT .002	-6-- FINE .002 -.02	-7-- COARSE .02 -.05	-8-- VF .05 -.10	-9-- F .10 -.25	-10- M .25 -.50	-11- C .5 -1	-12- VC 1 -2	-13- 2 -5	-14- 5 -20	-15- 20 -75	-16- .1- 75	-17- PCT OF WHOLE SOIL
			(- - -TOTAL - - -)				(- -CLAY- -)	(- -SILT- -)		(- - - - - -SAND- - - - - -)				(-COARSE FRACTIONS(MM)-)(>2MM)					
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - - ->											<- PCT OF <75MM(3B1)->					
98P3469S	0- 13	A	75.5	23.1	1.4	52.8		23.1	TR	0.9	0.2	0.2	0.1	TR	--	--	--	TR	--
98P3470S	13- 34	Bw	77.5	21.3	1.2	52.4		20.4	0.9	0.7	0.3	0.1	0.1	TR	--	--	--	TR	--
98P3471S	34- 61	Bss1	78.4	20.3	1.3	52.8		20.3	TR	0.7	0.3	0.2	0.1	TR	--	--	--	1	--
98P3472S	61- 94	Bss2	79.4	19.3	1.3	79.6		19.3	TR	0.7	0.3	0.2	0.1	TR	--	--	--	1	--
98P3473S	94-126	Bss3	78.7	19.8	1.5	30.1		19.8	TR	0.6	0.4	0.3	0.1	0.1	--	--	--	1	--
98P3474S	126-140	Bkss	52.2	41.7	6.1	21.4	4.0	33.4	8.3	1.6	0.9	1.2	1.6	0.8	1	2	--	7	3

98P3475S	140-146	2Bw1	34.6	50.1	15.3	18.8	2.6	25.1	25.0	12.5	0.8	0.5	0.9	0.6	1	2	--	6	3
98P3476S	146-158	2Bw2	35.2	52.5	12.3	17.9	2.6	26.3	26.2	10.7	0.6	0.3	0.3	0.4	1	1	--	4	2
98P3477S	158-182	2Bw3	34.9	51.6	13.5	17.9	2.6	25.2	26.4	11.9	0.7	0.3	0.4	0.2	TR	TR	--	2	TR
98P3478S	182-194	2Bw4	34.1	46.5	19.4	15.2	2.1	22.2	24.3	14.8	1.9	0.7	1.0	1.0	1	1	--	7	2
98P3479S	194-210	3Ab	24.3	36.7	39.0	13.6	0.7	13.7	23.0	29.5	9.1	0.2	0.1	0.1	1	2	--	12	3

DEPTH (CM)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR TOTAL P 6S3b PPM	S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g OF	MN 6D2g <2MM -->	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT	PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- - G/CC	1/3 BAR 4A1d - - ->	OVEN DRY 4A1h	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- - -PCT	1/10 BAR 4B1c OF	1/3 BAR 4B1c <2MM	15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 13		0.280			1.3	0.2	TR	0.75	0.48			1.38	1.04	1.75	0.189	25.9		47.5	36.6	0.11
13- 34		0.234			1.5	0.2	TR	0.72	0.44			1.43	1.09	1.83	0.189	27.5		47.5	33.9	0.15
34- 61		0.139			1.4	0.2	0.1	0.75	0.41			1.48	1.13	1.85	0.179	27.0		46.7	31.9	0.17
61- 94		0.125			1.6	0.2	TR	0.72	0.42			1.47	1.12	1.83	0.178	27.4		47.4	33.0	0.16
94-126		0.113			1.6	0.3	TR	0.72	0.42			1.49	1.13	1.84	0.176	26.7		46.7	32.7	0.16
126-140					1.3	0.2	TR	0.56	0.39			1.77	1.43	1.97	0.110	14.7		28.4	20.1	0.12
140-146					0.8	0.1	TR	0.59	0.43			1.79	1.51	1.93	0.084	10.4		23.4	15.0	0.13
146-158					0.7	0.1	TR	0.60	0.45			1.71	1.50	1.85	0.071	8.4		23.5	15.9	0.11
158-182					0.7	0.1	TR	0.60	0.45			1.72	1.50	1.79	0.060	9.9		24.3	15.6	0.13
182-194					0.7	0.1	TR	0.60	0.43			1.68	1.48	1.69	0.045	8.6		24.0	14.6	0.14
194-210					0.6	0.1	--	0.65	0.47			1.56	1.42	1.57	0.034	7.7		24.0	11.3	0.18

AVERAGES, DEPTH 25-100: PCT CLAY 79 PCT .1-75MM 1

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-004 PRINT DATE 12/06/99
SAMPLED AS : SND-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 582, SAMPLE 98P 3469- 3479

DEPTH (CM)	-1-- (- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	MG 5B5a 6O2h	NA 5B5a 6P2f	K 5B5a 6Q2f	SUM BASES	-2-- ACID-ITY 6H5a	-3-- (- -CEC- -) SUM CATS 5A3a	-4-- NH4-OAC 5A8b	-5-- EXCH NA 5D2 PCT	-6-- SAR 5E	-7-- BASE SATURATION SUM 5C3	NH4OAC 5C1	-8-- CARBONATE AS CACO3 <2MM 6E1h	<20MM 6E4b	-9-- CASO4 AS GYPSUM <2MM 6F1a	<20MM 6F4	-10- (- - - -PH - - -) SAT PASTE 8C1b	CACL2 .01M 8C1f 1:2	-11- H2O 8C1f 1:1
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->										<- -PCT- >		<- -PCT ->		<- -PCT ->				
0- 13	44.7	6.3	0.3	1.9	53.2	11.6	64.8	56.8	1	TR	82	94					5.5	5.7	5.9

13- 34	45.5	6.1	0.4	1.8	53.8	9.7		63.5	55.5	1		85	97						5.9	6.0
34- 61	48.9	5.6	0.5	1.6	56.6	7.6		64.2	58.8	1		88	96						6.7	7.0
61- 94	50.0	5.4	0.4	1.3	57.1	5.2		62.3	56.8	1		92	100						6.8	7.2
94-126	57.1	6.3	0.6	1.1	65.1	3.8		68.9	56.4	1	TR	94	100	TR				7.1	7.3	7.4
126-140		4.7	0.6	0.7					29.2	2	1	100	100	22				7.8	7.5	7.8
140-146		3.5	0.5	0.5					20.4	2		100	100	17					7.6	8.0
146-158		3.8	0.6	0.6					21.0	3		100	100	17					7.6	7.9
158-182		3.9	0.5	0.5					20.8	2		100	100	16					7.6	7.9
182-194		3.8	0.6	0.6					20.3	3		100	100	16					7.6	8.1
194-210		3.2	0.6	0.5					15.8	3	1	100	100	8				8.0	7.6	7.9

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	ELEC. COND. 8A3a MMHOS /cm	PRED. ELEC. COND. 8I MMHOS /cm
	(- - - -WATER EXTRACTED FROM SATURATED PASTE- - - -														)PRED.
	< - - - - -MEQ / LITER - - - -										->	<- -PCT-	->		
0- 13	4.1	0.9	0.5	0.4	--	2.6	TR	1.0	1.1	0.1	0.1	106.4	TR	0.57	0.32
13- 34															0.18
34- 61															0.18
61- 94															0.09
94-126	3.2	0.5	0.4	0.1	--	3.4	TR	0.4	0.4	TR	TR	110.4	TR	0.43	0.29
126-140	2.8	0.5	0.7	0.1	--	2.5	0.1	0.5	1.4	0.1	TR	79.4	TR	0.45	0.25
140-146															0.20
146-158															0.19
158-182															0.18
182-194															0.24
194-210	5.2	1.2	2.3	0.2	--	1.5	TR	5.0	3.1	0.1	0.1	53.7	TR	0.96	0.37

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 2, 3, 4, 7, 8, 9, 10,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-004 PRINT DATE 12/06/99

SAMPLED AS : SND-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT

USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 582, SAMPLE 98P 3469- 3479

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

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          < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - X-RAY - - - - - -><  - - - THERMAL - - - -><  - - - - - - - ELEMENTAL - - - - - - - -><  - -> EGME  INTER
SAMPLE      ION <                            ><  - DTA - -><  - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                < - - - - -  7A2i - - - - - -><  - 7A6b - ><  - 7A4c - ><  - - - - - - - - - - 7C4a- - - - - - - - -><    >  7D2   TION
NUMBER    <- - ><  - - - - - peak size - - - - -><  - - - Percent - - - -><  - - - - - - - - - Percent - - - - - - - -><  - -><  - ->

98P3470     TCLY  MT 3  MI 2  KK 2  QZ 2
98P3472     TCLY  MT 3  MI 2  KK 2  QZ 2
98P3474     TCLY  MT 3  CA 3  KK 2  MI 2  QZ 2
98P3475     TCLY  MT 3  KK 2  CA 2  MI 2  QZ 1
98P3478     TCLY  MT 3  MI 2  KK 2  CA 2  VR 1
98P3478     TCLY  QZ 1
98P3479     TCLY  MT 3  MI 2  KK 2  VR 1  QZ 1
98P3479     TCLY  CA 1

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FRACTION INTERPRETATION:

    TCLY  Total Clay, <0.002mm

MINERAL INTERPRETATION:

    MT  montmorillon     MI  mica             KK  kaolinite        QZ  quartz           CA  calcite          VR  vermiculite


RELATIVE PEAK SIZE:   5 Very Large   4 Large   3 Medium   2 Small   1 Very Small   6 No Peaks

INTERPRETATION (BY HORIZON):


PEDON MINERALOGY
    BASED ON SAND/SILT:
    BASED ON CLAY:
    FAMILY MINERALOGY:
    COMMENTS:


                              ***   P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A   ***
S98TX-039-004A                          (BRAZORIA COUNTY, TEXAS                          )
                                                                                                                PRINT DATE 12/06/99

SAMPLED AS    : SND-HIGH             ; FINE, SMECTITIC, THERMIC AERIC EPIAQUERT
REVISED TO    :                      ;
                                                                                          UNITED STATES DEPARTMENT OF AGRICULTURE
SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER                                             NATURAL RESOURCES CONSERVATION SERVICE
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- PEDON 98P 583, SAMPLES 98P 3480- 3486
- GENERAL METHODS 1B1A, 2A1, 2B

NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) CLAY LT .002 <- - - - - - - - - - - - - PCT OF <2MM	SILT .002 -.05	SAND .05 -2	FINE LT .0002	CO3 LT .002	(- -CLAY- -) FINE .002 -.02	COARSE .02 -.05	(- - - - - -SILT- -) VF .05 -.10	(- - - - - -SAND- - - - - - -) F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	(-COARSE FRACTIONS(MM)-)(>2MM) - - - - WEIGHT - - - - 2 -5	5 -20	20 -75	.1- 75	WT PCT OF WHOLE SOIL
								(3A1) - - - - - - - - - - - - - - - - - - ->							<- PCT OF <75MM(3B1)->				
98P3480S	0- 15	A	77.5	20.7	1.8	51.5		19.1	1.6	1.2	0.3	0.2	0.1	--	--	--	--	1	--
98P3481S	15- 30	Bw	76.8	21.1	2.1	53.1		20.3	0.8	1.0	0.4	0.4	0.2	0.1	TR	--	--	1	TR
98P3482S	30- 66		73.4	23.1	3.5	26.9		22.7	0.4	0.1	0.6	0.7	1.2	0.9	TR	1	--	4	1
98P3483S	66- 84		68.5	25.2	6.3	24.1	4.1	25.2	TR	0.6	0.8	1.1	1.7	2.1	1	2	--	9	3
98P3484S	84-103		65.1	28.8	6.1	23.1	4.1	27.0	1.8	0.8	0.8	1.0	1.7	1.8	TR	2	--	7	2
98P3485S	103-135		55.0	41.1	3.9	25.1	4.3	34.8	6.3	1.2	0.5	0.6	0.8	0.8	--	--	--	3	--
98P3486S	75-100		68.6	27.9	3.5	24.5	5.8	27.2	0.7	TR	0.9	0.8	0.9	0.9	2	TR	--	5	2

DEPTH (CM)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g OF	MN 6D2g <2MM -->	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT	PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- -	1/3 BAR 4A1d G/CC - -	OVEN DRY 4A1h ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- -	1/10 BAR 4B1c -PCT OF	1/3 BAR 4B1c <2MM	15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 15		0.367			1.4	0.2	TR	0.75	0.48			1.49	1.06	1.78	0.189	22.6		47.9	37.0	0.12
15- 30		0.189			1.9	0.3	0.1	0.70	0.43			1.53	1.09	1.78	0.177	23.5		46.9	33.3	0.15
30- 66		0.123			1.8	0.3	TR	0.65	0.40			1.58	1.18	1.85	0.161	21.2		39.9	29.5	0.12
66- 84		0.092			1.6	0.2	TR	0.59	0.38			1.67	1.26	1.88	0.140	17.8		35.9	25.9	0.12
84-103		0.078			1.5	0.2	TR	0.59	0.38			1.68	1.36	1.96	0.128	18.7		31.7	24.5	0.10
103-135					1.4	0.2	TR	0.56	0.37			1.75	1.40	1.99	0.124	16.6		30.5	20.5	0.14
75-100					1.5	0.2	TR	0.59	0.38			1.65	1.26	1.87	0.138	19.7		37.1	26.0	0.14

AVERAGES, DEPTH 25-100: PCT CLAY 69 PCT .1-75MM 6

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-004A
SAMPLED AS : SND-HIGH ; FINE, SMECTITIC, THERMIC AERIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 583, SAMPLE 98P 3480- 3486

PRINT DATE 12/06/99

DEPTH (CM)	-1- (- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	-2- MG 5B5a 6O2h	-3- NA 5B5a 6P2f	-4- K 5B5a 6Q2f	-5- SUM BASES	-6- ACID-ITY 6H5a	-7-	-8- (- -CEC- -) SUM CATS 5A3a	-9- NH4-OAC 5A8b	-10- EXCH NA 5D2	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- <20MM 6F4	-18- (- - - -PH - - -) SAT PASTE 8C1b	-19- CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->									PCT		<- -PCT- >		<- -PCT ->		<- -PCT ->				
0- 15	46.5	5.6	0.4	1.8	54.3	13.5		67.8	58.0	1		80	94						5.6	5.9
15- 30	53.2	5.2	0.3	1.8	60.5	5.9		66.4	53.8	1	--	91	100					6.5	6.8	6.9
30- 66		4.6	0.4	1.2		1.1			48.0	1	--		100	7				7.3	7.3	7.5
66- 84		4.2	0.4	0.8					40.3	1		100	100	20					7.5	7.8
84-103		4.6	0.4	1.0					38.5	1		100	100	18					7.6	7.9
103-135		4.4	0.5	0.9					31.0	2		100	100	21					7.6	7.9
75-100		4.9	0.5	0.9					40.6	1		100	100	19					7.5	7.8

DEPTH (CM)	(- - - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - - - -) CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	PRED. ELEC. COND. 8A3a MMHOS /cm	PRED. ELEC. COND. 8I MMHOS /cm
	< - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - - ->											<- -PCT- ->			
0- 15															0.18
15- 30	7.1	1.0	--	0.4	--	6.8	TR	0.3	0.6	TR	TR	112.0	TR	0.79	0.45
30- 66	4.6	0.5	--	0.2	--	3.7	TR	0.3	0.4	--	TR	105.2	TR	0.53	0.29
66- 84															0.20
84-103															0.20
103-135															0.18
75-100															0.21

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 1, 4, 5, 6, 7,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-004A PRINT DATE 12/06/99
SAMPLED AS : SND-HIGH ; FINE, SMECTITIC, THERMIC AERIC EPIAQUERT

USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 583, SAMPLE 98P 3480- 3486

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            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

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           < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - - - - -><- - - THERMAL - - - -><- - - - - - - - ELEMENTAL - - - - - - - -><- -> EGME  INTER
SAMPLE       ION <                             >< - DTA - -><- TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                 < - - - - - -  7A2i - - - - - -><- 7A6b - -><- 7A4c - -><- - - - - - - - - - 7C4a- - - - - - - - -><    >  7D2   TION
NUMBER     <- - -><- - - - - peak size - - - - -><- - - Percent - - - -><- - - - - - - - - Percent - - - - - - - -><- -><- - ->

98P3482     TCLY  MT 2  QZ 2  KK 2  CA 2  MI 2
98P3484     TCLY  CA 2  MT 2  QZ 2  KK 2  MI 2
98P3486     TCLY  CA 3  MT 2  QZ 2  KK 1  MI 1

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FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm

MINERAL INTERPRETATION:

MT montmorillon QZ quartz KK kaolinite CA calcite MI mica

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-005 (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SUMPF-LIKE-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 584, SAMPLES 98P 3487- 3494
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM) -1--	HORIZON -2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- - -TOTAL - - -)			(- -CLAY- -)		(- -SILT- -)		(- - - - - -SAND- - - - - -)					(-COARSE FRACTIONS(MM)-)				(>2MM)
				CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	- - - - WEIGHT - - - -				WT
				LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	PCT OF
				.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	WHOLE
				<- - - - - - - - - - - - - PCT OF <2MM (3A1)											- ->	<- PCT OF <75MM(3B1)->				SOIL
98P3487S	0- 11	A		71.4	28.0	0.6	51.8		26.2	1.8	0.3	0.1	0.1	TR	0.1	--	2	--	2	2
98P3488S	11- 38	Bw		72.6	26.9	0.5	52.1		25.6	1.3	0.3	0.1	0.1	TR	--	--	--	--	TR	--
98P3489S	38- 64	Bss		73.0	26.2	0.8	47.1		24.7	1.5	0.4	0.2	0.1	0.1	--	--	--	--	TR	--
98P3490S	64- 95	Bkss		75.0	23.0	2.0	32.5		22.8	0.2	0.3	0.3	0.4	0.5	0.5	--	--	--	2	--
98P3491S	95-125	Bss1		66.2	28.7	5.1	26.5	2.4	27.8	0.9	0.3	0.7	1.0	1.5	1.6	--	--	--	5	--
98P3492S	125-145	Bss2		71.5	26.8	1.7	31.3		26.2	0.6	0.2	0.3	0.3	0.4	0.5	--	--	--	1	--
98P3493S	145-175			55.2	43.5	1.3	28.0	4.9	38.9	4.6	0.2	0.3	0.3	0.2	0.3	--	--	--	1	--
98P3494S	175-200			56.6	42.4	1.0	26.3	4.3	40.0	2.4	0.2	0.3	0.2	0.2	0.1	4	4	--	9	8

DEPTH (CM)	ORGN C	TOTAL N	EXTR P	TOTAL S	(- - DITH-CIT - -)			(RATIO/CLAY)		(ATTERBERG)		(- BULK DENSITY -)			COLE	(- - -WATER CONTENT - -)				WRD
					EXTRACTABLE				15	- LIMITS -		FIELD	1/3	OVEN	WHOLE	FIELD	1/10	1/3	15	WHOLE
					FE	AL	MN	CEC	BAR	LL	PI	MOIST	BAR	DRY	SOIL	MOIST	BAR	BAR	BAR	SOIL
	6A1c	6B4a	6S3b	6R3c	6C2h	6G7g	6D2g	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT	OF	<2MM -->				PCT <0.4MM		<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->				CM/CM
0- 11		0.387			0.6	0.2	--	0.74	0.52			1.43	1.11	1.75	0.162	23.7		43.0	36.9	0.07
11- 38		0.230			1.0	0.2	TR	0.71	0.42			1.54	1.09	1.83	0.189	22.3		47.5	30.3	0.19
38- 64		0.135			1.4	0.2	TR	0.72	0.41			1.60	1.12	1.87	0.186	21.5		47.4	30.2	0.19
64- 95		0.093			1.3	0.2	TR	0.68	0.36			1.55	1.17	1.89	0.173	24.3		44.4	27.1	0.20
95-125		0.075			1.3	0.2	TR	0.63	0.39			1.72	1.27	1.85	0.134	16.1		36.2	25.8	0.13
125-145					1.4	0.2	TR	0.64	0.41			1.64	1.16	1.87	0.173	20.8		44.1	29.4	0.17
145-175					1.0	0.2	TR	0.59	0.40			1.77	1.40	1.95	0.117	16.2		31.4	21.9	0.13
175-200					1.0	0.2	TR	0.60	0.40			1.77	1.39	1.91	0.106	16.7		31.9	22.6	0.12

AVERAGES, DEPTH 25-100: PCT CLAY 73 PCT .1-75MM 1

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-005 PRINT DATE 12/06/99
SAMPLED AS : SUMPF-LIKE-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 584, SAMPLE 98P 3487- 3494

DEPTH (CM)	-1- CA 5B5a 6N2i	-2- MG 5B5a 6O2h	-3- NA 5B5a 6P2f	-4- K 5B5a 6Q2f	-5- SUM BASES	-6- ACID-ITY 6H5a	-7-	-8- SUM CATS 5A3a	-9- NH4-OAC 5A8b	-10- EXCH NA 5D2	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- <20MM 6F4	-18- PH SAT PASTE 8C1b	-19- CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<- -MEQ / 100 G ->									PCT		<- -PCT- >		<- -PCT ->		<- -PCT ->				
0- 11	39.4	5.2	0.3	1.8	46.7	15.5		62.2	53.1	1	TR	75	88					5.0	5.3	5.5
11- 38	42.8	4.9	0.3	1.7	49.7	9.3		59.0	51.6	1		84	96						6.0	6.2
38- 64	47.2	4.7	0.4	1.7	54.0	4.8		58.8	52.6	1	TR	92	100					6.7	6.7	6.7
64- 95		5.7	0.4	1.5		3.1			50.9	1	--		100	2				7.5	7.3	7.5
95-125		6.0	0.4	1.1					41.4	1	TR	100	100	16				7.8	7.6	7.7
125-145		7.1	0.5	1.2		1.0			45.9	1	TR		100	6				7.7	7.6	7.6
145-175		5.6	0.4	0.8					32.5	1	TR	100	100	21				7.4	7.6	7.7
175-200		6.0	0.4	1.1					33.8	1	TR	100	100	19				7.6	7.6	7.8

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	PRED. ELEC. COND. 8A3a MMHOS /cm	PRED. ELEC. COND. 8I MMHOS /cm
	-MEQ / LITER											<- -PCT- ->			
0- 11	4.1	0.8	0.1	0.4	--	1.6	TR	0.5	1.6	TR	0.1	105.2	TR	0.55	0.32
11- 38															0.20
38- 64	3.8	0.6	0.1	0.2	--	3.4	TR	0.5	0.5	TR	0.1	110.9	TR	0.49	0.31
64- 95	2.9	0.4	--	0.1	--	2.8	TR	0.3	0.7	TR	TR	118.2	TR	0.39	0.27
95-125	2.7	0.6	0.1	0.1	--	2.0	TR	0.5	1.3	0.1	0.1	95.4	TR	0.41	0.26
125-145	3.0	0.6	0.2	0.2	--	2.1	0.1	0.6	1.7	TR	0.1	110.2	TR	0.45	0.26
145-175	2.9	0.6	0.1	0.2	--	2.0	0.1	0.7	1.6	--	TR	78.8	TR	0.47	0.26
175-200	2.7	0.6	0.3	0.1	--	2.1	0.1	0.6	1.2	--	TR	87.0	TR	0.46	0.25

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 2,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

```
SAMPLED AS    : SUMPF-LIKE-LOW        ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 584, SAMPLE 98P 3487- 3494

            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- ------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - - - - -><  - - - THERMAL - - - -><  - - - - - - - - ELEMENTAL - - - - - - - -><  - -> EGME  INTER
SAMPLE      ION <                             ><  - DTA - -><  - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                < - - - - - -  7A2i - - - - - -><  - 7A6b - ><  - 7A4c - >< - - - - - - - - - - 7C4a- - - - - - - - -><    >  7D2   TION
NUMBER    <- - ><  - - - - - peak size - - - - -><  - - - Percent - - - -><  - - - - - - - - - Percent - - - - - - - -><  - -><  - ->

98P3488     TCLY  MT 2  QZ 2  KK 2  MI 2  FD 1
98P3490     TCLY  MT 3  QZ 2  KK 2  MI 2
98P3492     TCLY  MT 3  MI 2  KK 2  QZ 2  CA 1
98P3494     TCLY  MT 3  CA 2  KK 2  MI 2  QZ 1

--------- ------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - - SAND - SILT MINERALOGY (2.0-0.002mm) - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - -><  - - - THERMAL - - - -><  - - - - - - -  OPTICAL - - - - - - - - -><                > INTER
SAMPLE      ION <                       ><  - DTA - -><  - TGA - ->TOT RE<  - - - - - GRAIN COUNT - - - - - -><                > PRETA
                < - - - - 7A2i - - - - -><  - 7A6b - ><  - 7A4c - >< - - - - - - - -  7B1a - - - - - - - - -><                >  TION
NUMBER    < - -><  - - - Peak Size - - -><  - - - Percent - - - -><  - - - - - - - - - Percent - - - - - - - -><  - - - - - - - -><  - ->

98P3488     CSi                                                    72  QZ62  FK20  FE 6  OP 3  BT 2  GS 2
98P3488     CSi                                                        PR 1  MS 1  HN 1  FP 1  GN 1  CA 1
98P3488     CSi                                                        ZRtr  POtr  SStr  TMtr
98P3494     CSi                                                    50  QZ47  CA34  FK13  OP 2  MS 1  HN 1
98P3494     CSi                                                        FE 1  BT 1  PRtr  ZRtr  TMtr  POtr
98P3494     CSi                                                        GStr  BYtr

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FRACTION INTERPRETATION:

    TCLY  Total Clay, <0.002mm            CSi   Coarse Silt, 0.02-0.05mm

MINERAL INTERPRETATION:

    MT  montmorillon     QZ  quartz          KK  kaolinite        MI  mica            FD  feldspar         FK  potas feldsp
    FE  iron oxides      OP  opaques         BT  biotite          GS  glass           PR  pyroxene         MS  muscovite
    HN  hornblende       FP  plag-feldspa    GN  garnet           CA  calcite         ZR  zircon           PO  plant opal
    SS  spon spicule     TM  tourmaline      BY  beryl

RELATIVE PEAK SIZE:   5 Very Large   4 Large   3 Medium   2 Small   1 Very Small   6 No Peaks

INTERPRETATION (BY HORIZON):
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PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-005A (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SUMPF-LIKE-HIGH ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC EPIAQUERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 585, SAMPLES 98P 3495- 3502
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) CLAY LT .002	SILT .002 -.05	SAND .05 -2	FINE LT .0002	(- -CLAY- -) CO3 LT .002	(- -SILT- -) FINE .02 -.02	COARSE .05 -.05	VF .10 -.10	(- - - - - -SAND- - - - - -) F .25 -.25	M .50 -.50	C 1 -1	VC 2 -2	(-COARSE FRACTIONS(MM)-) 5 -5	- - - - WEIGHT - - - - 20 -20	-75	.1- 75	(>2MM) WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
98P3495S	0- 11	A	72.1	27.4	0.5	49.8		25.0	2.4	0.2	0.1	0.1	0.1	--	3	5	--	8	8
98P3496S	11- 20	Bw	71.4	27.8	0.8	47.1		25.4	2.4	0.3	0.2	0.1	0.1	0.1	1	2	--	3	3
98P3497S	20- 50	Bkss1	59.9	36.2	3.9	25.2	2.4	34.2	2.0	0.4	0.6	1.0	1.1	0.8	2	1	--	6	3
98P3498S	50- 75	Bkss2	57.8	38.8	3.4	28.7	3.8	35.4	3.4	0.3	0.6	0.8	0.8	0.9	2	TR	--	5	2
98P3499S	75-100	Bkss3	51.7	45.2	3.1	24.3	4.3	40.2	5.0	0.4	0.6	0.7	0.7	0.7	3	TR	--	6	3
98P3500S	100-130	Bss1	57.2	40.0	2.8	25.3	4.9	36.4	3.6	0.3	0.5	0.7	0.8	0.5	TR	1	--	3	1
98P3501S	130-153	Bss2	54.7	43.8	1.5	23.6	4.9	40.0	3.8	0.2	0.3	0.3	0.3	0.4	TR	1	--	2	1
98P3502S	153-200		57.6	41.6	0.8	24.7	6.0	39.7	1.9	0.1	0.1	0.2	0.2	0.2	TR	1	--	2	1

DEPTH (CM)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g OF	MN 6D2g <2MM -->	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT	PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- -	1/3 BAR 4A1d G/CC - - ->	OVEN DRY 4A1h	COLE WHOLE SOIL CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- -	1/10 BAR 4B1c -PCT OF	1/3 BAR 4B1c <2MM	15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 11		0.308			1.1	0.2	--	0.49	0.50			1.50	0.98	1.67	0.186	18.6		51.2	35.8	0.15
11- 20		0.154			1.9	0.2	TR	0.70	0.43			1.70	1.09	1.88	0.195	18.2		48.7	30.8	0.19

20- 50	0.094	1.3	0.2	TR	0.64	0.41	1.75	1.23	1.91	0.155	13.5	38.7	24.4	0.17
50- 75	0.069	1.1	0.2	TR	0.61	0.34	1.77	1.28	1.94	0.146	13.0	35.4	19.8	0.20
75-100	0.054	1.1	0.2	TR	0.62	0.41	1.84	1.35	1.99	0.136	11.5	32.1	21.0	0.15
100-130		1.1	0.2	TR	0.60	0.40	1.86	1.36	1.95	0.127	12.1	31.4	22.7	0.12
130-153		1.0	0.2	TR	0.60	0.40	1.87	1.41	1.98	0.119	11.8	29.5	22.1	0.10
153-200		1.0	0.1	TR	0.59	0.40	1.81	1.40	1.92	0.110	15.6	30.8	23.0	0.11

AVERAGES, DEPTH 25-100: PCT CLAY 53 PCT .1-75MM 6

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-005A PRINT DATE 12/06/99
SAMPLED AS : SUMPF-LIKE-HIGH ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 585, SAMPLE 98P 3495- 3502

DEPTH (CM)	-1- CA 5B5a 6N2i	-2- MG 5B5a 6O2h	-3- NA 5B5a 6P2f	-4- K 5B5a 6Q2f	-5- SUM BASES	-6- ACID-ITY 6H5a	-7-	-8- SUM CATS 5A3a	-9- NH4-OAC 5A8b	-10- EXCH NA 5D2	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- <20MM 6F4	-18- (-PH-) SAT PASTE 8C1b	-19- CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<-MEQ / 100 G->									PCT		<-PCT->		<-PCT->		<-PCT->				
0- 11	64.6	5.9	0.4	1.1	72.0	14.1		86.1	35.0	1		84	100						5.5	5.7
11- 20	46.2	4.0	0.3	1.7	52.2	8.0		60.2	49.7	1	TR	87	100			--		6.4	6.5	6.9
20- 50		2.8	0.3	1.3					38.2	1		100	100	17					7.4	7.7
50- 75		3.3	0.3	1.0					35.3	1		100	100	10					7.5	7.8
75-100		3.5	0.4	0.7					31.8	1		100	100	23					7.6	7.8
100-130		4.5	0.4	1.0					34.6	1		100	100	22					7.5	7.8
130-153		4.9	0.4	1.1					32.8	1		100	100	22					7.6	8.1
153-200		5.6	0.4	1.2					33.7	1		100	100	22				7.5	7.6	7.9

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	ELEC. COND. 8A3a MMHOS /cm	PRED. ELEC. COND. 8I MMHOS /cm
	<-MEQ / LITER->											<-PCT->			
0- 11															0.24
11- 20	5.2	0.7	TR	0.3	--	4.9	TR	0.5	0.5	TR	0.1	108.0	TR	0.66	0.51

```
 20- 50                                                                                                          0.22
 50- 75                                                                                                          0.19
 75-100                                                                                                          0.17
100-130                                                                                                          0.19
130-153                                                                                                          0.23
153-200      2.7   0.6         0.2    --   2.5   0.1   0.3   1.0    TR    TR  94.2    TR  0.42  0.32

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        MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS  1,  3,  4,  5,  6,  7,

        ANALYSES:  S= ALL ON SIEVED <2mm BASIS

                              ***   P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A   ***

S98TX-039-005A                                                                                          PRINT DATE 12/06/99
SAMPLED AS    : SUMPF-LIKE-HIGH       ; VERY-FINE, SMECTITIC, HYPERTHERMIC AERIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 585, SAMPLE 98P 3495- 3502

            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- -------------------------------------------------------------------------------------------------------------------
           < - - - - - - - - - - - - - - - - - - - - - - - CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - - - - - ->< - - - THERMAL - - - ->< - - - - - - - - ELEMENTAL - - - - - - - - ->< - -> EGME  INTER
SAMPLE       ION <                           >< - DTA - ->< - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                 < - - - - - -  7A2i - - - - - ->< - 7A6b - >< - 7A4c - >< - - - - - - - - - - 7C4a- - - - - - - - - -><    >  7D2   TION
NUMBER     <- - >< - - - - peak size - - - - ->< - - - Percent - - - ->< - - - - - - - - - Percent - - - - - - - - ->< - -->< - ->

98P3497     TCLY  MT 3  CA 2  KK 2  MI 2  QZ 2
98P3499     TCLY  CA 3  MT 2  QZ 2  KK 2  MI 2
98P3502     TCLY  MT 3  CA 3  KK 2  MI 2  QZ 1

--------- -------------------------------------------------------------------------------------------------------------------
           < - - - - - - - - - - - - - - - - - - - - - SAND - SILT MINERALOGY (2.0-0.002mm) - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - -->< - - - THERMAL - - - ->< - - - - - - - -  OPTICAL - - - - - - - - - -><               > INTER
SAMPLE       ION <                     >< - DTA - ->< - TGA - ->TOT RE< - - - - - - GRAIN COUNT - - - - - - -><               > PRETA
                 < - - - - - 7A2i - - - - - >< - 7A6b - >< - 7A4c - >< - - - - - - - - - -  7B1a - - - - - - - - - -><               >  TION
NUMBER     < - -->< - - - Peak Size - - -->< - - - Percent - - - ->< - - - - - - - - - Percent - - - - - - - - ->< - - - - - - - - -->< - ->

98P3497     CSi                                                     47  QZ42  CA40  FK 9  FE 4  MS 1  PR 1
98P3497     CSi                                                         OP 1  BT 1  MZ 1  HNtr  ZRtr  GNtr
98P3497     CSi                                                         BYtr  TMtr  POtr  GStr
98P3502     CSi                                                     52  QZ48  CA28  FK14  FE 3  HN 2  MS 2
98P3502     CSi                                                         OP 1  MZ 1  BT 1  PRtr  GStr  POtr
```

98P3502 CSi TMtr BYtr ZRtr LAtr GNtr FFtr

FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm CSi Coarse Silt, 0.02-0.05mm

MINERAL INTERPRETATION:

MT	montmorillon	CA	calcite	KK	kaolinite	MI	mica	QZ	quartz	FK	potas feldsp
FE	iron oxides	MS	muscovite	PR	pyroxene	OP	opaques	BT	biotite	MZ	monazite
HN	hornblende	ZR	zircon	GN	garnet	BY	beryl	TM	tourmaline	PO	plant opal
GS	glass	LA	lamprobolite	FF	foraminifera						

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-006 (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : SND ; FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 586, SAMPLES 98P 3503- 3510
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

---

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -)(- -CLAY- -)(- -SILT- -)(- - - - - -SAND- - - - - -)(-COARSE FRACTIONS(MM)-)(>2MM)																	
			CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	- - - - WEIGHT - - - -				WT	
			LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	PCT OF	
			.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	WHOLE	
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - ->											<- PCT OF <75MM(3B1)->					SOIL	

98P3503S	0- 14	A	60.3	36.1	3.6	42.5		21.9	14.2	3.3	0.1	0.1	0.1	TR	--	TR	--	TR	TR
98P3504S	14- 44	Bw	56.7	38.5	4.8	39.7		21.7	16.8	4.5	0.1	0.1	0.1	--	--	TR	--	TR	TR
98P3505S	44- 82	Bss1	55.9	38.5	5.6	35.3		21.5	17.0	4.6	0.3	0.2	0.3	0.2	--	--	--	1	--
98P3506S	82-129	Bss2	55.9	38.2	5.9	33.0		20.2	18.0	4.8	0.2	0.2	0.3	0.4	1	1	--	3	2
98P3507S	129-152	Bkss	50.4	39.5	10.1	28.2		21.4	18.1	5.6	0.7	1.0	1.1	1.7	TR	2	--	6	2
98P3508S	152-178	2Bk1	28.4	62.8	8.8	17.0	0.7	36.0	26.8	6.4	0.6	0.8	0.6	0.4	--	--	--	2	--
98P3509S	178-196	2Bk2	37.1	57.5	5.4	21.1	2.4	35.8	21.7	3.9	0.4	0.4	0.4	0.3	--	--	--	1	--
98P3510S	196-220	3Bss	58.6	39.0	2.4	29.4	5.4	33.6	5.4	1.0	0.3	0.4	0.3	0.4	--	--	--	1	--

DEPTH (CM)	ORGN TOTAL C 6A1c PCT	N 6B4a <2MM	EXTR TOTAL P 6S3b PPM	S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g OF	MN 6D2g <2MM -->	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT	PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- -	1/3 BAR 4A1d G/CC -	OVEN DRY 4A1h - ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- -	1/10 BAR 4B1c -PCT OF	1/3 BAR 4B1c <2MM	15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 14		0.337			1.0	0.2	TR	0.84	0.38			1.54	1.08	1.73	0.170	16.4		42.5	22.9	0.21
14- 44		0.185			1.0	0.2	TR	0.74	0.36			1.69	1.22	1.88	0.155	13.1		35.3	20.6	0.18
44- 82		0.122			1.0	0.2	TR	0.71	0.35			1.71	1.29	1.92	0.142	15.5		33.8	19.8	0.18
82-129		0.086			0.9	0.2	--	0.69	0.38			1.78	1.32	1.96	0.139	14.6		33.1	21.0	0.16
129-152					1.0	0.2	TR	0.69	0.43			1.84	1.39	1.99	0.125	12.0		29.1	21.9	0.10
152-178					1.0	0.1	TR	0.65	0.47			1.84	1.52	1.91	0.079	9.2		23.0	13.4	0.15
178-196					1.1	0.1	TR	0.60	0.42			1.80	1.50	1.99	0.099	10.4		24.2	15.7	0.13
196-220					1.5	0.1	TR	0.57	0.36			1.83	1.38	1.96	0.124	13.0		30.5	21.1	0.13

AVERAGES, DEPTH 25-100: PCT CLAY 56 PCT .1-75MM 1

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-006 PRINT DATE 12/06/99
SAMPLED AS : SND ; FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 586, SAMPLE 98P 3503- 3510

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	MG 5B5a 6O2h	NA 5B5a 6P2f	K 5B5a 6Q2f	SUM BASES <- - - - - - - - - -MEQ / 100	ACID-ITY 6H5a G - - - - - - - - - ->	(- -CEC- -) SUM CATS 5A3a	NH4- OAC 5A8b	EXCH NA 5D2 PCT	SAR 5E	BASE SATURATION SUM 5C3 <- -PCT- >	NH4OAC 5C1	CARBONATE AS CACO3 <2MM 6E1h <- -PCT ->	<20MM 6E4b	CASO4 AS GYPSUM <2MM 6F1a <- -PCT ->	<20MM 6F4	(- - - -PH - - -) SAT PASTE 8C1b	CACL2 .01M 8C1f 1:2	H2O 8C1f 1:1
0- 14	44.4	4.2	0.4	1.2	50.2	11.2	61.4	50.9	1	--	82	99					6.1	6.1	6.2

14- 44		3.7	0.4	1.2		3.7			42.1	1	TR		100	1				6.6	7.2	7.4
44- 82		4.8	0.5	0.8		1.1			39.8	1	TR		100	1				7.1	7.5	7.9
82-129		6.4	0.7	0.8		1.2			38.7	2	1		100	2				7.4	7.5	7.7
129-152		7.6	0.8	0.7		--			34.9	2	1	100	100	8				7.5	7.6	7.8
152-178		5.0	0.7	0.5					18.5	3	1	100	100	21				7.8	7.7	8.2
178-196		6.7	0.9	0.5					22.3	3	2	100	100	18		--		7.7	7.8	8.1
196-220		10.7	1.5	0.9					33.5	4	2	100	100	20				7.8	7.7	8.0

DEPTH (CM)	(- - - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - -												TOTAL SALTS EST.	ELEC. COND.	)PRED. ELEC. COND.
	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O			
	6N1d	6O1d	6P1d	6Q1d	6I1b	6J1b	6U1c	6K1e	6L1e	6W1c	6M1e	8A	8D5	8A3a	8I
	< - - - - - - - - - - - - - - - -MEQ / LITER	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - ->	<- -PCT-	->	MMHOS /cm	MMHOS /cm
0- 14	9.7	1.5	--	0.4	--	7.4	TR	0.4	1.4	--	TR	99.3	0.1	1.08	0.37
14- 44	8.1	1.0	0.1	0.2	--	7.5	TR	0.3	0.7	TR	--	96.6	TR	0.82	0.39
44- 82	4.8	0.8	0.4	0.1	--	4.8	TR	0.5	1.0	TR	TR	88.4	TR	0.65	0.30
82-129	4.0	0.9	0.8	0.1	--	3.0	0.1	1.2	1.9	--	TR	79.1	TR	0.65	0.30
129-152	4.2	1.4	1.6	0.1	--	2.6	0.1	1.0	4.3	--	TR	81.1	TR	0.80	0.40
152-178	2.4	1.0	1.4	0.1	--	2.1	0.1	1.1	2.1	--	TR	58.5	TR	0.58	0.30
178-196	2.1	1.0	2.0	0.1	--	2.5	0.1	1.0	2.0	--	TR	67.6	TR	0.60	0.59
196-220	1.5	0.8	2.2	0.1	--	10.1	0.1	1.5	1.3	--	TR	94.3	TR	0.57	0.43

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A ***

S98TX-039-006 PRINT DATE 12/06/99
SAMPLED AS : SND ; FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 586, SAMPLE 98P 3503- 3510

```
           -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- ------------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - - - - -><  - - - THERMAL - - - -><  - - - - - - - - ELEMENTAL - - - - - - - - -><  - -> EGME  INTER
SAMPLE      ION <                             >< - DTA - -><  - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
                < - - - - - -  7A2i - - - - - -><  - 7A6b - ><  - 7A4c - ><  - - - - - - - - - - 7C4a- - - - - - - - - -><    >  7D2   TION
NUMBER    <- - ><  - - - - peak size - - - - -><  - - - Percent - - - -><  - - - - - - - - - Percent - - - - - - - - -><  - -><  - ->
```

```
98P3504     TCLY  MT 3  KK 2  MI 2  QZ 2
98P3506     TCLY  MT 3  MI 2  VR 2  KK 2  QZ 2
98P3508     TCLY  MT 3  MI 2  KK 2  CA 2  VR 1
98P3508     TCLY  QZ 1
98P3510     TCLY  MT 3  CA 2  KK 2  MI 2  QZ 1

--------- ------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - SAND - SILT MINERALOGY (2.0-0.002mm) - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - - X-RAY - - -><- - - THERMAL - - - -><- - - - - - - -  OPTICAL - - - - - - - - -><                > INTER
SAMPLE      ION <                      >< - DTA - -><- TGA - ->TOT RE< - - - - - GRAIN COUNT - - - - - -><                > PRETA
                < - - - - 7A2i - - - - >< - 7A6b - >< - 7A4c - >< - - - - - - - - -  7B1a - - - - - - - - -><                >  TION
NUMBER    < - -><- - - Peak Size - - -><- - - Percent - - - -><- - - - - - - - - Percent - - - - - - - -><- - - - - - - - -><- ->

98P3510     CSi                                                   54  QZ51  CA27  FK14  FE 3  BT 1  MS 1
98P3510     CSi                                                       PR 1  OPtr  FFtr  TMtr  HNtr  BYtr
98P3510     CSi                                                       ANtr  GNtr

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FRACTION INTERPRETATION:

    TCLY  Total Clay, <0.002mm            CSi   Coarse Silt, 0.02-0.05mm

MINERAL INTERPRETATION:

    MT  montmorillon     KK  kaolinite        MI  mica            QZ  quartz           VR  vermiculite      CA  calcite
    FK  potas feldsp     FE  iron oxides      BT  biotite         MS  muscovite        PR  pyroxene         OP  opaques
    FF  foraminifera     TM  tourmaline       HN  hornblende      BY  beryl            AN  andalusite       GN  garnet

RELATIVE PEAK SIZE:   5 Very Large   4 Large   3 Medium   2 Small   1 Very Small   6 No Peaks

INTERPRETATION (BY HORIZON):


PEDON MINERALOGY
    BASED ON SAND/SILT:
    BASED ON CLAY:
    FAMILY MINERALOGY:
    COMMENTS:


                              ***   P R I M A R Y   C H A R A C T E R I Z A T I O N   D A T A   ***
S98TX-039-007                           (BRAZORIA COUNTY, TEXAS                          )
                                                                                                          PRINT DATE 12/06/99
SAMPLED AS    : PLEDGER-LOW-LOW      ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
REVISED TO    :                      ;
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SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 587, SAMPLES 98P 3511- 3519
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
			(- - -TOTAL - - -)			(- -CLAY- -)		(- -SILT- -)		(- - - - - -SAND- - - - - -)					(-COARSE FRACTIONS(MM)-)				(>2MM)
			CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	- - - - WEIGHT - - - -				WT
SAMPLE	DEPTH	HORIZON	LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	PCT OF
NO.	(CM)		.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	WHOLE
			<- - - - - - - - - - - - - PCT OF <2MM						(3A1) - - - - - - - - - - - - - - ->						<- PCT OF <75MM(3B1)->				SOIL
98P3511S	0- 23	A	59.3	29.1	11.6	37.7		22.0	7.1	8.7	1.4	0.4	0.4	0.7	--	--	--	3	--
98P3512S	23- 43	Bw	60.1	28.7	11.2	35.8		22.5	6.2	8.5	1.7	0.5	0.4	0.1	--	--	--	3	--
98P3513S	43- 65	Bss1	61.5	27.5	11.0	31.9		21.6	5.9	8.3	1.5	0.5	0.3	0.4	--	--	--	3	--
98P3514S	65- 88	Bss2	60.9	28.2	10.9	32.8		22.5	5.7	8.9	1.2	0.4	0.3	0.1	--	--	--	2	--
98P3515S	88-119	Bss3	59.0	28.0	13.0	30.3		21.9	6.1	9.5	1.5	0.5	0.5	1.0	--	--	--	3	--
98P3516S	119-147	Bss4	55.3	29.7	15.0	27.5	2.7	22.9	6.9	10.5	1.9	0.6	0.9	1.1	--	--	--	4	--
98P3517S	147-163	Bssk1	55.9	33.0	11.1	26.9	3.2	27.7	5.3	7.6	1.6	0.6	0.7	0.6	--	TR	--	3	--
98P3518S	163-190	Bssk2	71.1	25.2	3.7	29.8	3.5	24.7	0.5	2.0	0.5	0.4	0.4	0.4	--	--	--	2	--
98P3519S	190-212	Bssk3	75.7	21.3	3.0	33.6		21.3	TR	0.9	0.4	0.5	0.7	0.5	--	TR	--	2	TR

	ORGN	TOTAL	EXTR	TOTAL	(- - DITH-CIT - -)			(RATIO/CLAY)		(ATTERBERG)		(- BULK DENSITY -)			COLE	(- - -WATER CONTENT - -)				WRD
	C	N	P	S	EXTRACTABLE				15	- LIMITS -		FIELD	1/3	OVEN	WHOLE	FIELD	1/10	1/3	15	WHOLE
DEPTH					FE	AL	MN	CEC	BAR	LL	PI	MOIST	BAR	DRY	SOIL	MOIST	BAR	BAR	BAR	SOIL
(CM)	6A1c	6B4a	6S3b	6R3c	6C2h	6G7g	6D2g	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT		OF	<2MM -->			PCT <0.4MM		<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->				CM/CM
0- 23		0.283			1.2	0.2	TR	0.78	0.56			1.56	1.17	1.80	0.154	16.4		38.4	33.0	0.06
23- 43		0.201			1.2	0.2	TR	0.73	0.49			1.59	1.18	1.80	0.151	14.2		36.0	29.5	0.08
43- 65		0.149			1.2	0.2	TR	0.73	0.41			1.67	1.24	1.90	0.153	15.7		35.6	25.3	0.13
65- 88		0.130			1.2	0.2	TR	0.71	0.38			1.72	1.26	1.90	0.147	15.7		36.2	23.2	0.16
88-119		0.114			1.1	0.2	TR	0.71	0.41			1.80	1.26	1.91	0.149	13.5		35.3	24.3	0.14
119-147		0.079			1.1	0.2	TR	0.65	0.39			1.88	1.40	2.00	0.126	10.5		29.3	21.8	0.11
147-163		0.059			1.1	0.1	TR	0.60	0.39			1.87	1.44	2.01	0.117	12.2		28.2	21.8	0.09
163-190		0.072			1.6	0.2	TR	0.56	0.36			1.77	1.26	1.96	0.159	16.5		37.7	25.5	0.15
190-212		0.070			1.8	0.2	TR	0.59	0.39			1.66	1.21	1.93	0.168	20.2		41.5	29.7	0.14

AVERAGES, DEPTH 25-100: PCT CLAY 61 PCT .1-75MM 3

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-007 PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-LOW-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 587, SAMPLE 98P 3511- 3519

DEPTH (CM)	-1-- CA 5B5a 6N2i	-2-- MG 5B5a 6O2h	-3-- NA 5B5a 6P2f	-4-- K 5B5a 6Q2f	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7--	-8-- SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- NA 5D2	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- <20MM 6F4	-18- PH SAT PASTE 8C1b	-19- CACL2 .01M 8C1f	-20- H2O 8C1f
	(- NH4OAC EXTRACTABLE BASES -)					ACID-		(- -CEC- -)		EXCH	SAR	BASE		CARBONATE		CASO4 AS		(- - - -PH - - -)		
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - ->									PCT		<- -PCT- >		<- -PCT ->		<- -PCT ->			1:2	1:1
0- 23		5.4	0.5	1.3		2.3			46.0	1	TR		100	5				6.7	7.4	7.5
23- 43		5.0	0.5	1.1		1.3			43.9	1			100	5					7.4	7.6
43- 65		6.5	0.9	1.1		1.1			44.6	2	1		100	4				7.3	7.6	7.8
65- 88		7.2	1.1	0.8		1.2			43.3	2	1		100	5				7.4	7.5	7.7
88-119		8.7	1.5	0.7		--			42.0	3	2	100	100	5				7.6	7.6	7.7
119-147		9.4	2.0	0.7					35.8	4	3	100	100	11				7.6	7.6	7.8
147-163		10.5	3.1	0.6					33.5	7	5	100	100	16		--		7.6	7.9	7.9
163-190	58.9	14.2	5.0	0.9	79.0			79.0	39.5	8	7	100	100			--		7.6	7.6	7.9
190-212		16.4	6.2	1.0		--			44.3	8	7	100	100	7		--		7.6	7.7	7.9

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	ELEC. COND. 8A3a MMHOS /cm	PRED. ELEC. COND. 8I MMHOS /cm
	(- - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - -)														
	< - - - - - - - - - - - - - -MEQ / LITER - - - - - - - - - - - - ->											<- -PCT- ->			
0- 23	10.6	1.9	0.4	0.3	--	10.1	--	0.8	0.9	TR	TR	90.8	0.1	1.23	0.42
23- 43															0.22
43- 65	4.1	0.9	1.2	0.1	--	4.3	TR	0.9	0.9	--	TR	91.5	TR	0.68	0.27
65- 88	3.1	0.8	1.6	0.1	--	3.8	0.1	0.9	0.9	--	TR	94.5	TR	0.63	0.33
88-119	2.3	0.8	2.5	0.1	--	3.2	0.1	1.4	1.2	--	TR	89.9	TR	0.65	0.36
119-147	2.4	1.0	4.3	0.1	--	3.4	0.1	3.1	1.6	--	0.1	86.6	TR	0.89	0.44
147-163	3.4	2.0	8.8	0.1	--	2.5	0.1	8.2	4.6	--	0.1	83.9	0.1	1.58	0.82
163-190	8.0	5.9	17.6	0.3	--	1.5	0.2	20.8	10.8	--	--	102.0	0.2	3.40	1.94
190-212	10.2	6.2	21.2	0.2	--	1.0	0.2	26.1	13.1	--	--	118.3	0.3	3.75	2.85

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 2,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-007 PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-LOW-LOW ; VERY-FINE, SMECTITIC, HYPERTHERMIC TYPIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 587, SAMPLE 98P 3511- 3519

```
            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- ------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - -  CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - X-RAY - - - - - -><- - - THERMAL - - - -><- - - - - - - ELEMENTAL - - - - - - -><- -> EGME  INTER
SAMPLE      ION <                            ><- DTA - -><- TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <    > RETN  PRETA
              < - - - - -  7A2i - - - - -><- 7A6b - ><- 7A4c - ><- - - - - - - - - 7C4a- - - - - - - -><    >  7D2   TION
NUMBER    <- - ><- - - - peak size - - - -><- - - Percent - - -><- - - - - - - - Percent - - - - - - -><- -><- - ->

98P3512     TCLY  MT 3  KK 2  QZ 2  MI 2  CA 1
98P3514     TCLY  MT 3  KK 3  MI 2  CA 2  QZ 2
98P3517     TCLY  MT 3  KK 2  MI 2  CA 2  QZ 2
98P3519     TCLY  MT 2  KK 2  MI 2  QZ 1  CA 1

--------- ------------------------------------------------------------------------------------------------------------------------
          < - - - - - - - - - - - - - - - - - - - - - - SAND - SILT MINERALOGY (2.0-0.002mm) - - - - - - - - - - - - - - - - - - - - >
          FRACT < - - - - - X-RAY - - -><- - - THERMAL - - - -><- - - - - - -  OPTICAL - - - - - - - - -><                > INTER
SAMPLE      ION <                     ><- DTA - -><- TGA - ->TOT RE< - - - - - GRAIN COUNT - - - - - -><                > PRETA
              < - - - - 7A2i - - - - -><- 7A6b - ><- 7A4c - ><- - - - - - - -  7B1a - - - - - - - - -><                >  TION
NUMBER    < - -><- - - Peak Size - - -><- - - Percent - - -><- - - - - - - - Percent - - - - - - - -><- - - - - - - -><- - ->

98P3519     VFS                                                   54  CB32  QZ28  FE21  FK12  OP 4  CD 1
98P3519     VFS                                                       BT 1  MS 1  GStr  GNtr  HNtr

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FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm VFS Very Fine Sand, 0.05-0.10mm

MINERAL INTERPRETATION:

MT	montmorillon	KK	kaolinite	QZ	quartz	MI	mica	CA	calcite	CB	carb-aggrega
FE	iron oxides	FK	potas feldsp	OP	opaques	CD	chalcedony	BT	biotite	MS	muscovite
GS	glass	GN	garnet	HN	hornblende						

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-007A (BRAZORIA COUNTY, TEXAS)

PRINT DATE 12/06/99

SAMPLED AS : PLEDGER-HIGH ; VERY-FINE, SMECTITIC, THERMIC AERIC EPIAQUERT
REVISED TO : ;

SSL - PROJECT 98P 100, (CP98TX146) TX-PLEDGER
- PEDON 98P 588, SAMPLES 98P 3520- 3527
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SAMPLE NO.	DEPTH (CM)	HORIZON	-1-- CLAY LT .002	-2-- SILT .002 -.05	-3-- SAND .05 -2	-4-- FINE LT .0002	-5-- CO3 LT .002	-6-- FINE .02 -.02	-7-- COARSE .02 -.05	-8-- VF .05 -.10	-9-- F .10 -.25	-10- M .25 -.50	-11- C .5 -1	-12- VC 1 -2	-13- 2 -5	-14- 5 -20	-15- 20 -75	-16- .1- 75	-17- PCT OF WHOLE SOIL
			(- - -TOTAL - - -)			(- -CLAY- -)		(- -SILT- -)		(- - - - - -SAND- - - - - -)				(-COARSE FRACTIONS(MM)-)(>2MM)					
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - ->											<- PCT OF <75MM(3B1)->					
			- - - - WEIGHT - - - -																
98P3520S	0- 12	A	49.6	32.8	17.6	34.6		21.5	11.3	13.4	2.5	0.6	0.8	0.3	--	--	--	4	--
98P3521S	12- 32	Bk	40.0	39.5	20.5	21.8	4.6	25.6	13.9	15.8	2.9	0.6	0.7	0.5	--	--	--	5	--
98P3522S	32- 63	Bkss1	44.8	39.0	16.2	21.7	4.0	29.7	9.3	8.2	2.1	1.2	1.8	2.9	--	--	--	8	--
98P3523S	63- 97	Bkss2	60.9	30.6	8.5	25.7	4.1	28.3	2.4	2.3	1.0	1.0	1.6	2.6	--	--	--	6	--
98P3524S	97-123	Bkss3	62.1	36.2	1.7	28.2	4.9	35.1	1.1	0.4	0.4	0.3	0.3	0.3	--	--	--	1	--
98P3525S	123-146	Bkss4	67.5	30.4	2.1	32.1	4.9	30.3	0.1	1.0	0.3	0.3	0.2	0.3	--	--	--	1	--
98P3526S	146-183	Bkss5	77.9	20.6	1.5	36.0	3.8	20.6	TR	0.3	0.2	0.3	0.4	0.3	--	--	--	1	--
98P3527S	183-212	Bss	69.5	28.7	1.8	33.4	3.5	27.3	1.4	0.9	0.3	0.2	0.3	0.1	--	--	--	1	--

DEPTH (CM)	ORGN TOTAL C 6A1c	N 6B4a	EXTR TOTAL P 6S3b	S 6R3c	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g	MN 6D2g	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1	PI 4F	(- BULK DENSITY -) FIELD MOIST 4A5	1/3 BAR 4A1d	COLE OVEN DRY 4A1h	WHOLE SOIL 4D1	(- - -WATER CONTENT - -) FIELD MOIST 4B4	1/10 BAR 4B1c	1/3 BAR 4B1c	15 BAR 4B2a	WRD WHOLE SOIL 4C1

	PCT <2MM	PPM <- PERCENT OF <2MM -->					PCT <0.4MM	<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->			CM/CM
0- 12	0.363	1.1	0.2	TR	0.85	0.62		1.33	1.02	1.54	0.147	18.1	42.0	30.9	0.11
12- 32	0.104	1.0	0.2	TR	0.65	0.51		1.78	1.44	1.79	0.075	6.4	23.6	20.3	0.05
32- 63	0.077	1.1	0.2	TR	0.63	0.43		1.90	1.49	1.95	0.094	7.5	23.6	19.4	0.06
63- 97	0.070	1.4	0.2	TR	0.58	0.38		1.81	1.35	1.97	0.134	13.8	31.6	23.3	0.11
97-123	0.074	1.4	0.2	TR	0.58	0.39		1.81	1.32	1.96	0.141	14.0	33.2	24.1	0.12
123-146		1.5	0.1	TR	0.56	0.38		1.81	1.31	1.95	0.142	13.0	33.2	25.8	0.10
146-183		1.9	0.1	TR	0.56	0.38		1.66	1.28	1.92	0.145	20.2	37.0	29.9	0.09
183-212		1.8	0.1	TR	0.60	0.40		1.58	1.23	1.92	0.160	23.9	40.7	27.8	0.16

AVERAGES, DEPTH 25-100: PCT CLAY 48 PCT .1-75MM 7

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

S98TX-039-007A PRINT DATE 12/06/99
SAMPLED AS : PLEDGER-HIGH ; VERY-FINE, SMECTITIC, THERMIC AERIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 588, SAMPLE 98P 3520- 3527

DEPTH (CM)	-1-- CA 6N2i	-2-- MG 6O2h	-3-- NA 6P2f	-4-- K 6Q2f	-5-- SUM BASES	-6-- ACIDITY 6H5a	-7--	-8-- SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- EXCH NA 5D2	-11- SAR 5E	-12- BASE SATURATION SUM 5C3	-13- NH4OAC 5C1	-14- CARBONATE AS CACO3 <2MM 6E1h	-15- <20MM 6E4b	-16- CASO4 AS GYPSUM <2MM 6F1a	-17- <20MM 6F4	-18- (- - - -PH - - -) SAT PASTE 8C1b	-19- CACL2 .01M 8C1f	-20- H2O 8C1f
	<- - - - - - - - - -MEQ / 100 G - - - - - - - - - - ->									PCT		<- -PCT- >		<- -PCT ->		<- -PCT ->			1:2	1:1
0- 12		4.6	0.5	1.0					42.3	1	TR	100	100	6		--		7.0	7.2	7.3
12- 32		3.4	0.3	0.4					26.0	1	TR	100	100	17				7.3	7.5	8.0
32- 63		6.8	0.7	0.5					28.1	2		100	100	28					7.7	8.1
63- 97		11.2	1.5	0.7					35.3	4	2	100	100	22				7.7	7.7	8.1
97-123		13.7	3.4	0.7					35.9	8	4	100	100	19		--		7.6	7.8	8.0
123-146		15.5	4.9	0.8					37.6	8	6	100	100	16		--		7.5	7.8	7.8
146-183		17.8	6.4	0.8					43.8	8	7	100	100	10		--		7.5	7.7	7.7
183-212		17.1	5.9	1.1					41.5	8	6	100	100	13		--		7.5	7.7	7.8

DEPTH (CM)	CA 6N1d	MG 6O1d	NA 6P1d	K 6Q1d	CO3 6I1b	HCO3 6J1b	F 6U1c	CL 6K1e	SO4 6L1e	NO2 6W1c	NO3 6M1e	H2O 8A	TOTAL SALTS EST. 8D5	ELEC. COND. 8A3a MMHOS	PRED. ELEC. COND. 8I MMHOS
	(- - - - - - - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - - - - - - - - - - -)														

	< - - -	- - -	- - -	- - -	- - -MEQ / LITER	- - -	- - -	- - -	- - -	- - - ->	<- -PCT	- ->		/cm	/cm
0- 12	14.0	2.2	0.6	0.3	--	12.3	--	1.4	1.2	TR	0.1	85.4	0.1	1.53	0.66
12- 32	5.2	0.9	0.2	0.1	--	4.8	TR	0.8	0.5	TR	0.1	68.3	TR	0.70	0.26
32- 63															0.22
63- 97	1.7	0.9	2.7	0.1	--	2.5	0.1	1.8	0.8	--	0.1	83.1	TR	0.63	0.32
97-123	3.2	2.2	5.8	0.1	--	1.9	0.3	9.2	3.8	--	0.2	103.2	0.1	1.52	1.05
123-146	8.8	7.2	18.1	0.1	--	1.5	0.7	23.5	12.8	--	--	98.2	0.2	3.51	2.08
146-183	13.0	10.3	23.6	0.2	--	1.0	--	32.8	19.5	--	--	123.9	0.4	4.56	3.13
183-212	24.2	17.5	25.3	0.2	--	1.1	--	24.9	40.0	--	--	105.2	0.5	5.71	3.54

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MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 3,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

*** P R I M A R Y C H A R A C T E R I Z A T I O N D A T A ***

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S98TX-039-007A                                                                                   PRINT DATE 12/06/99
SAMPLED AS    : PLEDGER-HIGH          ; VERY-FINE, SMECTITIC, THERMIC AERIC EPIAQUERT
USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 588, SAMPLE 98P 3520- 3527

            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-

--------- ---------------------------------------------------------------------------------------------------------------
           < - - - - - - - - - - - - - - - - - - - - - - - CLAY MINERALOGY (<.002mm) - - - - - - - - - - - - - - - - - - - - - - - - >
           FRACT < - - - - - - X-RAY - - - - - - ->< - - - THERMAL - - - ->< - - - - - - - - ELEMENTAL - - - - - - - - ->< - -> EGME  INTER
SAMPLE       ION <                             >< - DTA - -><  - TGA - -> SiO2 AL2O3 Fe2O3  MgO   CaO   K2O   Na2O <     > RETN  PRETA
                 < - - - - - -  7A2i - - - - - -><  - 7A6b - >< - 7A4c - >< - - - - - - - - - - 7C4a- - - - - - - - - -><     >  7D2   TION
NUMBER     <- - >< - - - - peak size - - - - -><  - - - Percent - - - ->< - - - - - - - - - Percent - - - - - - - - -><  - -><  - ->

98P3522     TCLY  CA 3  MT 2  KK 2  QZ 2  MI 2
98P3523     TCLY  CA 2  MT 2  QZ 2  KK 2  MI 2
98P3525     TCLY  MT 2  KK 2  CA 2  MI 2  QZ 2
98P3527     TCLY  MT 2  KK 2  CA 2  MI 2  QZ 1

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FRACTION INTERPRETATION:

TCLY Total Clay, <0.002mm

MINERAL INTERPRETATION:

CA calcite MT montmorillon KK kaolinite QZ quartz MI mica

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

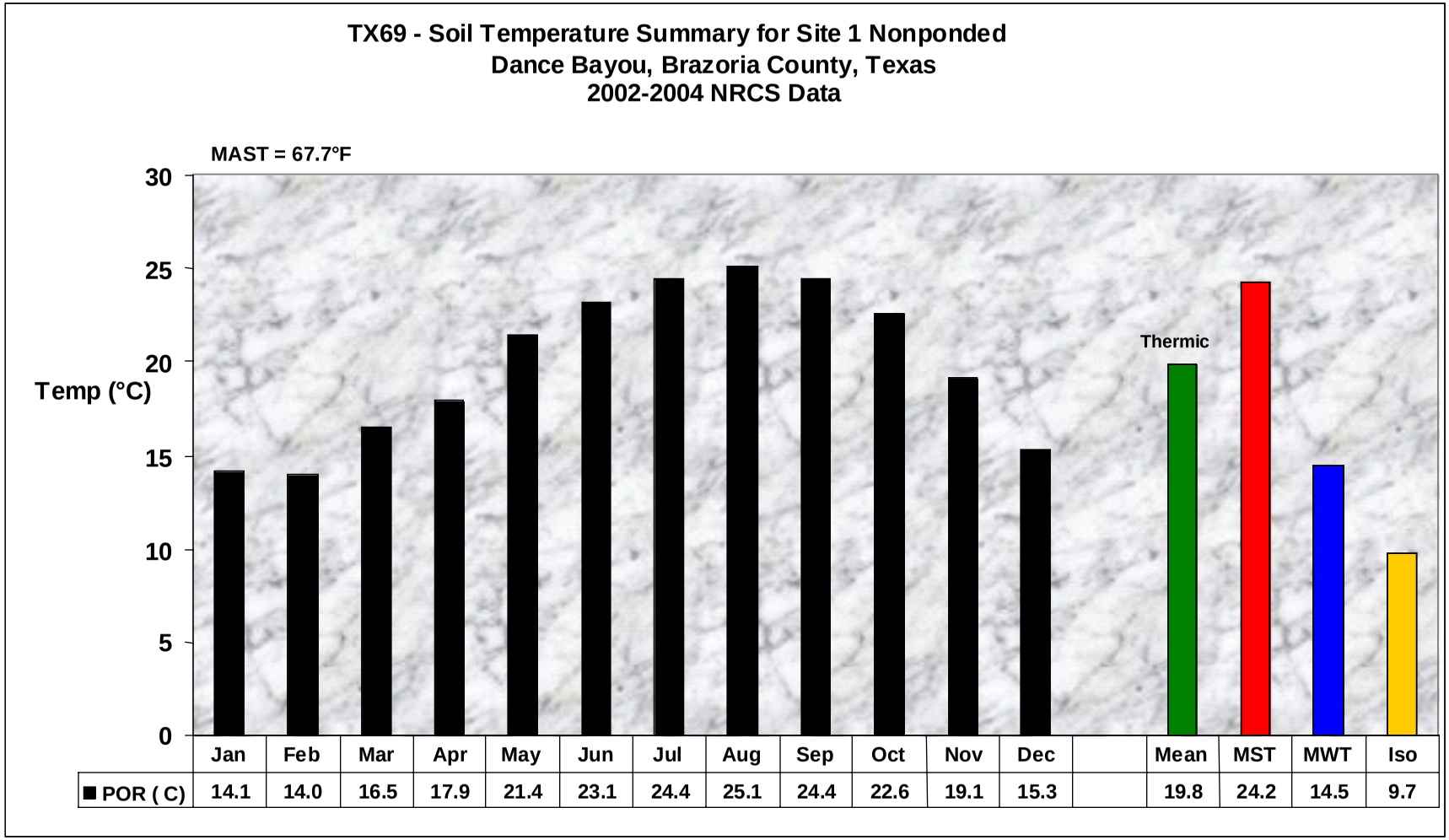
INTERPRETATION (BY HORIZON):

PEDON MINERALOGY
BASED ON SAND/SILT:
BASED ON CLAY:
FAMILY MINERALOGY:
COMMENTS:

Click Here To Return To Beginning

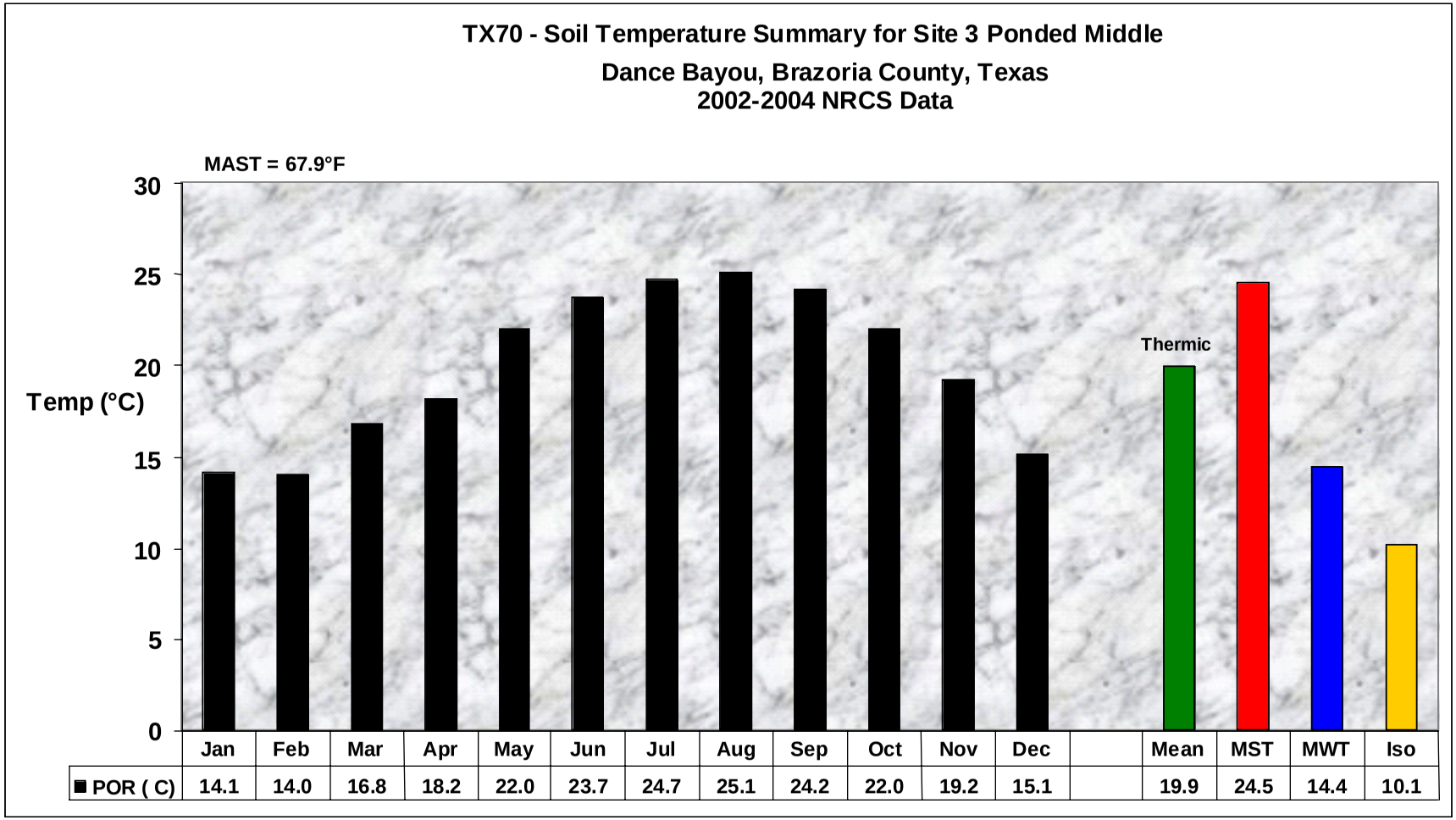
APPENDIX D. SOIL TEMPERATURE STUDY, BOTTOMLAND HARDWOOD STUDY, BRAZORIA COUNTY, TEXAS AND SELECTED SOIL TEMPERATURE STUDY SITES IN THE TEXAS GULF COAST PRAIRIE MLRA

This appendix contains selected soil temperature study data from sites that were part of a four-year National Thermic-Hyperthermic Soil Temperature study initiated in 2001 by the USDA-NRCS National Soil Survey Center (NSSC) in Lincoln, Nebraska, to investigate soil temperature regimes in the southern United States.



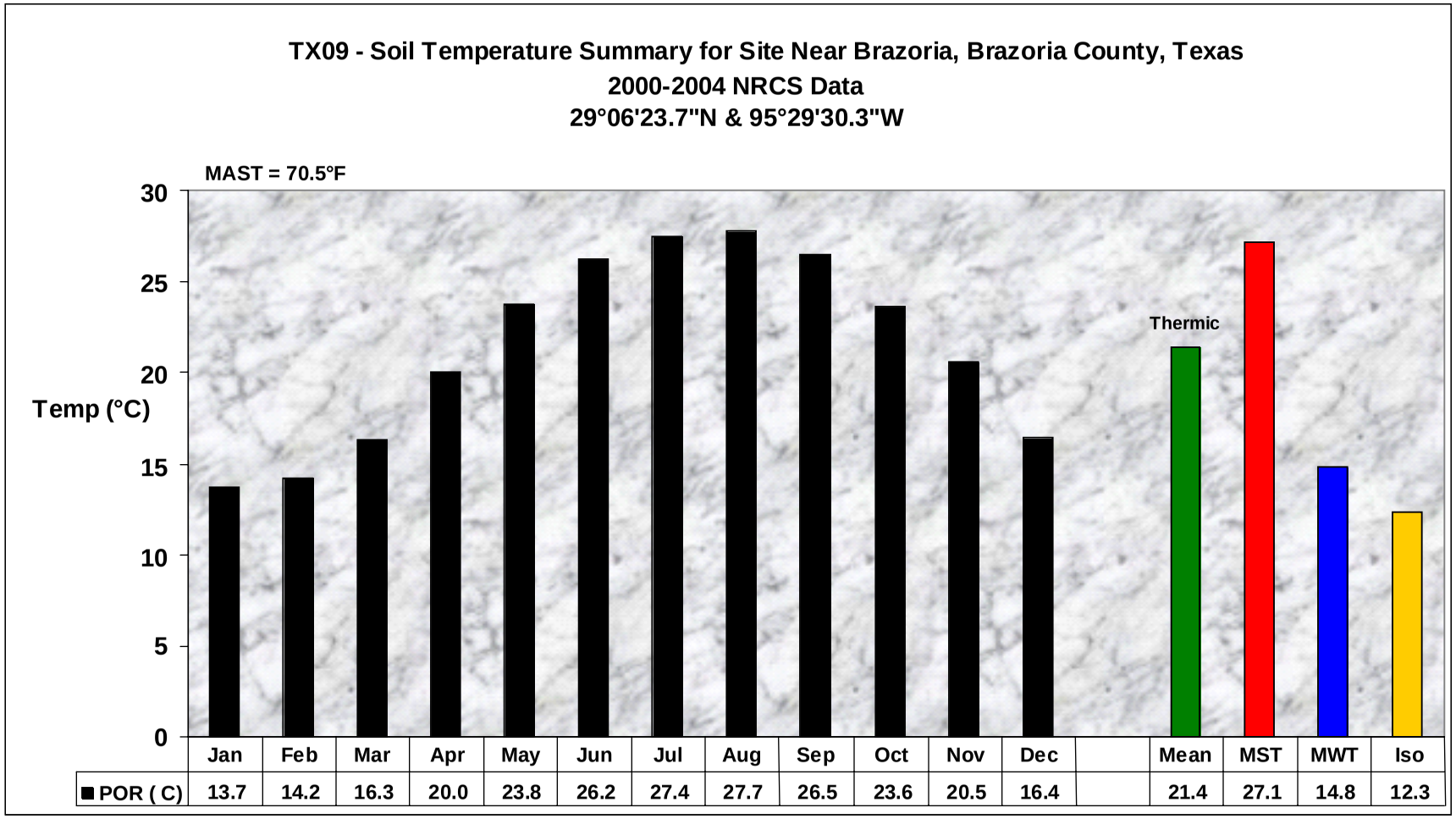
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Mean	MST	MWT	Iso
■ POR (C)	14.1	14.0	16.5	17.9	21.4	23.1	24.4	25.1	24.4	22.6	19.1	15.3		19.8	24.2	14.5	9.7

Fig. D1. Site TX69 soil temperature, 2002-2004 NRCS soil temperature summary for Site 1 nonponded, Dance Bayou Unit, Brazoria County, Texas, bottomland hardwood study. Graph shows average monthly temperature, mean annual, mean summer, and mean winter temperatures at 50 cm.



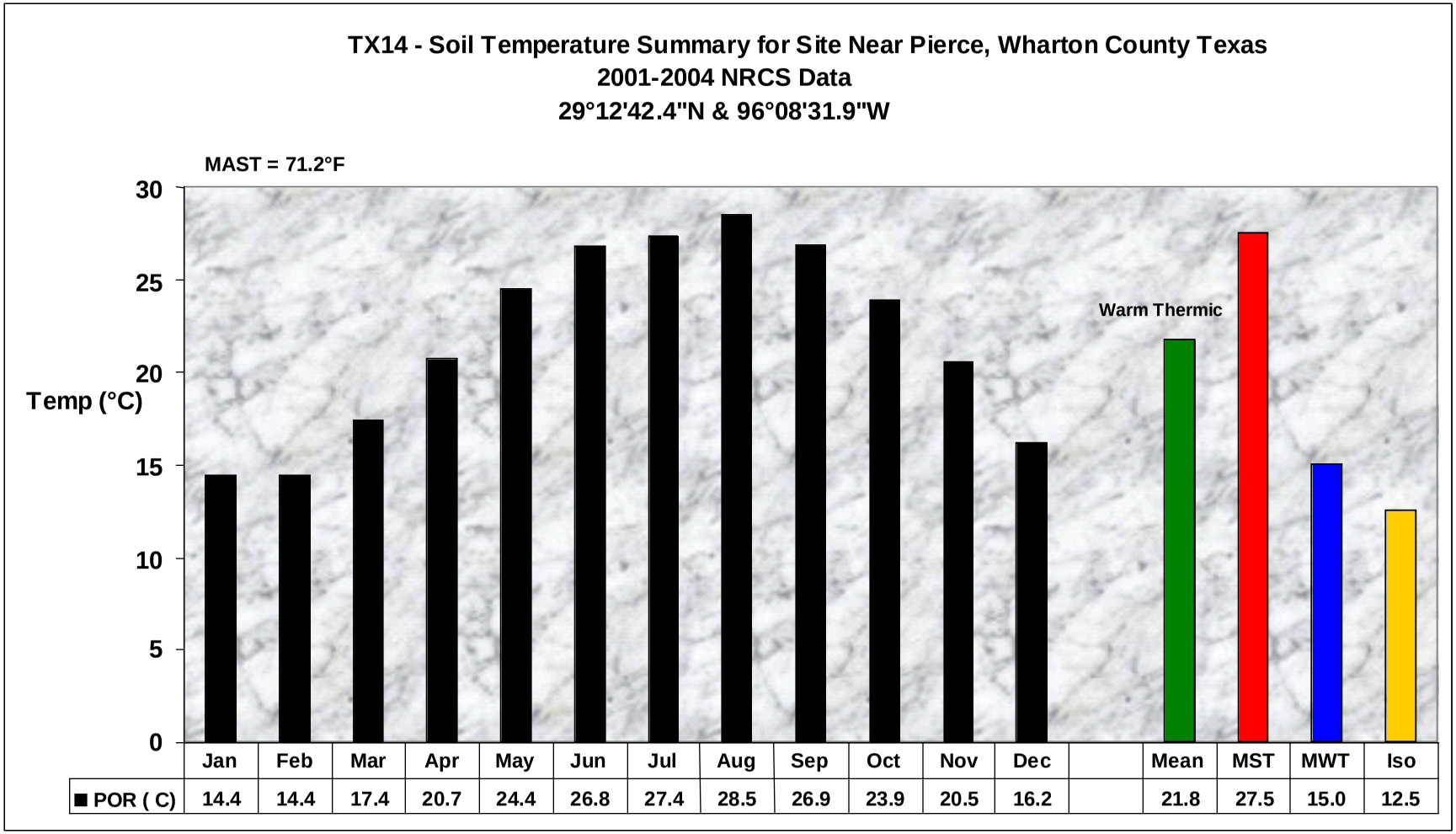
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Mean	MST	MWT	Iso
POR (C)	14.1	14.0	16.8	18.2	22.0	23.7	24.7	25.1	24.2	22.0	19.2	15.1		19.9	24.5	14.4	10.1

Fig. D2. Site TX70 soil temperature, 2002-2004 NRCS soil temperature summary for Site 3 ponded middle, Dance Bayou Unit, Brazoria County, Texas, bottomland hardwood study. Graph shows average monthly temperature, mean annual, mean summer, and mean winter temperatures at 50 cm.



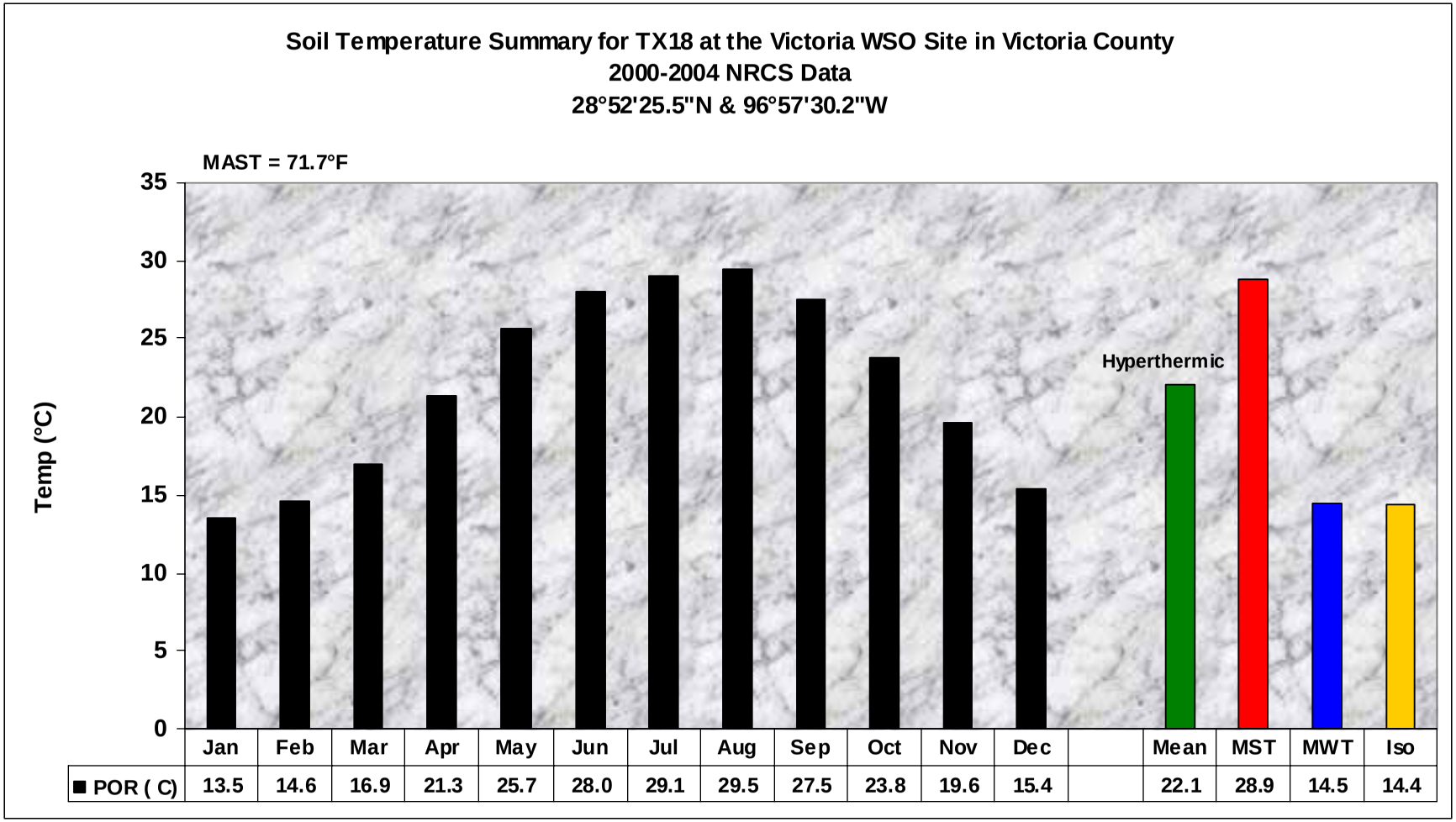
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Mean	MST	MWT	Iso
POR (C)	13.7	14.2	16.3	20.0	23.8	26.2	27.4	27.7	26.5	23.6	20.5	16.4		21.4	27.1	14.8	12.3

Fig. D3. Site TX09 soil temperature, 2000-2004 NRCS soil temperature summary for site near Brazoria, Brazoria County, Texas. Graph shows average monthly temperature, mean annual, mean summer, and mean winter temperatures at 50 cm.



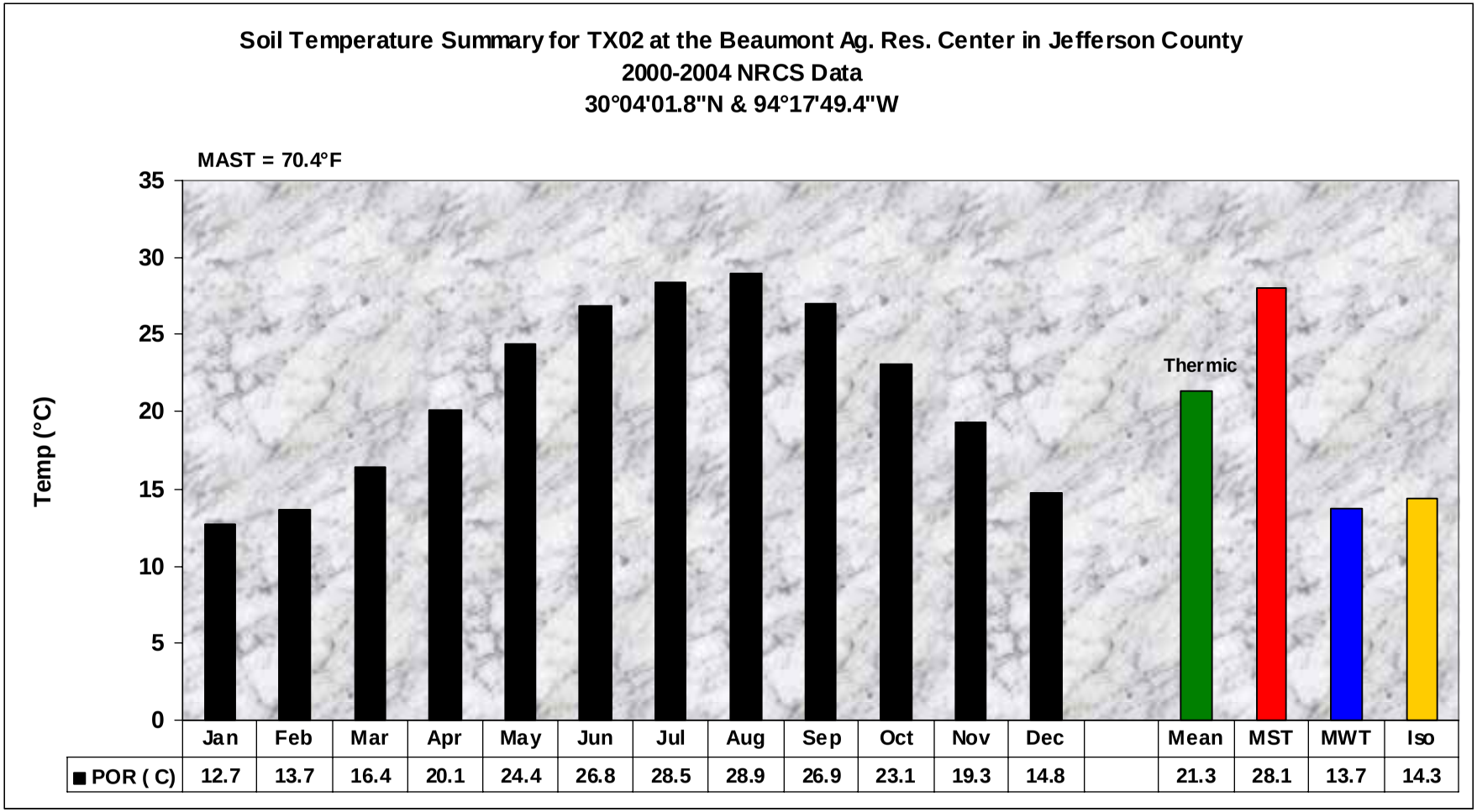
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Mean	MST	MWT	Iso
■ POR (C)	14.4	14.4	17.4	20.7	24.4	26.8	27.4	28.5	26.9	23.9	20.5	16.2		21.8	27.5	15.0	12.5

Fig. D4. Site TX14 soil temperature, 2001-2004 NRCS soil temperature summary for site near Pierce, Wharton County, Texas. Graph shows average monthly temperature, mean annual, mean summer, and mean winter temperatures at 50 cm.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Mean	MST	MWT	Iso
■ POR (C)	13.5	14.6	16.9	21.3	25.7	28.0	29.1	29.5	27.5	23.8	19.6	15.4		22.1	28.9	14.5	14.4

Fig. D5. Site TX18 soil temperature, 2000-2004 NRCS soil temperature summary for site near Victoria, Victoria County, Texas. Graph shows average monthly temperature, mean annual, mean summer, and mean winter temperatures at 50 cm.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Mean	MST	MWT	Iso
POR (C)	12.7	13.7	16.4	20.1	24.4	26.8	28.5	28.9	26.9	23.1	19.3	14.8		21.3	28.1	13.7	14.3

Fig. D6. Site TX02 soil temperature, 2000-2004 NRCS soil temperature summary for site near Beaumont Agriculture Research Center, Jefferson County, Texas. Graph shows average monthly temperature, mean annual, mean summer, and mean winter temperatures at 50 cm.

APPENDIX E. NATIONAL WEATHER SERVICE PRECIPITATION DATA, WEST COLUMBIA, TEXAS, 1996-1997 TO 2001-2002 WATER-YEARS

This appendix contains NWS precipitation data, West Columbia, Texas, showing daily and monthly precipitation, normal monthly precipitation and ranges of normal monthly precipitation, and combined method 30-day rolling totals, 1996-1997 to 2001-2002 water-years.

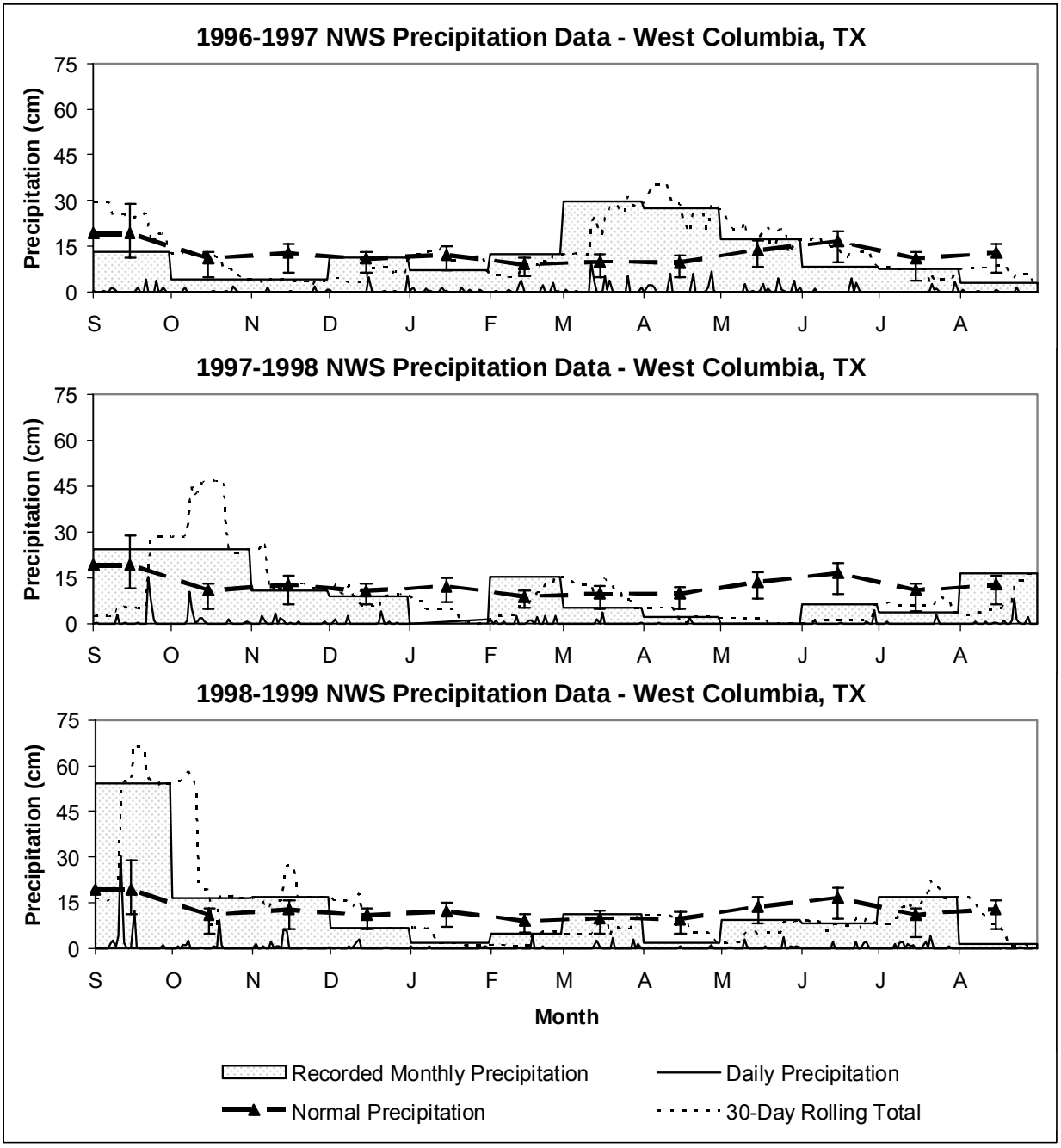


Fig. E1. NWS precipitation West Columbia, Texas, showing daily and monthly precipitation, normal monthly precipitation and ranges of normal monthly precipitation, and combined method 30-day rolling totals[1], 1996-1999 water-years.

[1] Sprecher et al., 2000

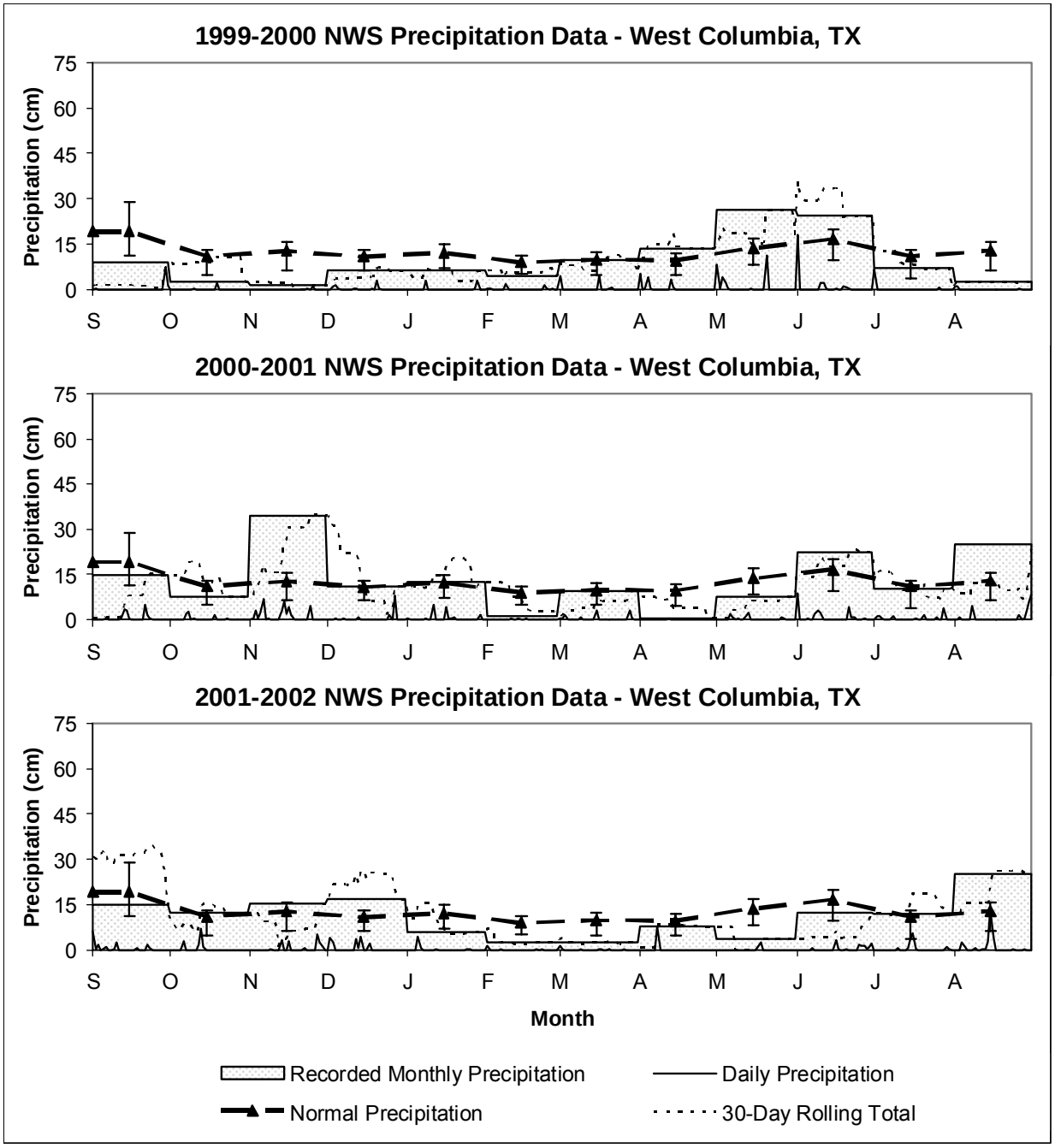


Fig. E2. NWS precipitation West Columbia, Texas, showing daily and monthly precipitation, normal monthly precipitation and ranges of normal monthly precipitation, and combined method 30-day rolling totals[2], 1999-2002 water-years.

[2] Sprecher et al., 2000

APPENDIX F. MONTHLY PRECIPITATION (NWS WEST COLUMBIA, TEXAS), AVERAGE MONTHLY PRECIPITATION (NWS, ANGLETON TEXAS), AND PONDING DEPTHS FOR ALL SITES

This appendix contains 1996-2002, water-years, monthly precipitation (NWS West Columbia, Texas), average monthly precipitation (NWS, Angleton, Texas), and ponding depths for all sites. NWS WETS table's normal monthly precipitation (N), above- normal monthly precipitation (A), and below-normal monthly precipitation (B) are noted for each month.

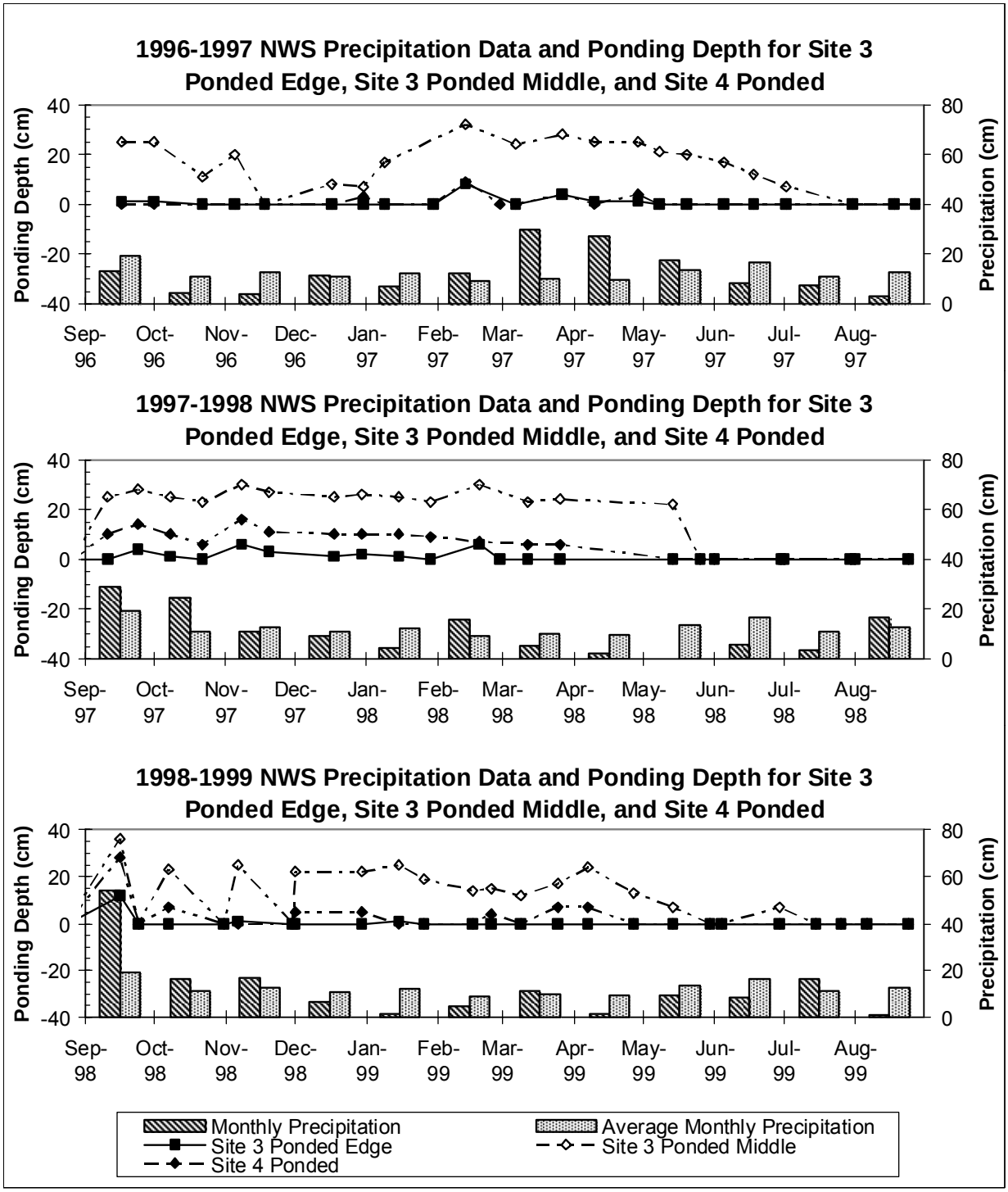


Fig. F1. Ponding depths at site 3 ponded edge, site 3 ponded middle, and site 4 ponded, and NWS Station monthly and average monthly precipitation, 1996-1999 water-years.

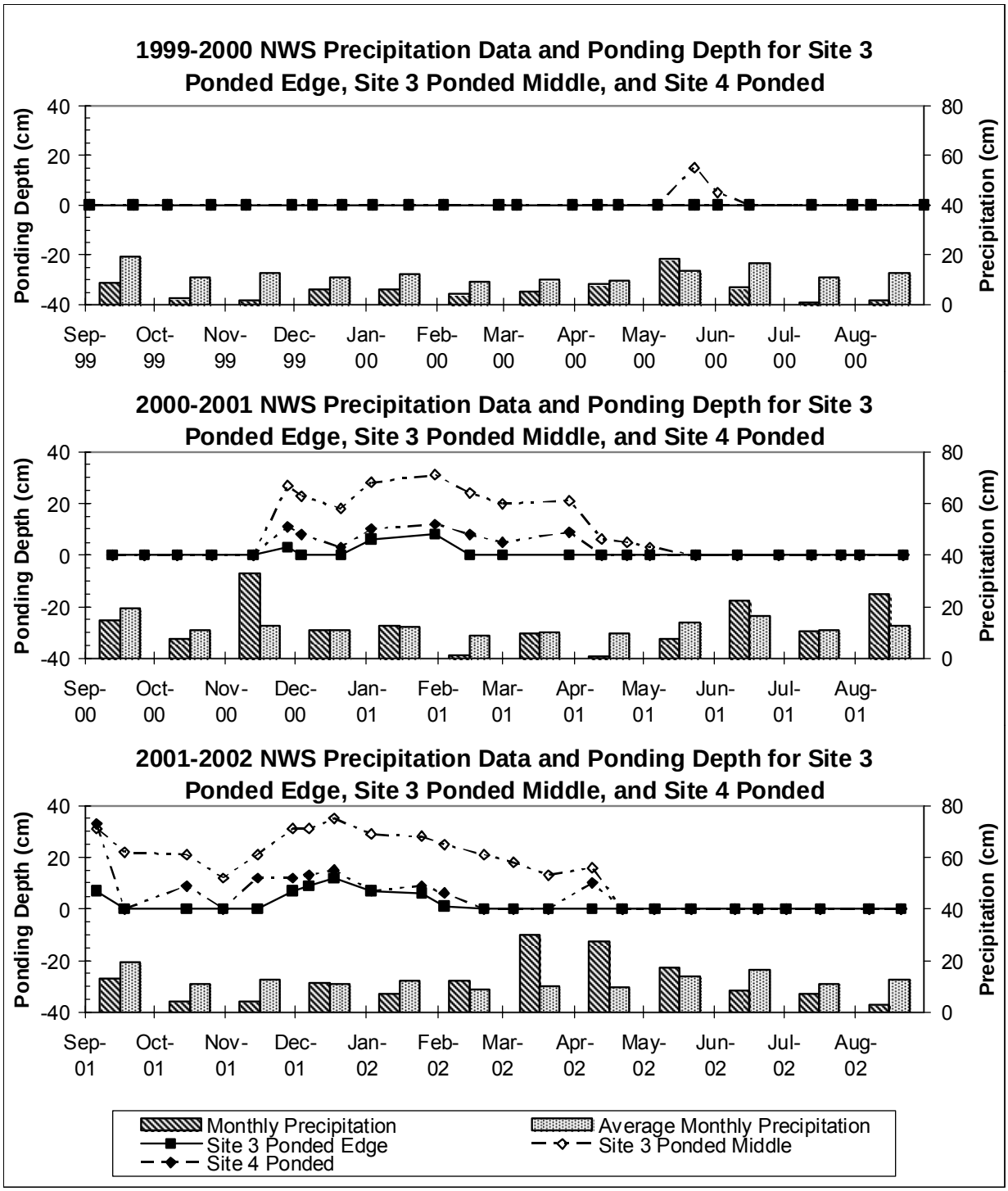


Fig. F2. Ponding depths at site 3 ponded edge, site 3 ponded middle, and site 4 ponded, and NWS Station monthly and average monthly precipitation, 1999-2002 water-years.

Table F1. Water-year 1996-1997, monthly precipitation (NWS West Columbia, Texas), average monthly precipitation (NWS, Angleton, Texas), and ponding depths for all sites. Normal monthly precipitation (N), above-normal monthly precipitation (A), and below-normal monthly precipitation (B) noted for each month. "-" represents observations that were not measured or recorded. Based on daily precipitation events and field conditions from either preceding or postobservations of field conditions, some observations were not measured but were recorded as ponded (P) or not ponded (NP). The double line represents non-growing season, approximately December 12 – February 12.

Date	Monthly Precipitation cm	Average Monthly Precipitation cm	Ponding Depths, cm						
			Site 1 Nonponded Microlow	Site 1 Ponded	Site 2 Nonponded Microlow	Site 3 Ponded Edge	Site 3 Ponded Middle	Site 4 Ponded	Site 5 Nonponded Microlow
9/17/96	13.03[N]	19.21	1	-	-	1	25	10	0
10/1/96	4.11[B]	10.97	0	-	-	1	25	0	0
10/22/96			0	-	-	0	11	0	0
11/5/96	3.96[B]	12.74	0	-	-	0	20	0	0
11/18/96			0	-	-	0	0	0	0
12/17/96	11.20[N]	10.77	0	-	-	0	8	4	0
12/31/96			3	-	-	0	7	5	3
1/9/97	6.99[B]	12.21	0	-	-	0	17	5	0
1/30/97			-	-	-	NP	P	P	-
2/13/97	12.12[A]	8.97	1	-	-	8	32	22	9
2/28/97			-	-	-	P	P	P	-
3/7/97	29.67[A]	9.87	0	-	-	0	24	7	0
3/27/97			6	-	-	4	28	15	4
4/10/97	27.25[A]	9.67	0	-	-	1	25	8	0
4/29/97			4	-	-	1	25	10	4
5/8/97	17.32[A]	13.67	0	-	-	0	21	0	0
5/20/97			0	-	-	0	20	0	0
6/5/97	8.28[B]	16.51	0	-	-	0	17	0	0
6/18/97			0	-	-	0	12	0	0
7/2/97	7.29[N]	10.97	0	-	-	0	7	0	0
7/31/97			0	-	-	0	0	0	0
8/18/97	2.84[B]	12.79	0	-	-	0	0	0	0
8/27/97			0	-	-	0	0	0	0

Table F2. Water-year 1997-1998, monthly precipitation (NWS West Columbia, Texas), average monthly precipitation (NWS, Angleton, Texas), and ponding depths for all sites. Normal monthly precipitation (N), above-normal monthly precipitation (A), and below-normal monthly precipitation (B) noted for each month. "-" represents observations that were not measured or recorded. Based on daily precipitation events and field conditions from either preceding or postobservations of field conditions, some observations were not measured but were recorded as ponded (P) or not ponded (NP). The double line represents non-growing season, approximately December 12 – February 12.

Date	Monthly Precipitation cm	Average Monthly Precipitation cm	Ponding Depths, cm						
			Site 1 Nonponded Microlow	Site 1 Ponded	Site 2 Nonponded Microlow	Site 3 Ponded Edge	Site 3 Ponded Middle	Site 4 Ponded	Site 5 Nonponded Microlow
9/11/97	28.80[N]	19.21	0	-	0	0	0	0	0
9/24/97			0	-	0	4	28	14	0
10/8/97	24.72[A]	10.97	5	-	0	1	25	10	4
10/22/97			0	-	0	0	23	6	0
11/8/97	11.05[N]	12.74	0	-	0	6	30	16	1
11/20/97			0	-	0	3	27	11	0
12/18/97	9.21[N]	10.77	0	-	0	1	25	10	0
12/30/97			0	-	0	2	26	10	0
1/15/98	4.19[B]	12.21	1	-	0	1	25	10	1
1/29/98			0	-	0	0	23	9	0
2/19/98	15.49[A]	8.97	6	-	0	6	30	7	7
2/31/98			0	-	0	0	P	P	0
3/12/98	5.26[N]	9.87	0	-	0	0	23	6	0
3/26/98			-	-	0	0	24	6	0
4/1/98	2.01[B]	9.67	NP	-	NP	NP	P	NP	NP
4/30/98			NP	-	NP	NP	NP	NP	NP
5/14/98	0.00[B]	13.67	0	-	0	0	22	0	0
5/26/98			0	-	0	0	0	0	0
6/1/98	5.51[B]	16.51	0	-	0	0	0	0	0
6/30/98			0	-	0	0	0	0	0
7/1/98	3.51[B]	10.97	0	-	0	0	0	0	0
7/30/98			0	-	0	0	0	0	0
8/1/98	16.33[A]	12.79	0	-	0	0	0	0	0
8/24/98			0	-	0	0	0	0	0

Table F3. Water-year 1998-1999, monthly precipitation (NWS West Columbia, Texas), average monthly precipitation (NWS, Angleton, Texas), and ponding depths for all sites. Normal monthly precipitation (N), above-normal monthly precipitation (A), and below-normal monthly precipitation (B) noted for each month. "-" represents observations that were not measured or recorded. Based on daily precipitation events and field conditions from either preceding or postobservations of field conditions, some observations were not measured but were recorded as ponded (P) or not ponded (NP). The double line represents non-growing season, approximately December 12 – February 12.

Date	Monthly Precipitation cm	Average Monthly Precipitation cm	Ponding Depths, cm						
			Site 1 Nonponded Microlow	Site 1 Ponded	Site 2 Nonponded Microlow	Site 3 Ponded Edge	Site 3 Ponded Middle	Site 4 Ponded	Site 5 Nonponded Microlow
9/16/98	54.33[A]	19.21	4	P	0	12	36	28	6
9/24/98			0	0	0	NP	P	P	0
10/7/98	16.43[A]	10.97	0	7	0	0	23	7	0
10/31/98			-	-	-	NP	P	NP	-
11/6/98	16.94[A]	12.74	0	0	0	1	25	0	0
11/31/98			-	-	0	NP	P	NP	-
12/1/98	6.65[N]	10.77	0	0	0	0	22	5	0
12/30/98			0	0	0	0	22	5	0
1/15/99	1.65[B]	12.21	0	0	0	1	25	0	0
1/26/99			0	0	0	0	19	0	0
2/16/99	4.80[B]	8.97	0	0	0	0	14	0	0
2/24/99			0	0	0	0	15	4	0
3/9/99	11.02[N]	9.87	0	0	0	0	12	0	0
3/25/99			0	0	0	0	17	7	0
4/7/99	1.75[B]	9.67	0	0	0	0	24	7	0
4/27/99			0	0	0	0	13	0	0
5/14/99	9.22[N]	13.67	0	0	0	0	7	0	0
5/30/99			0	0	0	0	0	0	0
6/4/99	8.33[B]	16.51	0	0	0	0	0	0	0
6/29/99			0	0	0	0	7	0	0
7/15/99	16.40[A]	10.97	0	0	0	0	0	0	0
7/26/99			0	0	0	0	0	0	0
8/6/99	1.17[B]	12.79	0	0	0	0	0	0	0
8/24/99			0	0	0	0	0	0	0

Table F4. Water-year 1999-2000, monthly precipitation (NWS West Columbia, Texas), average monthly precipitation (NWS, Angleton, Texas), and ponding depths for all sites. Normal monthly precipitation (N), above-normal monthly precipitation (A), and below-normal monthly precipitation (B) noted for each month. "-" represents observations that were not measured or recorded. Based on daily precipitation events and field conditions from either preceding or postobservations of field conditions, some observations were not measured but were recorded as ponded (P) or not ponded (NP). The double line represents non-growing season, approximately December 12 – February 12.

Date	Monthly Precipitation cm	Average Monthly Precipitation cm	Ponding Depths, cm						
			Site 1 Nonponded Microlow	Site 1 Ponded	Site 2 Nonponded Microlow	Site 3 Ponded Edge	Site 3 Ponded Middle	Site 4 Ponded	Site 5 Nonponded Microlow
9/3/99	8.86[B]	19.21	0	0	0	0	0	0	0
9/22/99			0	0	0	0	0	0	0
10/7/99	2.41[B]	10.97	0	0	0	0	0	0	0
10/26/99			0	0	0	0	0	0	0
11/10/99	1.53[B]	12.74	0	0	0	0	0	0	0
11/30/99			0	0	0	0	0	0	0
12/9/99	6.10[B]	10.77	0	0	0	0	0	0	0
12/22/99			0	0	0	0	0	0	0
1/4/00	6.07[B]	12.21	0	0	0	0	0	0	0
1/20/00			0	0	0	0	0	0	0
2/4/00	4.22[B]	8.97	0	0	0	0	0	0	0
2/28/00			0	0	0	0	0	0	0
3/7/00	5.18[N]	9.87	0	0	0	0	0	0	0
3/31/00			0	0	0	0	0	0	0
4/11/00	8.13[N]	9.67	0	0	0	0	0	0	0
4/20/00			0	0	0	0	0	0	0
5/7/00	18.16[N]	13.67	0	0	0	0	0	0	0
5/23/00			0	0	0	0	15	0	0
6/2/00	6.63[B]	16.51	0	0	0	0	5	0	0
6/16/00			0	0	0	0	0	0	0
7/13/00	0.86[B]	10.97	0	0	0	0	0	0	0
7/31/00			0	0	0	0	0	0	0
8/8/00	1.50[B]	12.79	0	0	0	0	0	0	0
8/31/00			0	0	0	0	0	0	0

Table F5. Water-year 2000-2001, monthly precipitation (NWS West Columbia, Texas), average monthly precipitation (NWS, Angleton, Texas), and ponding depths for all sites. Normal monthly precipitation (N), above-normal monthly precipitation (A), and below-normal monthly precipitation (B) noted for each month. "-" represents observations that were not measured or recorded. Based on daily precipitation events and field conditions from either preceding or postobservations of field conditions, some observations were not measured but were recorded as ponded (P) or not ponded (NP). The double line represents non-growing season, approximately December 12 – February 12.

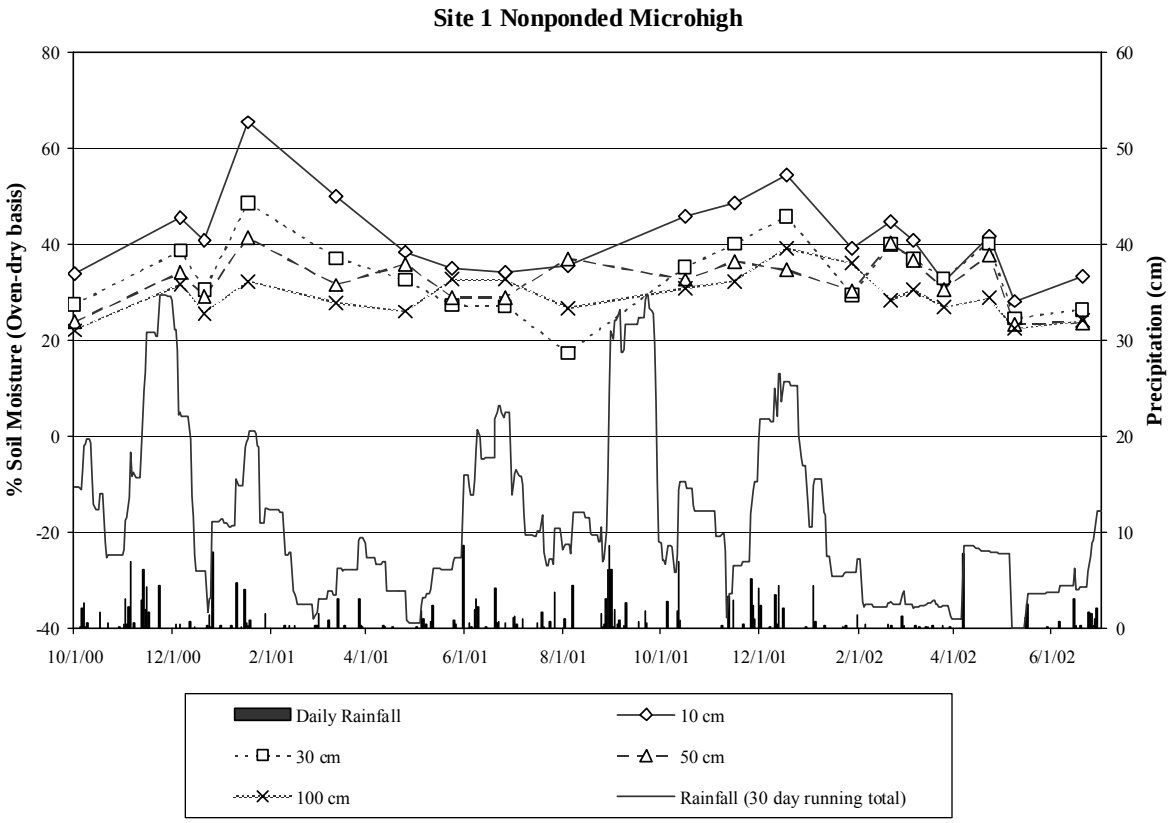
Date	Monthly Precipitation	Average Monthly Precipitation	Ponding Depths, cm						
	cm	cm	Site 1 Nonponded Microlow	Site 1 Ponded	Site 2 Nonponded Microlow	Site 3 Ponded Edge	Site 3 Ponded Middle	Site 4 Ponded	Site 5 Nonponded Microlow
9/13/00	14.76[N]	19.21	0	0	0	0	0	0	0
9/27/00			0	0	0	0	0	0	0
10/11/00	7.67[N]	10.97	0	0	0	0	0	0	0
10/26/00			0	0	0	0	0	0	0
11/13/00	32.99[A]	12.74	0	0	0	0	0	0	0
11/28/00			4	9	0	3	27	11	6
12/4/00	11.02[N]	10.77	0	0	0	0	23	8	0
12/21/00			0	0	0	0	18	3	0
1/17/01	12.55[N]	12.21	4	9	0	6	28	10	5
1/31/01			0	0	0	8	31	12	0
2/15/01	0.94[B]	8.97	0	0	0	0	24	8	0
3/1/01	9.47[N]	9.87	0	0	0	0	20	5	0
3/30/01			0	0	0	0	21	9	0
4/13/01	0.48[B]	9.67	0	0	0	0	6	0	0
4/24/01			0	0	0	0	5	0	0
5/4/01	7.39[B]	13.67	0	0	0	0	3	0	0
5/24/01			0	0	0	0	0	0	0
6/11/01	22.45[A]	16.51	0	0	0	0	0	0	0
6/29/01			0	0	0	0	0	0	0
7/13/01	10.41[N]	10.97	0	0	0	0	0	0	0
7/26/01			0	0	0	0	0	0	0
8/3/01	24.84[A]	12.79	0	0	0	0	0	0	0
8/22/01			0	0	0	0	0	0	0

Table F6. Water-year 2001-2002, monthly precipitation (NWS West Columbia, Texas), average monthly precipitation (NWS, Angleton, Texas), and ponding depths for all sites. Normal monthly precipitation (N), above-normal monthly precipitation (A), and below-normal monthly precipitation (B) noted for each month. "-" represents observations that were not measured or recorded. Based on daily precipitation events and field conditions from either preceding or postobservations of field conditions, some observations were not measured but were recorded as ponded (P) or not ponded NP). The double line represents non-growing season, approximately December 12 – February 12.

			Ponding Depths, cm						
Date	**Monthly Precipitation** cm	**Average Monthly Precipitation** cm	Site 1 Nonponded Microlow	Site 1 Ponded	Site 2 Nonponded Microlow	Site 3 Ponded Edge	Site 3 Ponded Middle	Site 4 Ponded	Site 5 Nonponded Microlow
9/6/01	15.14[N]	19.21	2	8	0	7	31	33	-
9/18/01			0	0	0	0	22	0	-
10/15/01	12.22[N]	10.97	0	0	0	0	21	9	-
10/31/01			0	0	0	0	12	0	-
11/15/01	15.27[N]	12.74	3	6	0	0	21	12	-
11/30/01			1	19	0	7	31	12	-
12/7/01	16.97[A]	10.77	1	12	0	9	31	13	-
12/18/01			3	11	0	12	35	15	-
1/3/02	5.74[B]	12.21	0	0	0	7	29	7	-
1/25/02			0	0	0	6	28	9	-
2/4/02	2.41[B]	8.97	0	0	0	1	25	6	-
2/21/02			0	0	0	0	21	0	-
3/6/02	2.43[B]	9.87	0	0	0	0	18	0	-
3/21/02			0	0	0	0	13	0	-
4/9/02	7.75[N]	9.67	2	8	0	0	16	10	-
4/22/02			0	0	0	0	0	0	-
5/6/02	3.68[B]	13.67	0	0	0	0	0	0	-
5/22/02			0	0	0	0	0	0	-
6/10/02	12.19[N]	16.51	0	0	0	0	0	0	-
6/20/02			0	0	0	0	0	0	-
7/2/02	11.84[N]	10.97	0	0	0	0	0	0	-
7/17/02			0	0	0	0	0	0	-
8/7/02	25.20[A]	12.79	0	0	0	0	0	0	-
8/21/02			0	0	0	0	0	0	-

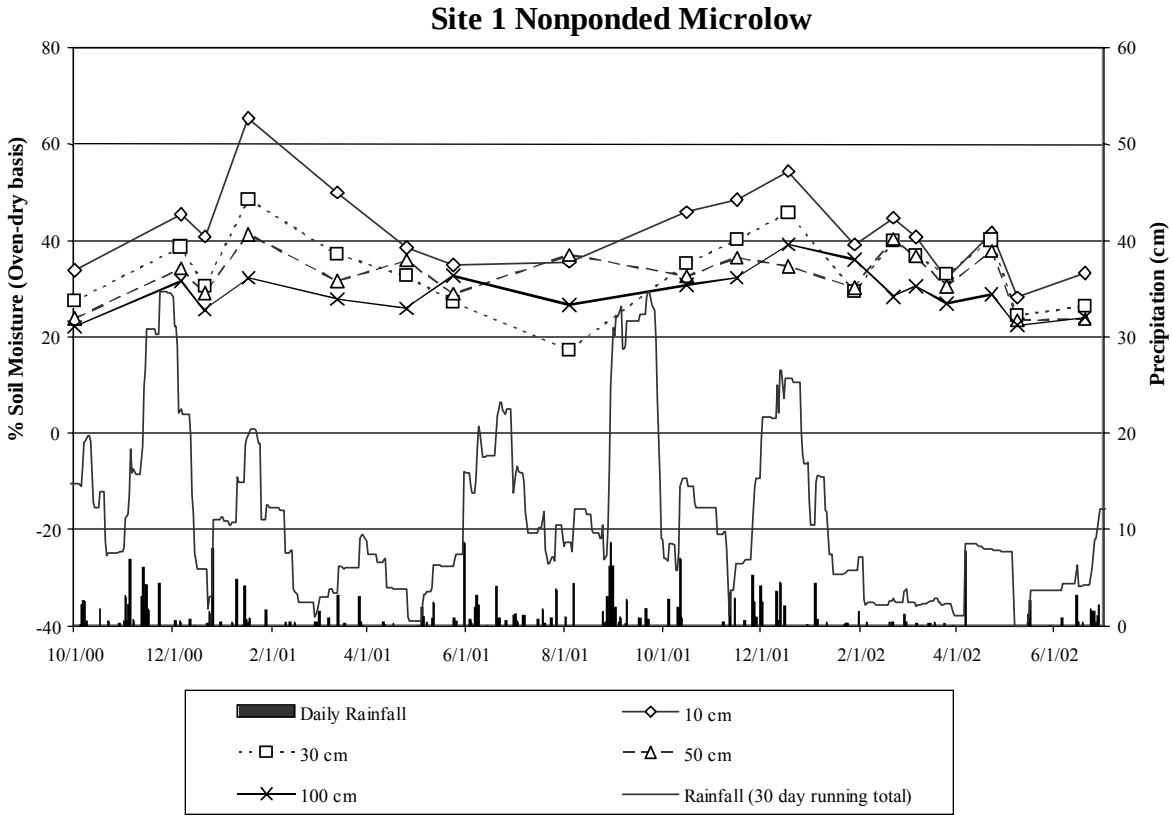
APPENDIX G. GRAVIMETRIC SOIL WATER DATA

This appendix contains tables and graphs of daily and 30-day running total rainfall, gravimetric soil water on an oven dry weight basis determinations at depths of 10, 30, 50, and 100cm at all of the monitoring sites during periodic wet field conditions and periodic dry field conditions from 10/00 to 6/02.



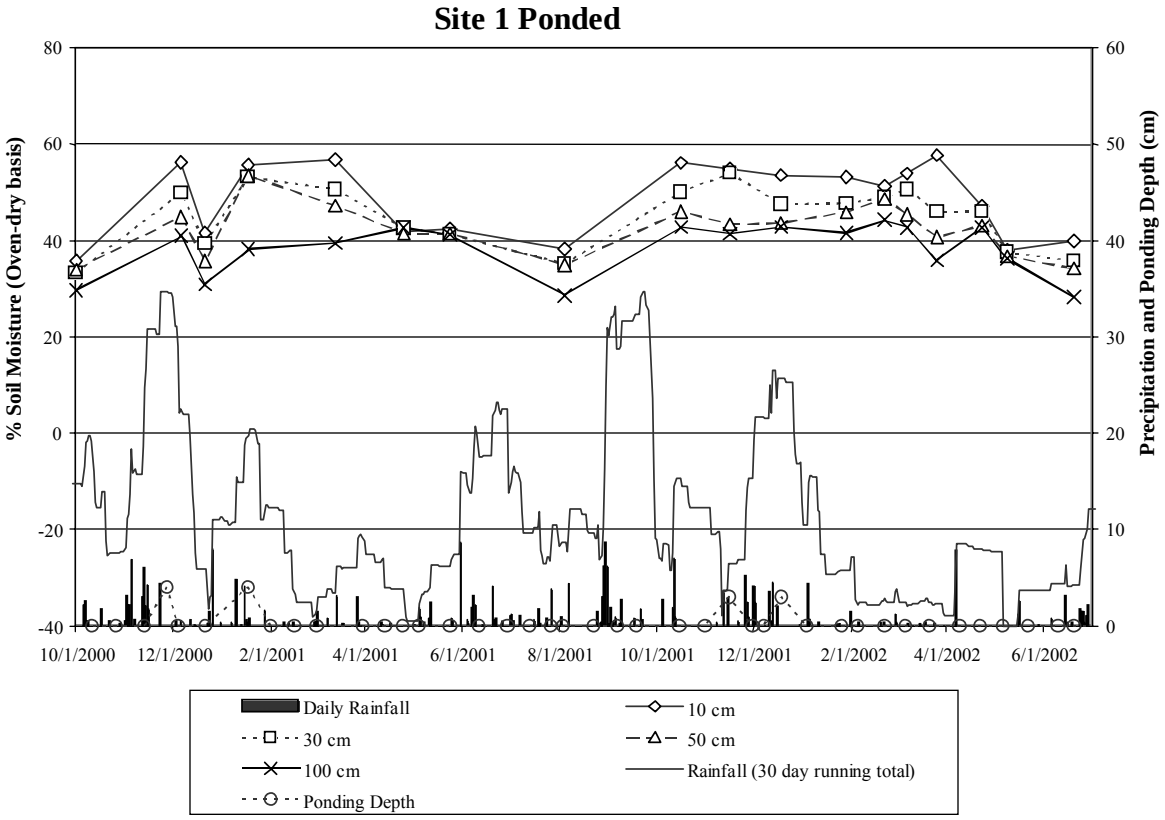
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	33.8	27.4	23.8	22.1
12/6/00	45.5	38.7	34.2	31.6
12/21/00	40.9	30.5	29.1	25.6
1/17/01	65.4	48.6	41.4	32.3
3/13/01	50.0	37.1	31.5	27.8
4/25/01	38.5	32.6	35.9	25.9
5/24/01	34.9	27.2	28.9	32.7
8/4/01	35.6	17.3	37.0	26.6
10/16/01	45.9	35.2	32.7	30.8
11/16/01	48.6	40.1	36.4	32.3
12/18/01	54.4	45.8	34.7	39.2
1/28/02	39.2	29.3	30.3	36.0
2/21/02	44.7	39.9	40.3	28.3
3/7/02	40.8	36.9	36.7	30.5
3/26/02	32.2	32.9	30.5	26.9
4/23/02	41.5	40.1	37.9	28.8
5/9/02	28.2	24.5	23.4	22.4
6/20/02	33.3	26.4	23.7	24.1

Fig G1. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 1 nonponded microhigh during periodic wet field and periodic dry field conditions from 10/00 to 6/02.



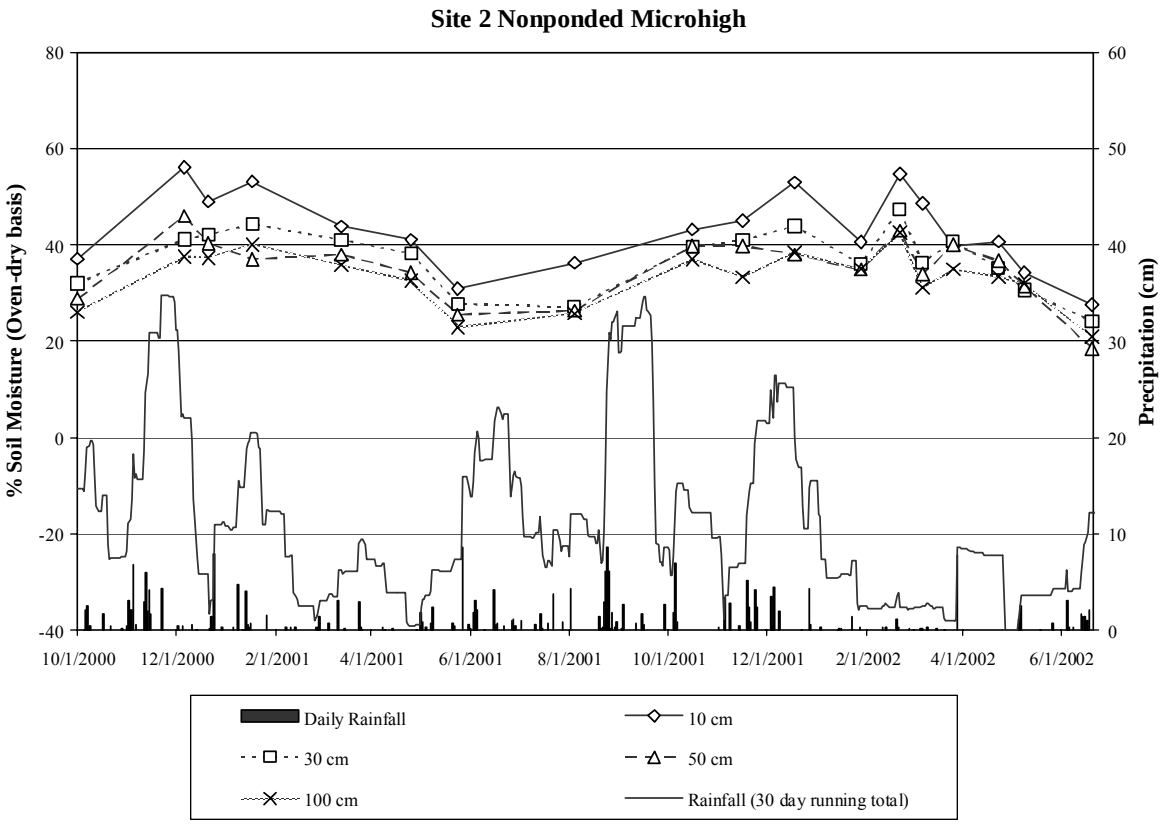
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	35.7	33.3	34.0	29.6
12/6/00	56.2	49.9	44.9	41.0
12/21/00	41.6	39.3	35.7	30.9
1/17/01	55.6	53.2	53.5	38.2
3/13/01	56.8	50.6	47.2	39.4
4/25/01	41.9	42.6	41.5	42.7
5/24/01	42.4	41.3	41.4	41.2
8/4/01	38.3	35.1	34.9	28.6
10/16/01	56.1	50.1	46.0	42.8
11/16/01	54.9	53.9	43.4	41.4
12/18/01	53.6	47.6	43.7	42.8
1/28/02	53.2	47.7	45.9	41.5
2/21/02	51.3	48.9	48.7	44.3
3/7/02	54.0	50.6	45.5	42.7
3/26/02	57.7	45.9	40.7	35.8
4/23/02	47.2	46.0	43.1	42.7
5/9/02	37.9	37.5	36.8	36.3
6/20/02	39.9	35.8	34.2	28.2

Fig. G2. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 1 nonponded microlow during periodic wet and periodic dry field conditions from 10/00 to 6/02.



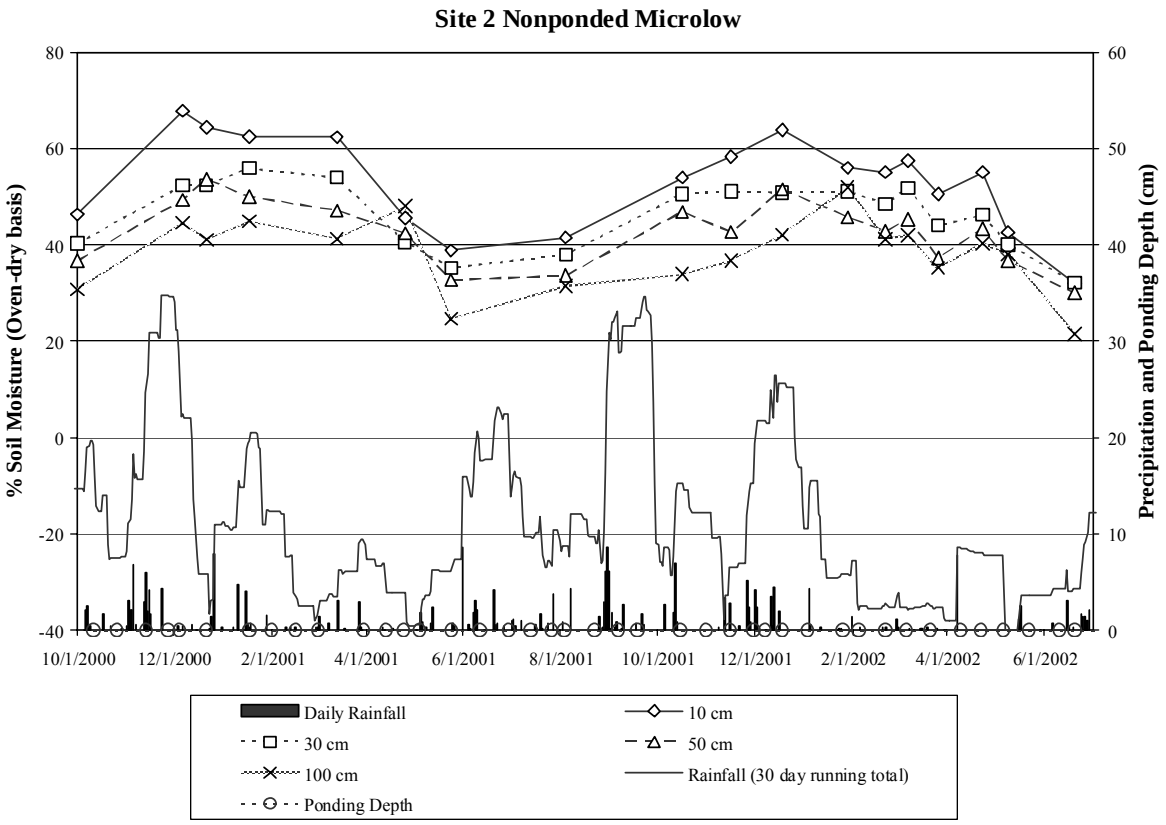
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	28.3	26.3	28.8	24.9
12/6/00	50.5	42.6	42.8	40.6
12/21/00	30.5	32.9	33.5	21.9
1/17/01	42.6	35.1	33.2	30.5
3/13/01	37.9	36.8	33.0	22.1
4/25/01	21.5	30.4	28.0	19.3
5/24/01	40.5	32.3	31.5	37.1
8/4/01	36.5	31.0	33.6	22.2
10/16/01	28.9	32.2	34.0	20.0
11/16/01	50.4	38.2	32.6	24.8
12/18/01	46.7	38.8	42.9	35.2
1/28/02	45.2	41.9	41.7	36.5
2/21/02	53.8	45.6	43.3	36.0
3/7/02	49.5	46.1	51.4	26.4
3/26/02	45.5	40.5	42.9	27.1
4/23/02	43.2	36.6	38.3	37.5
5/9/02	38.6	37.2	37.2	40.0
6/20/02	37.8	31.2	32.0	32.4

Fig. G3. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 1 ponded during periodic wet and periodic dry field conditions from 10/00 to 6/02.



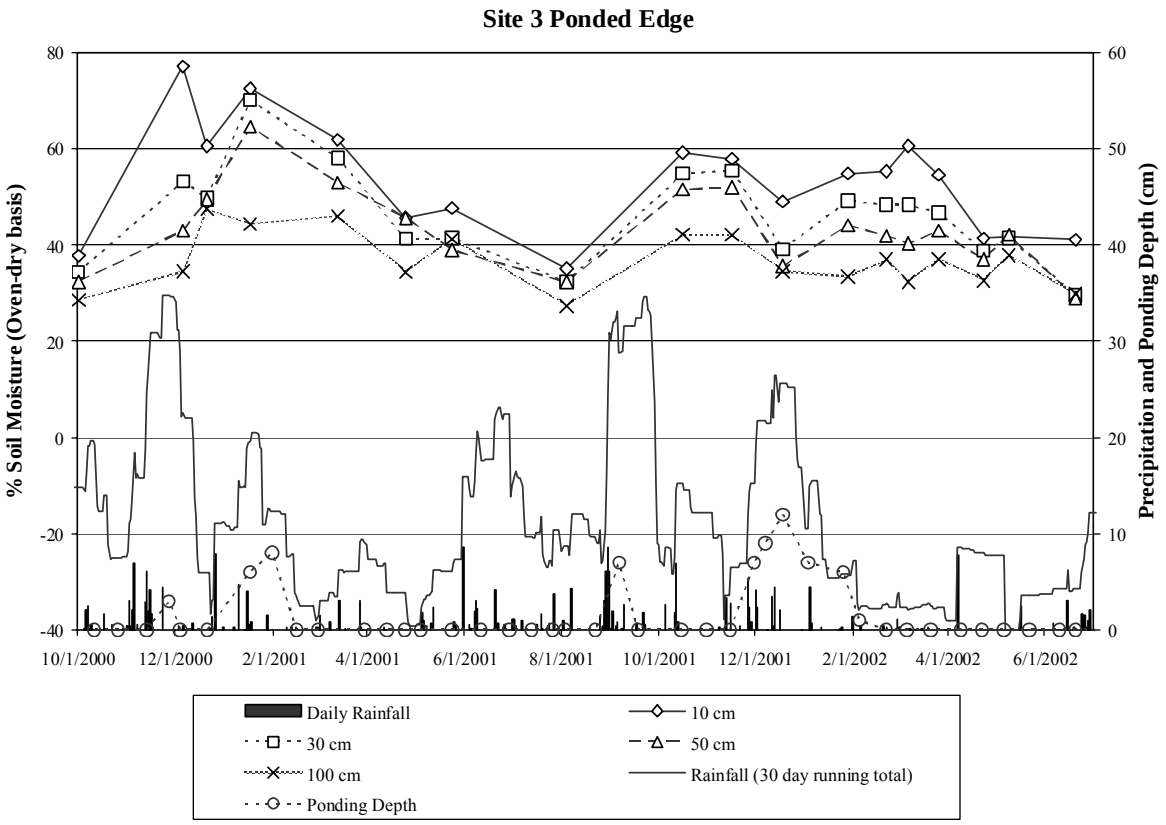
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	37.1	32.0	28.8	26.0
12/6/00	56.1	41.1	46.0	37.5
12/21/00	49.1	42.1	40.4	37.3
1/17/01	53.2	44.4	37.0	40.1
3/13/01	43.8	41.1	38.0	35.8
4/25/01	41.1	38.2	34.2	32.6
5/24/01	30.9	27.8	25.5	22.9
8/4/01	36.3	27.1	26.3	25.8
10/16/01	43.2	39.6	39.8	37.0
11/16/01	45.1	41.0	39.9	33.3
12/18/01	53.0	43.9	38.0	38.4
1/28/02	40.6	35.9	35.0	35.0
2/21/02	54.7	47.3	43.0	42.5
3/7/02	48.6	36.3	33.9	31.2
3/26/02	39.9	40.7	40.0	35.0
4/23/02	40.7	35.3	36.7	33.4
5/9/02	34.3	30.6	31.4	31.9
6/20/02	27.5	24.1	18.5	21.0

Fig. G4. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 2 nonponded microhigh during periodic wet and periodic dry field conditions from 10/00 to 6/02.



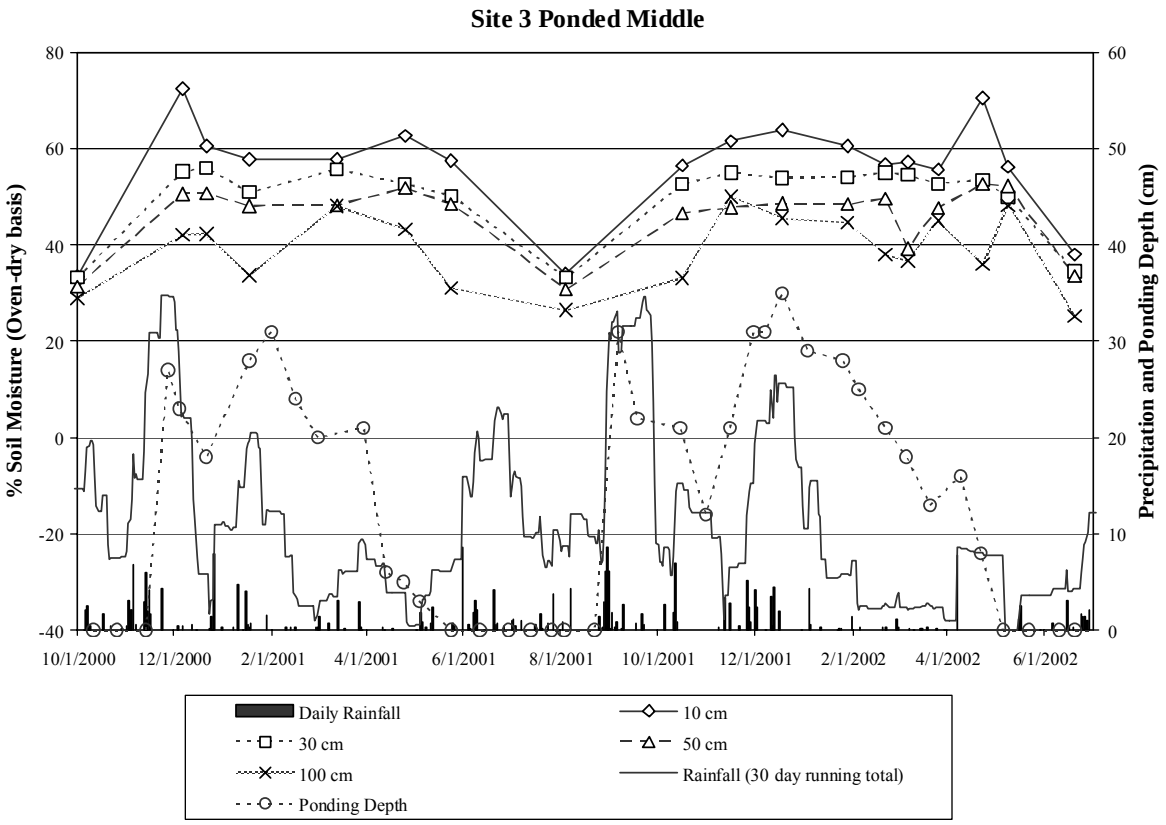
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	46.4	40.3	36.7	30.8
12/6/00	67.9	52.3	49.4	44.6
12/21/00	64.5	52.3	53.7	41.1
1/17/01	62.5	55.9	50.0	44.9
3/13/01	62.4	54.0	47.2	41.3
4/25/01	45.6	40.6	42.4	48.0
5/24/01	38.9	35.3	32.7	24.7
8/4/01	41.6	38.0	33.6	31.5
10/16/01	54.0	50.6	46.9	33.9
11/16/01	58.4	51.1	42.6	36.8
12/18/01	63.9	50.9	51.5	42.1
1/28/02	56.0	51.1	45.8	51.9
2/21/02	55.1	48.5	42.8	41.2
3/7/02	57.5	51.8	45.3	42.0
3/26/02	50.6	44.0	37.3	35.2
4/23/02	55.1	46.2	43.4	40.3
5/9/02	42.7	40.0	36.7	38.0
6/20/02	31.9	32.2	30.0	21.6

Fig. G5. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 2 nonponded microlow during periodic wet and periodic dry field conditions from 10/00 to 6/02.



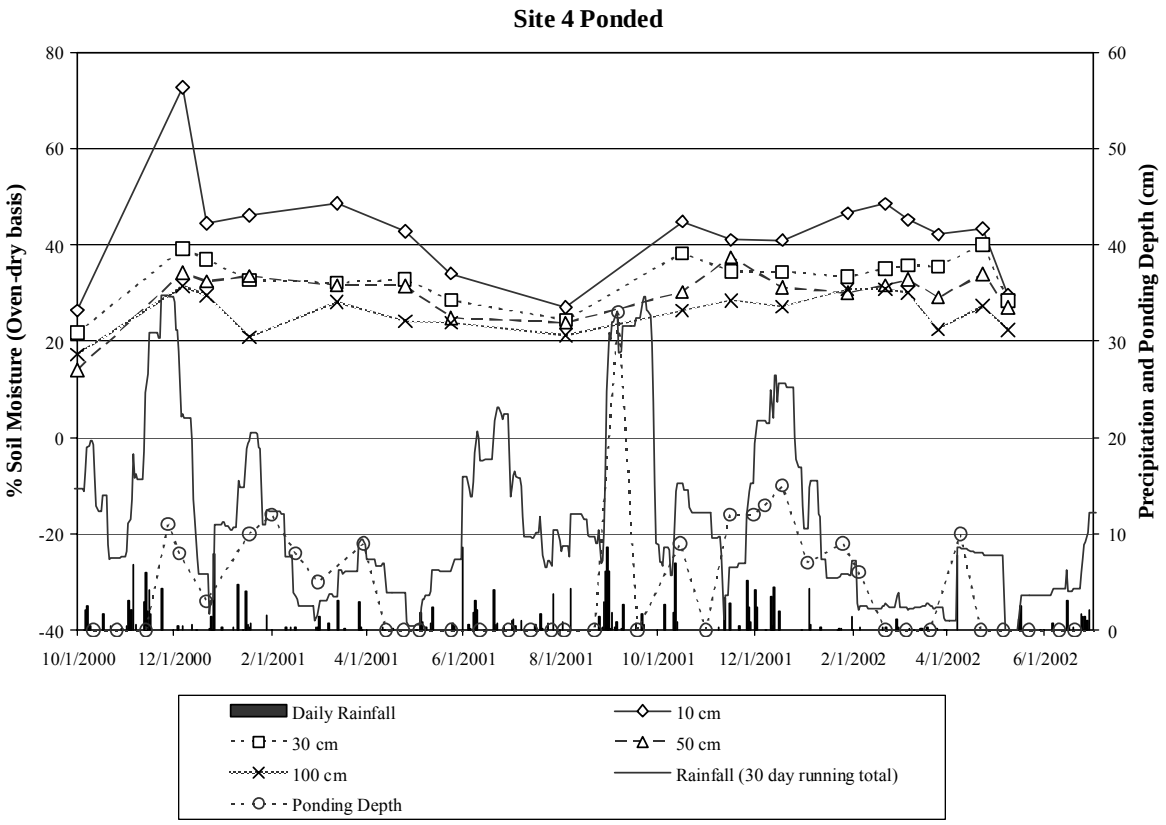
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	37.7	34.4	32.3	28.5
12/6/00	77.0	53.1	43.0	34.5
12/21/00	60.6	49.7	49.5	47.4
1/17/01	72.5	70.0	64.6	44.3
3/13/01	61.9	58.0	53.0	46.0
4/25/01	45.6	41.2	45.6	34.4
5/24/01	47.7	41.4	39.0	41.3
8/4/01	35.0	32.4	32.3	27.3
10/16/01	59.1	54.7	51.5	42.2
11/16/01	57.9	55.5	52.0	42.1
12/18/01	49.0	39.1	35.6	34.5
1/28/02	54.9	49.2	44.1	33.4
2/21/02	55.3	48.3	41.9	36.9
3/7/02	60.5	48.4	40.4	32.3
3/26/02	54.5	46.7	43.0	37.0
4/23/02	41.3	38.7	37.0	32.6
5/9/02	41.8	41.4	42.1	37.9
6/20/02	41.1	29.5	28.9	29.8

Fig. G6. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50-, and 100 cm at Site3 ponded edge during periodic wet and periodic dry field conditions from 10/00 to 6/02.



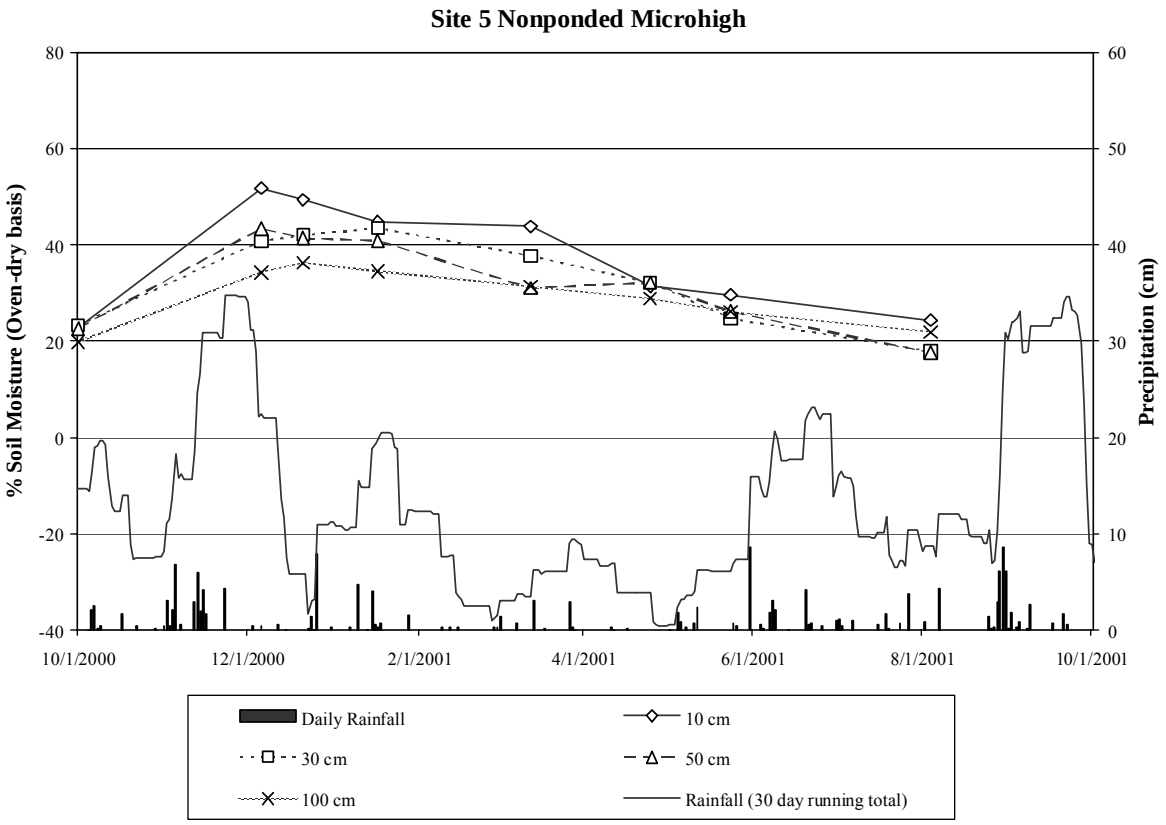
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	33.3	33.2	31.4	28.9
12/6/00	72.5	55.3	50.7	42.1
12/21/00	60.5	56.0	50.7	42.3
1/17/01	57.7	50.9	48.1	33.6
3/13/01	57.8	55.7	48.3	48.1
4/25/01	62.6	52.7	51.8	43.2
5/24/01	57.5	50.2	48.5	31.1
8/4/01	34.0	33.2	30.8	26.5
10/16/01	56.5	52.6	46.6	33.2
11/16/01	61.5	55.1	47.8	50.0
12/18/01	63.8	53.9	48.6	45.5
1/28/02	60.6	54.1	48.4	44.7
2/21/02	56.7	55.0	49.7	38.0
3/7/02	57.3	54.5	39.3	36.7
3/26/02	55.7	52.7	47.7	45.0
4/23/02	70.6	53.5	52.7	36.0
5/9/02	56.2	49.9	52.2	48.2
6/20/02	38.0	34.6	33.5	25.2

Fig. G7. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 3 ponded middle during periodic wet and periodic dry field conditions from 10/00 to 6/02.



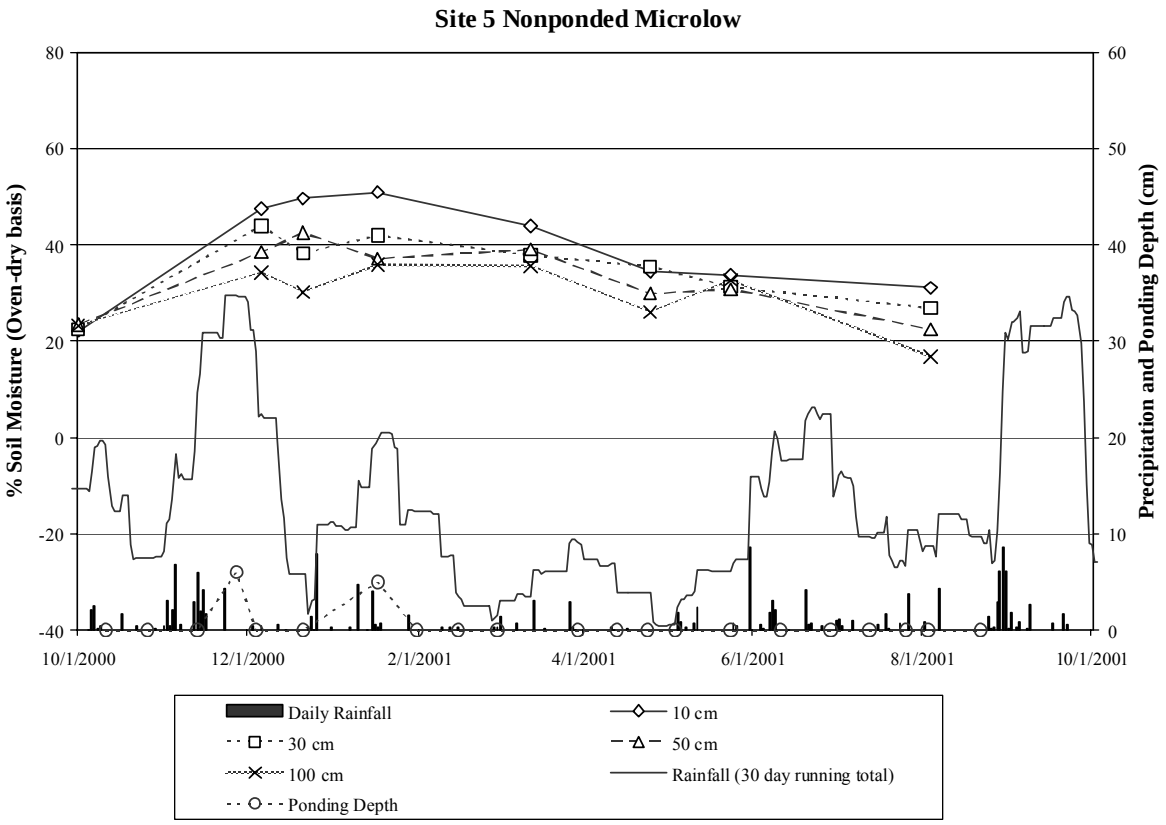
Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	26.4	21.8	14.1	17.3
12/6/00	72.8	39.2	34.2	31.4
12/21/00	44.5	37.0	32.5	29.6
1/17/01	46.1	32.7	33.6	20.9
3/13/01	48.6	32.2	31.6	28.1
4/25/01	42.8	32.8	31.5	24.2
5/24/01	34.1	28.5	24.9	23.9
8/4/01	27.0	24.4	23.8	21.2
10/16/01	44.9	38.3	30.3	26.4
11/16/01	41.1	34.5	37.5	28.5
12/18/01	41.0	34.5	31.2	27.1
1/28/02	46.6	33.4	30.1	30.8
2/21/02	48.6	35.0	31.6	30.8
3/7/02	45.2	35.8	32.8	30.2
3/26/02	42.2	35.5	29.1	22.5
4/23/02	43.4	40.0	34.0	27.3
5/9/02	29.7	28.4	27.0	22.3

Fig. G8. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 4 ponded during periodic wet and periodic dry field conditions from 10/00 to 6/02.



Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	22.9	23.3	22.7	19.8
12/6/00	51.8	40.8	43.5	34.3
12/21/00	49.4	42.0	41.4	36.3
1/17/01	44.8	43.5	40.9	34.5
3/13/01	43.8	37.7	31.1	31.4
4/25/01	31.4	32.1	32.2	28.9
5/24/01	29.6	24.7	26.2	26.1
8/4/01	24.4	17.9	17.6	21.9

Fig. G9. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 5 nonponded microhigh during periodic wet and periodic dry field conditions from 10/00 to 6/02.



Date Sampled	% Moisture			
	10 cm	30 cm	50 cm	100 cm
10/1/00	22.2	22.4	23.4	23.3
12/6/00	47.6	44.0	38.5	34.3
12/21/00	49.6	38.3	42.6	30.2
1/17/01	50.9	42.0	37.1	35.9
3/13/01	43.9	37.9	39.1	35.7
4/25/01	34.5	35.5	29.9	26.1
5/24/01	33.7	31.3	30.8	32.7
8/4/01	31.1	26.9	22.4	16.8

Fig. G10. Tables and graphs of daily and 30-day running total rainfall, percent gravimetric soil water on an oven dry weight basis determination at depths of 10, 30, 50, and 100 cm at Site 5 nonponded microlow during periodic wet and periodic dry field conditions from 10/00 to 6/02.

APPENDIX H. PONDING DEPTHS, AADP DYE REACTIONS AND EH VALUES

This appendix contains bi-weekly measurements of ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000-Aug. 2000.). Positive AADP dye is $\geq$60% alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. AADP dye reactions are slightly positive (SP-faint pink); positive (P-distinct pink); and very positive (VP-distinct red). The double line represents non-growing season, approximately December 12 – February 12

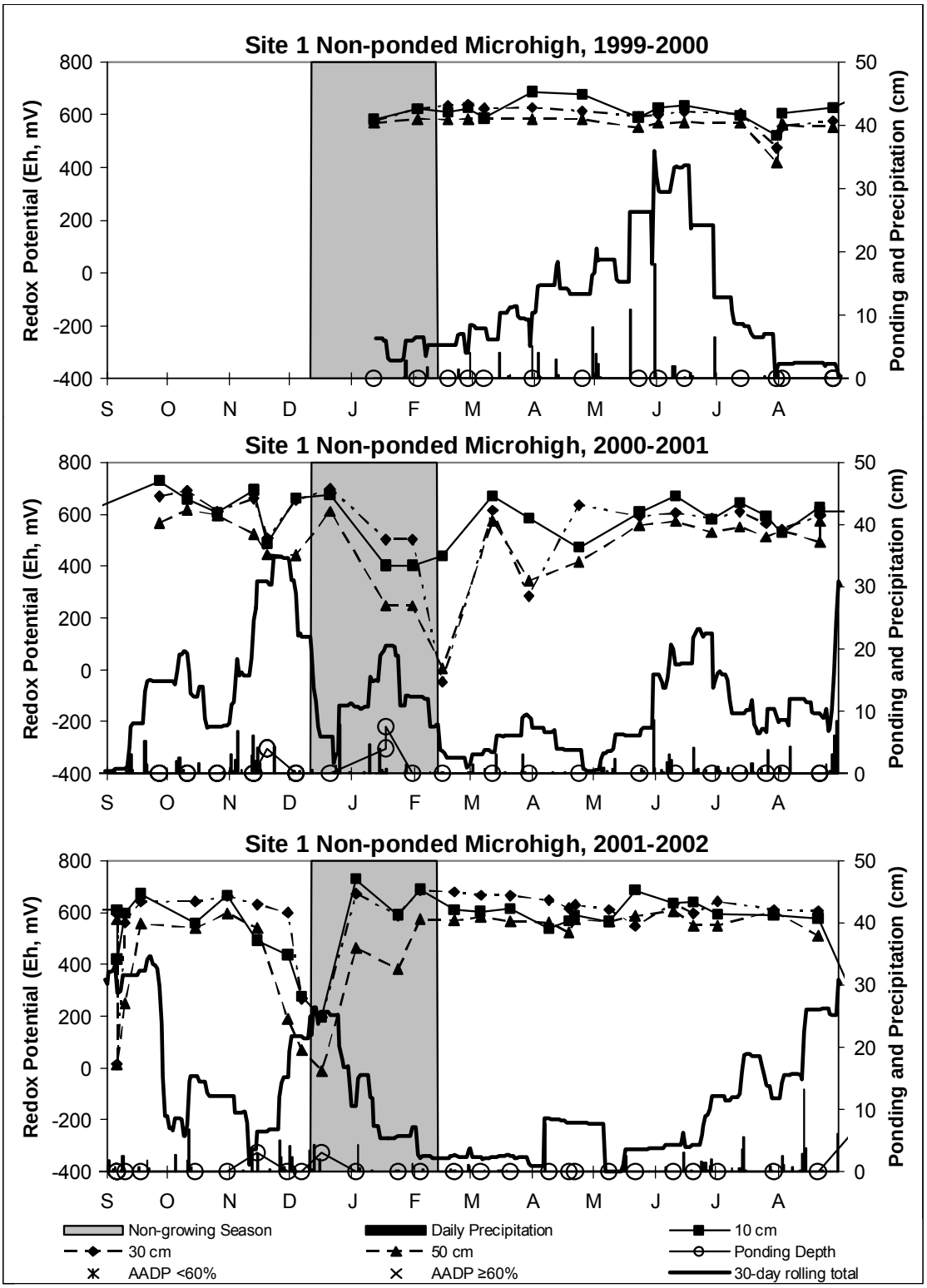


Fig. H1. Site 1 nonponded microhigh, measurements during a 3-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H1. Site 1 nonponded microhigh: Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000 – Aug. 2001.) AADP dye reactions not observed. The double line represents non-growing season, approximately December 12 – February 12.

Date	**10 cm**					**30 cm**					**50 cm**				
	Eh					Eh					Eh				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1/12/00	609	595	601	562	547	509	597	619	566	597	636	590	625	439	554
2/3/00	652	626	596	639	591	572	627	636	638	641	643	586	664	471	561
2/18/00	611	624	603	613	585	649	619	643	639	624	662	610	602	486	538
2/28/00	611	646	646	635	588	633	634	621	655	651	609	620	607	522	565
3/7/00	608	630	557	563	579	631	633	616	622	624	609	606	629	507	577
3/31/00	648	682	714	716	669	625	599	624	646	634	597	602	640	522	559
4/25/00	640	703	681	699	656	607	585	614	637	628	586	599	648	501	577
5/23/00	622	586	544	607	587	581	561	588	628	606	555	569	596	494	540
6/2/00	597	649	646	643	595	590	567	599	632	619	563	581	631	509	555
6/15/00	623	657	649	684	568	606	577	608	648	622	575	590	628	523	543
7/13/00	601	566	581	674	561	604	566	588	640	612	575	600	593	535	537
7/31/00	575	546	553	550	387	474	475	469	498	460	405	426	446	415	399
8/3/00	586	634	601	653	557	544	558	567	563	556	544	552	616	556	537
8/28/00	604	653	614	629	627	634	545	559	580	569	545	565	559	562	530

Table H2. Site 1 nonponded microhigh: Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 – Aug. 2001) AADP dye reactions not observed. The double line represents non-growing season, approximately December 12 – February 12.

Date	10 cm					30 cm					50 cm				
	Eh					Eh					Eh				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
9/27/00	759	734	728	696	725	674	609	634	726	702	558	585	579	558	548
10/11/00	640	674	687	666	626	672	639	733	694	712	585	688	657	576	575
10/26/00	611	617	578	624	599	567	592	620	634	631	591	604	619	562	600
11/13/00	763	680	724	696	594	624	613	703	670	698	557	574	535	498	451
11/20/00	308	605	650	629	246	288	475	540	627	613	412	531	565	477	230
12/4/00	683	640	708	685	583	609	618	681	710	646	99	549	542	479	540
12/21/00	702	633	719	680	641	626	650	729	740	743	576	634	650	584	604
1/18/01	323	484	518	462	230	327	486	548	597	555	126	55	363	448	244
1/31/01	174	628	652	660	71	-211	270	-381	55	30	67	-8	-165	105	31
2/15/01	616	592	586	574	578	544	583	596	624	616	132	484	445	514	544
3/1/01	665	662	700	652	672	580	578	617	655	645	636	534	550	556	589
3/12/01	583	634	581	559	563	229	319	94	394	381	162	244	517	521	267
3/30/01	344	605	563	554	294	556	714	606	651	648	6	445	529	554	544
4/24/01	637	593	637	639	524	572	564	615	609	604	574	527	560	559	566
5/24/01	664	707	718	716	531	583	562	604	650	624	562	552	600	567	580
6/11/01	589	586	598	592	531	607	557	601	544	606	523	494	534	516	581
6/29/01	629	682	688	690	534	594	573	604	649	623	525	536	591	541	565
7/13/01	594	589	618	663	493	572	552	571	576	554	543	506	538	552	421
7/26/01	542	536	586	564	409	524	546	552	556	529	547	521	568	509	535
8/3/01	608	623	668	685	539	572	555	599	651	598	544	509	549	539	313
8/22/01	602	584	625	688	554	579	576	592	625	600	569	533	605	558	588

Table H3. Site 1 nonponded microhigh: Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2001 – Aug. 2002.) AADP dye reactions not observed. The double line represents non-growing season, approximately December 12 – February 12.

Date	10 cm					30 cm					50 cm				
	Eh					Eh					Eh				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
9/6/01	-159	580	588	599	484	-172	176	-179	94	149	14	114	-144	69	14
9/18/01	724	691	719	531	694	677	599	617	659	645	532	534	574	572	567
10/15/01	365	618	616	630	561	686	640	615	637	631	518	504	570	555	554
10/31/01	676	695	724	722	514	698	614	653	689	658	593	583	625	579	602
11/13/01	615	606	607	689	510	692	595	612	609	646	632	533	570	551	573
11/30/01	322	514	624	447	276	679	471	606	649	588	182	100	126	317	220
12/7/01	104	165	596	270	242	242	289	197	313	297	127	-35	1	137	107
12/17/01	43	284	176	228	239	211	184	120	216	249	19	-55	-93	137	-64
1/3/02	738	795	765	725	615	711	556	732	728	629	261	476	505	563	513
1/24/02	595	600	641	594	523	664	529	609	566	569	285	119	466	520	512
2/4/02	673	687	661	678	740	713	645	674	715	681	521	633	559	594	562
2/21/02	643	660	614	641	499	708	661	657	693	674	550	552	567	598	577
3/6/02	631	637	624	643	484	701	667	664	644	658	564	559	603	600	590
3/21/02	636	666	632	648	488	697	656	636	673	656	552	559	544	593	569
4/9/02	465	620	643	651	307	651	674	630	655	629	564	553	534	585	567
4/19/02	590	581	591	582	485	599	613	592	642	634	519	502	499	544	547
4/22/02	610	616	599	615	501	615	622	612	659	637	555	560	552	598	592
5/9/02	622	608	603	509	478	553	599	624	639	640	564	565	551	573	570
5/22/02	702	712	682	719	607	689	635	648	696	66	574	584	582	606	589
6/10/02	624	644	682	669	550	604	592	635	677	655	673	574	594	589	594
6/20/02	651	695	652	657	538	574	559	599	636	612	545	571	525	545	564
7/2/02	625	601	592	624	530	693	635	604	636	640	537	556	509	578	562
7/17/02	219	594	584	644	302	584	449	547	216	562	504	515	502	532	552
7/30/02	564	604	586	675	519	622	533	616	660	625	538	740	579	593	572
8/21/02	584	606	614	544	534	609	606	605	607	594	529	514	484	544	484

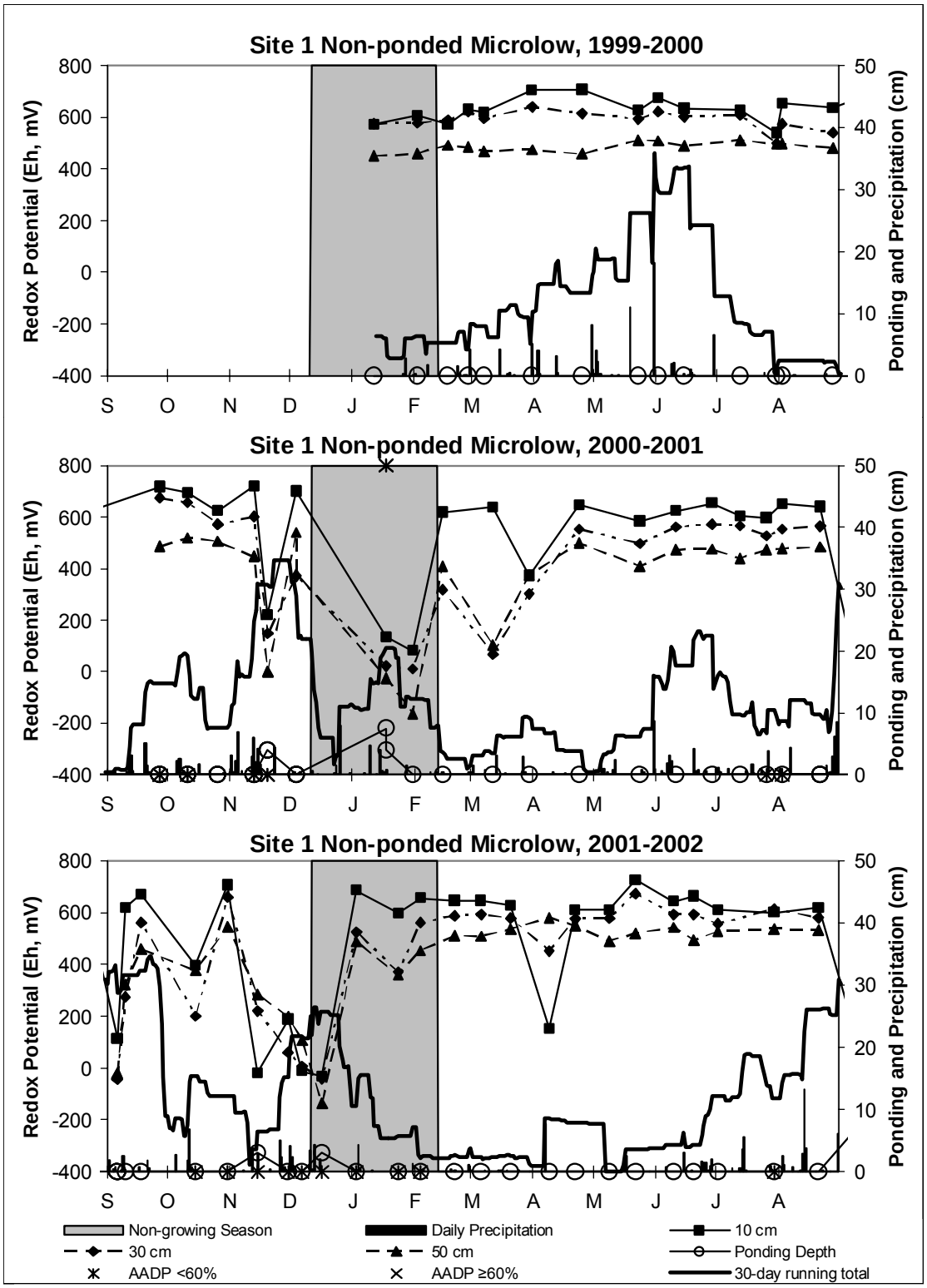


Fig. H2. Site 1 nonponded microlow, measurements during a 3-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H4. Site 1 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000-Aug. 2000.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	**Pnd**	**10 cm**							**30 cm**							**50 cm**						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
01/12/00	0	0		556	517	600	578	609	0		630	499	618	554	571	0		239	354	508	581	565
02/03/00	0	0		578	537	646	630	642	0		657	474	609	619	526	0		357	383	499	619	435
02/18/00	0	0		604	544	540	597	577	0		645	539	630	608	524	0		406	400	499	553	594
02/28/00	0	0		616	601	664	592	674	0		685	577	669	653	521	0		418	407	512	487	598
03/07/00	0	0		607	641	599	626	616	0		659	568	630	619	492	0		355	397	498	522	571
03/31/00	0	0		714	641	726	718	722	0		699	592	664	664	577	0		371	395	523	501	583
04/25/00	0	0		699	651	714	736	731	0		673	584	658	659	501	0		369	383	527	580	431
05/23/00	0	0		606	611	628	630	650	0		641	581	651	488	597	0		534	341	547	531	598
06/02/00	0	0		640	635	684	700	710	0		665	591	647	586	617	0		390	417	550	595	591
06/15/00	0	0		618	594	627	679	649	0		645	561	611	597	595	0		377	405	521	572	567
07/13/00	0	0		612	596	622	658	650	0		644	555	619	625	595	0		401	450	543	582	584
07/31/00	0	0		545	552	554	535	510	0		494	473	510	532	480	0		405	457	525	538	563
08/03/00	0	0		598	626	670	682	692	0		574	548	581	602	563	0		405	457	525	538	563
08/28/00	0	0		570	615	671	666	653	0		559	557	554	519	507	0		319	459	513	546	560

Table H5. Site 1 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 – Aug. 2001.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
09/27/00	0	0		736	740	671	721	724	0		683	607	733	680	672	0		319	456	513	566	570
10/11/00	0	0		650	634	751	707	726	0		658	642	700	663	613	0		404	400	574	605	613
10/26/00	0	0		604	629	631	624	628	0		574	559	609	554	563	0		427	443	530	572	555
11/13/00	0	0		746	700	790	694	679	0		608	537	688	532	641	0		445	451	418	499	419
11/20/00	4	0		154	255	51	462	188	0		140	253	323	-104	129	0		-173	228	212	-89	-172
12/04/00	0	0		694	667	769	680	695	0		98	557	654	163	388	0		380	580	559	593	589
12/21/00	0	0		714	667	781	679	722	0		666	614	683	433	463	0		-158	385	584	608	615
01/18/01	4	40P		14	277	198	-48	231	0		-98	239	228	-132	-134	0		-142	-65	208	-10	-117
01/31/01	0	0		-198	221	444	-157	98	0		-116	212	133	-11	-169	0		-199	-206	44	-225	-236
02/15/01	0	0		608	626	609	599	648	0		-144	565	634	167	360	0		192	159	552	585	554
03/12/01	0	0		634	596	636	647	669	0		-26	236	210	68	-152	0		199	84	81	139	6
03/30/01	0	0		164	331	649	355	368	0		297	477	600	-157	296	0		206	219	355	584	509
04/24/01	0	0		615	649	644	650	688	0		626	594	635	477	430	0		322	403	564	614	588
05/24/01	0	0		555	539	599	607	625	0		562	513	560	457	389	0		245	330	462	516	493
06/11/01	0	0		609	635	625	631	616	0		594	566	640	503	505	0		301	387	529	596	545
06/29/01	0	0		601	645	677	663	684	0		631	567	625	541	490	0		308	406	528	577	560
07/13/01	0	0		583	564	627	631	615	0		599	539	554	583	551	0		340	397	463	503	490
07/26/01	0	0		608	594	574	594	622	0		603	547	587	450	442	0		305	412	518	568	556
08/03/01	0	0		594	622	695	680	665	0		619	549	608	547	439	0		304	424	524	574	560
08/22/01	0	0		585	637	686	669	626	0		597	589	624	564	442	0		336	441	524	565	554

Table H6. Site 1 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2001 – Aug. 2002.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
09/06/01	0	0		-206	4	374	-151	544	0		-54	174	64	-204	-196	0		-133	234	149	-199	-156
09/18/01	0	0		626	638	711	672	692	0		657	541	644	522	441	0		290	358	529	582	535
10/15/01	0	0		-102	503	608	328	643	0		346	299	525	-28	-138	0		170	374	369	457	505
10/31/01	0	0		717	634	760	705	706	0		676	627	684	739	567	0		352	444	666	665	596
11/13/01	3	0		282	577	299	547	525	0		504	542	606	449	389	0		191	349	674	643	527
11/30/01	0	0		49	552	-47	121	268	0		131	227	341	-196	-201	0		128	226	219	217	197
12/07/01	0	0		-24	177	-246	-143	178	0		41	185	259	-229	-224	0		192	83	91	76	83
12/17/01	3	0		-63	134	-225	-179	174	0		-71	153	171	-242	-218	0		-196	22	-72	-219	-215
01/03/02	0	0		663	704	623	720	714	0		589	593	679	457	297	0		244	116	604	684	781
01/24/02	0	0		597	622	558	582	623	0		123	511	618	366	230	0		259	150	574	658	146
02/04/02	0	0		658	646	631	656	683	0		662	572	663	588	320	0		260	59	663	700	583
02/21/02	0	0		639	650	624	630	687	0		682	596	673	635	347	0		245	313	695	710	584
03/06/02	0	0		641	644	629	627	684	0		670	616	666	672	339	0		121	390	697	709	628
03/21/02	0	0		616	625	600	614	679	0		669	580	654	634	347	0		361	363	647	692	622
04/09/02	0	0		-77	295	-136	283	395	0		602	557	605	269	220	0		512	404	668	693	619
04/19/02	0	0		602	575	572	588	659	0		665	574	626	592	524	0		414	377	637	672	657
04/22/02	0	0		597	602	593	590	665	0		662	577	628	588	422	0		496	395	619	634	594
05/09/02	0	0		613	589	585	594	673	0		641	555	626	628	437	0		327	411	562	566	579
05/22/02	0	0		701	714	776	700	724	0		736	640	683	724	574	0		433	414	560	612	577
06/10/02	0	0		618	651	634	661	649	0		673	512	647	646	480	0		444	536	566	576	585
06/20/02	0	0		594	693	694	662	673	0		637	552	619	607	546	0		404	424	541	543	549
07/02/02	0	0		617	604	574	614	638	0		653	537	626	600	363	0		427	433	547	668	556
07/30/02	0	0		582	607	633	591	588	0		611	713	602	611	524	0		427	440	581	651	578
08/21/02	0	0		614	604	584	664	624	0		594	544	654	649	454	0		374	414	584	694	599

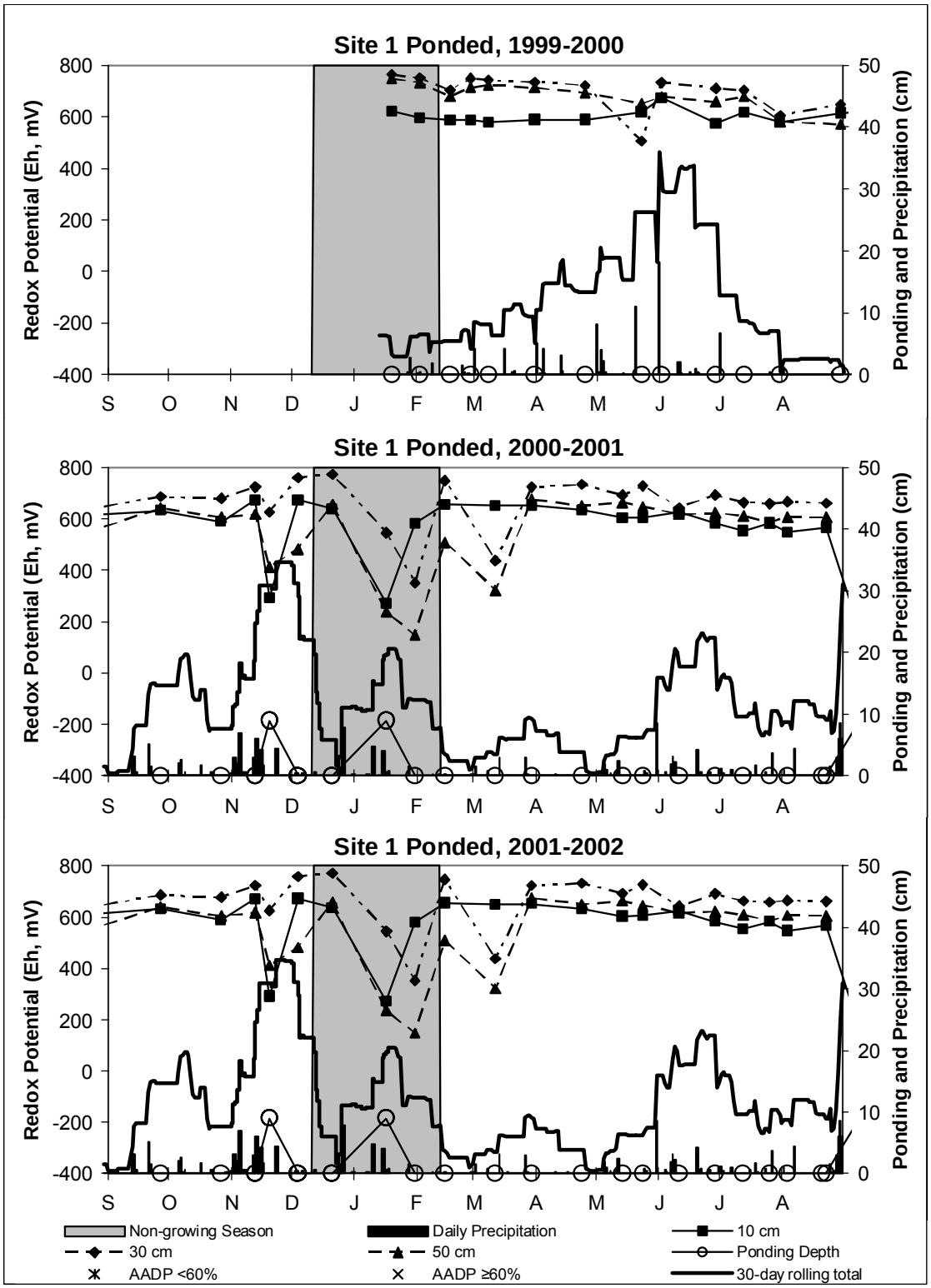


Fig. H3. Site 1 ponded, measurements during a 3-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H7. Site 1 ponded: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000-Aug. 2000.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
1/20/00	0	0		708	698	571	678	452	0		789	777	774	757	726	0		758	784	760	702	736
2/3/00	0	0		699	580	542	474	679	0		756	787	773	732	695	0		764	783	763	669	688
2/18/00	0	0		669	656	566	556	490	0		714	715	710	695	683	0		677	694	691	648	681
2/28/00	0	0		720	667	602	516	427	0		795	746	755	729	712	0		737	756	748	636	693
3/8/00	0	0		684	653	556	555	446	0		770	756	753	725	708	0		748	768	765	637	697
3/31/00	0	0		727	640	530	588	454	0		769	789	733	706	677	0		740	744	781	613	682
4/25/00	0	0		686	631	444	621	562	0		757	783	720	688	659	0		724	735	758	585	665
5/23/00	0	0		669	676	536	596	-	0		602	547	527	420	434	0		686	680	646	610	627
6/2/00	0	0		691	660	764	647	604	0		784	785	733	694	665	0		703	719	764	559	644
6/29/00	0	0		665	620	450	605	529	0		776	778	704	674	618	0		704	724	748	489	624
7/13/00	0	0		678	714	499	677	517	0		785	776	700	670	584	0		714	714	718	620	630
7/31/00	0	0		618	610	526	623	509	0		614	642	653	641	474	0		600	592	619	542	554
8/30/00	0	0		661	664	675	498	576	0		670	666	673	651	582	0		646	567	514	616	506

Table H7. Site 1 ponded: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 –Aug. 2001.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/27/00	0	0		694	624	569	680	594	0		736	749	715	662	568	0		654	656	701	518	662
10/27/00	0	0		626	629	544	595	551	0		721	734	677	644	617	0		673	644	674	422	610
11/13/00	0	0		704	698	640	659	649	0		760	796	687	711	662	0		693	660	648	479	607
11/20/00	9	0		261	312	346	260	276	0		747	773	616	648	343	0		464	584	367	308	338
12/4/00	0	0		681	708	620	696	658	0		792	868	735	711	692	0		691	205	489	405	618
12/21/00	0	0		610	697	563	676	637	0		796	899	738	726	702	0		744	638	714	513	668
1/17/01	9		100P	244	241	296	285	289	0		644	637	606	605	231	0		232	249	244	244	210
1/31/01	0	0		686	693	649	282	596	0		570	476	263	243	206	0		-11	129	198	219	206
2/15/01	0	0		624	682	614	719	637	0		729	890	728	706	689	0		684	163	626	429	641
3/12/01	0	0		630	667	625	696	629	0		715	582	364	293	234	0		265	375	277	241	444
3/30/01	0	0		654	684	634	664	626	0		784	715	738	704	678	0		724	664	682	630	674
4/24/01	0	0		644	642	504	721	656	0		765	862	730	645	660	0		752	676	716	485	621
5/14/01	0	0		602	578	516	717	601	0		708	810	664	631	643	0		750	643	734	688	502
5/24/01	0	0		625	624	486	709	583	0		776	836	712	673	638	0		760	677	731	474	592
6/11/01	0	0		617	623	588	702	595	0		734	738	612	575	557	0		738	661	700	405	579
6/29/01	0	0		618	594	471	661	564	0		709	770	688	651	636	0		727	621	708	478	577
7/13/01	0	0		659	544	416	643	505	0		694	741	654	616	609	0		724	631	686	433	572
7/26/01	0	0		655	531	511	635	579	0		720	638	645	646	644	0		679	591	676	409	564
8/4/01	0	0		634	504	414	662	524	0		705	725	638	639	618	0		710	622	698	427	579
8/23/01	0	0		671	463	491	674	525	0		622	577	634	745	724	0		691	647	672	440	574

Table H8. Site 1 ponded: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2001- Aug. 2002.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/7/01	8		100VP	120	154	245	284	242	10P		437	214	204	224	219	0		139	240	264	239	231
9/18/01	0	0		649	555	617	672	556	0		751	766	643	619	574	0		701	641	695	526	605
10/15/01	0	0		207	187	245	233	227	0		666	688	566	559	429	0		663	616	622	438	538
10/31/01	0	0		654	594	662	724	612	0		758	774	710	662	632	0		729	694	731	531	614
11/13/01	6		100SP	356	613	544	661	604	0		704	764	693	676	622	0		702	672	714	530	594
11/30/01	19	0		303	568	301	391	433	0		612	359	108	256	180	0		111	203	220	238	115
12/7/01	12	0		139	200	252	285	245	0		414	323	204	260	171	0		104	201	158	244	214
12/17/01	15		100P	184	215	203	265	220	0		352	254	199	239	132	0		79	160	104	221	160
1/3/02	0	0		683	695	708	684	698	0		661	258	187	222	155	0		107	127	181	238	199
1/24/02	0	1SP		695	692	716	713	705	0		574	254	167	195	171	0		115	190	78	240	142
2/4/02	0	0		669	675	703	704	687	0		498	496	453	173	161	0		292	164	66	234	120
2/21/02	0	0		636	650	684	704	664	0		757	829	666	203	574	0		664	386	192	244	535
3/6/02	0	0		608	641	663	685	659	0		747	831	649	602	275	0		512	215	177	274	247
3/21/02	0	0		622	626	634	704	640	0		755	825	679	652	624	0		684	483	566	486	590
4/9/02	8	0		304	606	454	624	604	0		730	710	681	664	615	0		662	641	654	534	598
4/22/02	0	0		626	634	662	720	634	0		737	811	689	643	570	0		696	538	697	517	574
5/9/02	0	0		632	572	571	718	538	0		746	792	683	592	604	0		715	505	707	431	552
5/22/02	0	0		644	617	636	710	632	0		749	796	697	669	612	0		726	589	711	513	576
6/10/02	0	0		634	596	622	686	559	0		719	783	659	664	604	0		729	554	654	459	517
6/20/02	0	0		653	566	610	686	582	0		707	743	660	645	544	0		716	544	655	404	494
7/3/02	0	0		634	602	664	669	644	0		742	701	689	657	615	0		650	544	653	501	545
7/17/02	0	0		204	226	256	297	288	0		654	632	330	564	234	0		636	489	219	489	500
7/30/02	0	0		616	601	620	670	572	0		692	748	645	607	549	0		709	515	663	480	520
8/21/02	0	0		-	-	-	-	-	0		-	-	-	-	-	0		-	-	-	-	-

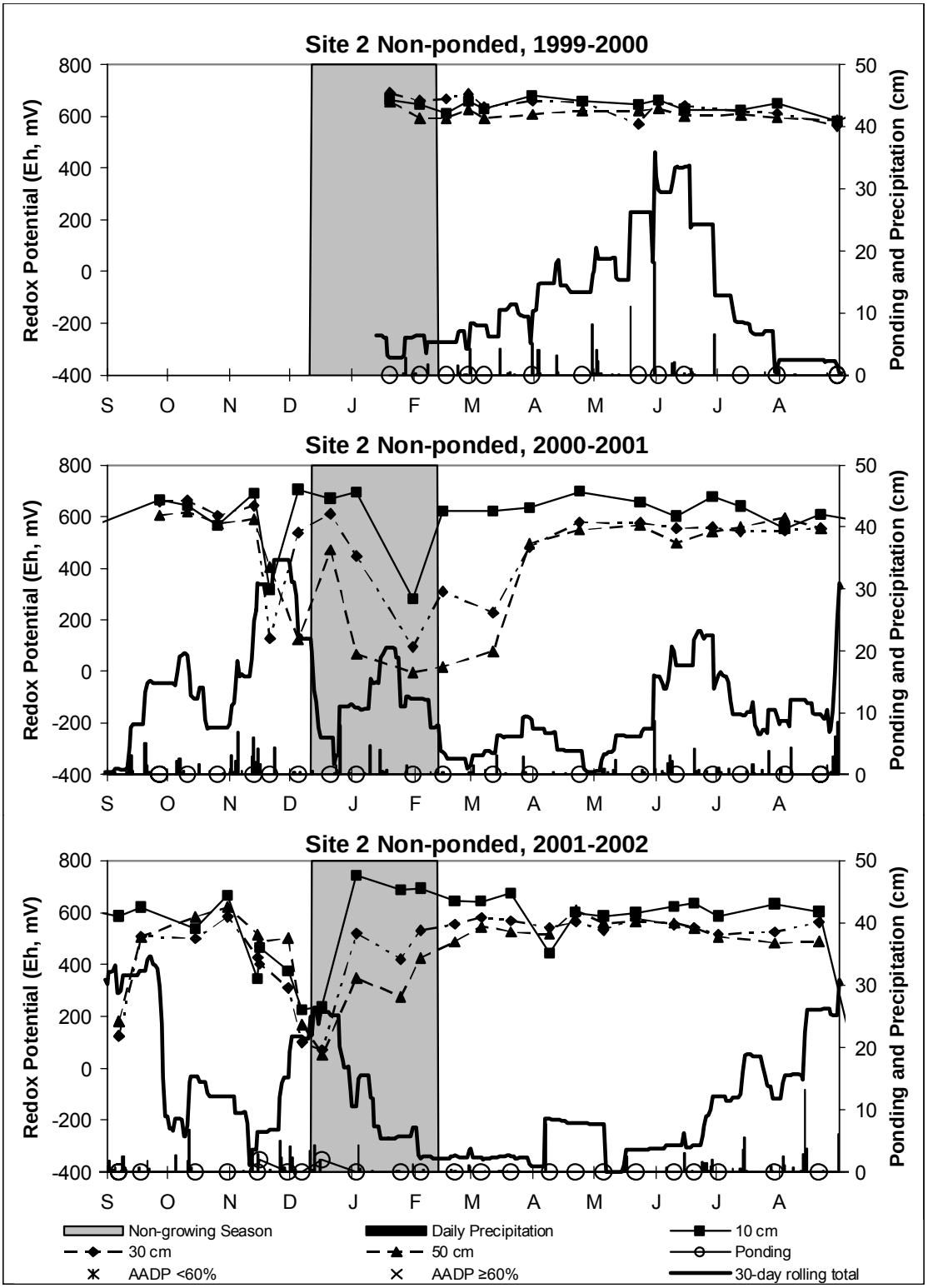


Fig. H4. Site 2 nonponded microlow, measurements during a 3-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H9. Site 2 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000 – Aug. 2000.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	**Pnd**	**10 cm**							**30 cm**							**50 cm**						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
1/20/00	0	0		700	677	650	660	629	0		680	679	666	738	686	0		614	693	665	677	629
2/4/00	0	0		688	665	651	636	579	0		663	648	653	691	645	0		594	625	649	617	479
2/17/00	0	0		656	556	620	629	597	0		647	662	651	729	642	0		583	634	631	607	507
2/28/00	0	0		706	679	604	647	649	0		678	689	656	723	684	0		660	644	649	664	516
3/7/00	0	0		673	639	614	617	600	0		664	584	642	683	591	0		578	600	602	657	522
3/31/00	0	0		769	692	627	626	684	0		664	656	626	731	618	0		659	619	614	623	525
4/25/00	0	0		722	690	606	604	671	0		656	680	617	717	598	0		660	619	637	647	542
5/23/00	0	0		685	657	619	638	623	0		481	674	536	615	543	0		643	592	619	628	623
6/2/00	0	0		652	730	654	619	655	0		652	677	632	702	616	0		732	601	620	632	565
6/15/00	0	0		678	646	621	584	605	0		649	676	607	687	577	0		650	597	557	637	571
7/13/00	0	0		707	605	609	626	567	0		634	664	575	673	550	0		633	605	613	603	577
7/31/00	0	0		681	671	680	619	590	0		615	653	536	686	564	0		613	589	600	603	568
8/30/00	0	0		591	587	577	586	554	0		547	624	521	618	504	0		586	604	573	582	568

Table H10. Site 2 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 – Aug. 2001.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/27/00	0	0		706	660	669	634	653	0		664	736	584	700	612	0		636	599	631	585	576
10/11/00	0	0		578	677	654	639	679	0		669	714	656	684	593	0		613	554	680	630	615
10/26/00	0	0		583	580	575	573	518	0		598	627	588	644	556	0		607	543	606	548	565
11/13/00	0	0		636	781	662	648	727	0		674	680	644	628	589	0		606	538	638	597	572
11/21/00	0	0		326	-36	599	339	355	0		196	-232	238	232	208	0		531	473	571	220	232
12/5/00	0	0		657	742	693	677	755	0		648	567	455	439	577	0		-142	53	545	-64	222
12/21/00	0	0		648	697	687	660	661	0		677	661	477	630	606	0		387	413	642	498	411
1/18/01	0	0		660	717	651	694	747	0		583	613	502	289	246	0		-191	-143	258	2	407
1/31/01	0	0		320	-105	294	261	641	0		59	-156	197	181	192	0		-226	-113	204	-67	176
2/15/01	0	0		619	652	607	634	585	0		553	484	160	156	194	0		-216	-62	204	-1	159
3/12/01	0	0		628	633	589	646	614	0		198	329	205	207	200	0		-57	6	234	9	195
3/30/01	0	0		614	616	652	655	637	0		660	595	257	370	524	0		565	388	584	504	433
4/24/01	0	0		694	720	713	687	671	0		622	669	564	465	564	0		624	415	612	551	545
5/24/01	0	0		649	620	670	700	643	0		626	690	555	484	524	0		639	446	625	558	560
6/11/01	0	0		613	639	569	599	585	0		619	641	527	497	492	0		559	367	521	510	528
6/29/01	0	0		691	728	669	656	652	0		580	583	528	499	600	0		511	625	536	523	515
7/13/01	0	0		596	653	648	661	651	0		559	652	476	546	480	0		632	429	607	558	570
8/4/01	0	0		604	434	608	552	575	0		544	564	455	671	489	0		611	590	606	599	570
8/22/01	0	0		634	594	599	611	607	0		606	646	484	548	490	0		596	446	598	550	572

Table H11. Site 2 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2001 – Aug. 2002.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/7/01	0	0		610	594	584	589	559	0		54	245	174	184	-41	0		124	194	196	202	184
9/18/01	0	0		620	587	624	628	642	0		544	558	509	634	297	0		564	347	583	595	441
10/15/01	0	0		634	643	325	627	450	0		633	706	329	512	314	0		638	386	685	670	533
10/31/01	0	0		634	669	680	667	670	0		700	732	547	552	385	0		657	483	680	662	614
11/15/01	0	0		251	200	345	592	334	0		500	632	230	459	313	0		541	350	600	561	518
11/16/01	2	0		283	608	539	554	333	0		325	594	304	459	324	0		516	348	568	554	444
11/30/01	0	0		358	365	310	446	391	0		552	320	257	284	134	0		584	432	660	460	372
12/7/01	0	0		276	218	184	214	230	0		162	-130	219	164	84	0		155	198	207	192	91
12/17/01	2	0		297	236	221	236	192	0		-22	-59	227	190	10	0		-167	148	187	105	-14
1/3/02	0	0		687	726	792	702	801	0		664	680	550	394	312	0		136	356	609	362	281
1/25/02	0	0		656	683	713	674	707	0		646	642	246	324	239	0		289	292	341	249	205
2/4/02	0	0		676	703	723	677	683	0		663	693	555	428	312	0		268	347	595	620	297
2/21/02	0	0		648	651	639	640	642	0		650	667	568	542	344	0		535	382	627	594	289
3/6/02	0	0		646	632	648	652	632	0		661	729	600	548	369	0		579	477	708	628	333
3/21/02	0	0		670	708	695	633	666	0		648	655	565	539	432	0		595	391	629	610	402
4/9/02	0	0		608	101	422	591	491	0		637	666	569	448	380	0		592	400	627	612	352
4/22/02	0	0		613	612	596	594	582	0		625	633	555	469	542	0		590	563	636	599	642
5/6/02	0	0		624	594	582	564	565	0		574	669	484	558	374	0		595	388	632	616	560
5/22/02	0	0		630	585	591	574	614	0		624	729	558	486	491	0		617	408	663	639	494
6/10/02	0	0		599	652	636	649	576	0		584	628	485	594	474	0		612	499	599	592	489
6/20/02	0	0		634	689	664	594	590	0		554	594	484	584	490	0		603	475	569	570	479
7/2/02	0	0		594	603	609	584	542	0		553	494	510	507	517	0		490	441	554	591	461
7/30/02	0	0		598	686	628	624	631	0		565	594	542	575	350	0		544	362	576	545	384
8/21/02	0	0		624	594	614	604	584	0		584	524	574	594	534	0		484	504	544	549	354

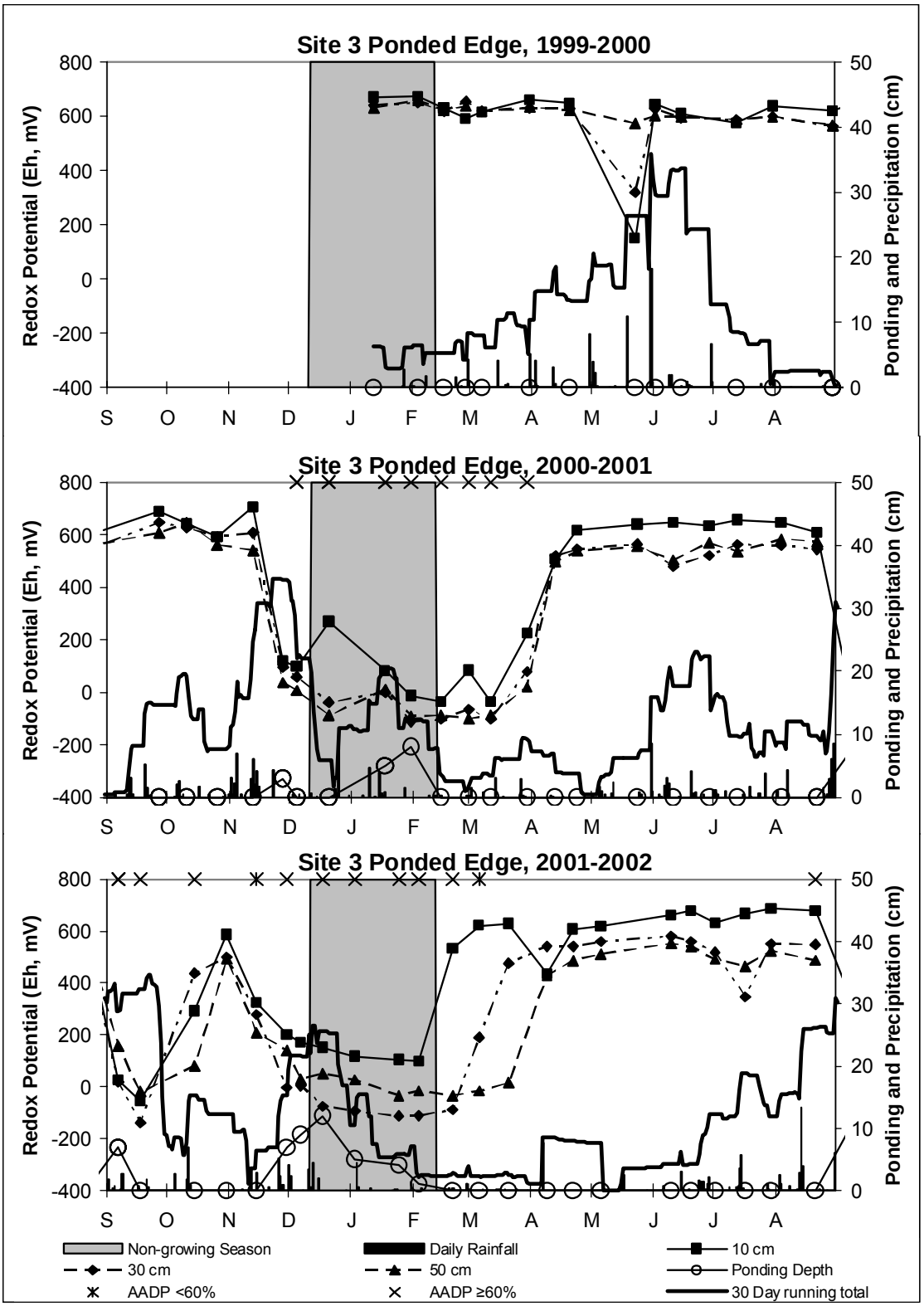


Fig. H5. Site 3 ponded edge, measurements during a 3-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H12. Site 3 ponded edge: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000 – Aug. 2000.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
1/13/00	0	0		660	661	667	668	693	0		633	642	648	655	624	0		567	601	638	677	675
2/4/00	0	0		692	668	671	643	688	0		669	688	603	655	635	0		718	556	652	682	680
2/17/00	0	0		620	545	628	677	676	0		619	622	595	612	645	0		590	605	659	622	633
2/28/00	0	0		598	553	555	621	620	0		697	670	615	658	632	0		598	607	664	653	660
3/7/00	0	0		625	559	618	651	629	0		631	567	608	628	656	0		632	573	641	598	651
3/31/00	0	0		721	579	675	692	639	0		655	651	615	614	609	0		628	571	626	685	649
4/11/00	0	0		-	-	-	-	-	0		-	-	-	-	-	0		-	-	-	-	-
4/20/00	0	0		719	595	652	658	618	0		650	622	627	575	660	0		615	592	615	672	621
5/23/00	0	0		11	170	116	271	196	0		243	324	395	172	461	0		576	458	596	646	590
6/2/00	0	0		648	640	655	654	630	0		650	638	605	578	668	0		619	566	599	659	569
6/15/00	0	0		684	569	610	609	575	0		634	599	569	514	660	0		601	579	577	644	596
7/13/00	0	0		637	537	592	570	532	0		633	600	559	485	659	0		590	588	586	614	567
7/31/00	0	0		716	605	641	623	602	0		623	606	567	523	672	0		609	598	602	621	561
8/30/00	0	0		704	618	602	594	576	0		580	573	548	515	600	0		575	565	558	564	569

Table H13. Site 3 ponded edge: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 – Aug. 2001.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/27/00	0	0		751	661	686	691	651	0		702	668	614	591	659	0		619	614	611	604	589
10/11/00	0	0		667	729	618	592	602	0		612	621	604	573	719	0		616	609	680	662	672
10/26/00	0	0		629	589	577	579	585	0		640	588	554	547	636	0		567	554	570	569	547
11/13/00	0	0		679	772	680	670	718	0		651	579	564	618	621	0		588	582	591	589	352
11/28/00	3	0		231	3	-13	166	212	0		36	178	181	218	-138	0		123	52	-39	69	-17
12/5/00	0		100P	283	68	-121	51	207	0		-67	153	156	215	-167	0		97	-13	-13	39	-76
12/21/00	0		100P	604	63	-90	466	305	0		-130	-61	-41	195	-160	0		-37	-67	-147	-82	-109
1/18/01	5		100VP	217	6	-88	110	155	0		-40	-92	67	178	-110	0		17	32	-58	148	-81
1/31/01	8		100VP	168	-20	-174	-101	63	10VP		-170	-145	-108	66	-199	0		-131	-143	53	-91	-136
2/15/01	0		100VP	153	-137	-174	-105	76	30VP		-164	-149	-115	30	-112	2P		-114	-129	32	-88	-137
3/1/01	0		100VP	262	-146	-41	224	121	40VP		-136	-115	-99	63	-39	2P		-119	-122	-49	-89	-126
3/12/01	0		100VP	113	-183	-161	-49	107	2P		-140	-151	-127	24	-123	0		-125	-133	36	-98	-108
3/30/01	0		100VP	320	84	196	262	261	0		94	171	3	224	-97	0		98	-123	74	177	-126
4/13/01	0	0		647	432	625	387	445	0		565	498	524	477	531	0		554	489	541	456	446
4/24/01	0	0		706	610	637	502	632	0		609	597	482	508	532	0		581	521	550	623	413
5/24/01	0	0		660	659	643	627	613	0		614	598	496	511	607	0		559	537	567	610	495
6/11/01	0	0		639	691	689	554	656	0		580	564	229	506	527	0		537	507	552	540	384
6/29/01	0	0		649	639	610	648	629	0		474	497	459	642	536	0		609	498	630	545	562
7/13/01	0	0		681	708	645	654	599	0		604	578	516	505	612	0		499	518	538	601	523
8/4/01	0	0		642	724	639	634	592	0		600	577	514	524	580	0		568	637	545	621	549
8/22/01	0	0		608	684	629	568	558	0		555	562	499	507	604	0		624	549	547	596	554

Table H14. Site 3 ponded edge: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2001 – Aug. 2002.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/7/01	7		100VP	116	-61	-44	84	39		100SP	-116	49	84	189	-119	0		188	129	211	108	154
9/18/01	0		100VP	-16	-105	-79	95	-172	0		-271	-160	-49	8	-223	0		154	-100	69	-87	-128
10/15/01	0		100VP	372	248	254	330	262	40P		-102	42	126	245	-124	0		232	162	146	-36	-95
10/31/01	0	0		650	574	621	620	464	0		544	530	414	486	529	0		464	542	587	652	224
11/15/01	0	40VP		327	240	297	504	254	0		264	281	273	266	302	0		241	166	216	174	246
11/30/01	7		100VP	201	31	264	272	239	0		-137	-110	204	132	-98	0		244	117	218	208	-82
12/7/01	9	0		201	-17	226	214	229	0		-126	-68	150	84	-14	0		-94	-11	199	144	-88
12/18/01	12		100VP	230	-87	206	205	204		100VP	-159	-146	77	-18	-128	10SP		229	-71	180	19	-104
1/3/02	5		100VP	190	-194	215	170	206		100VP	-160	-140	9	-47	-130		100SP	236	-79	103	-24	-98
1/25/02	4		100VP	138	-115	215	86	199		60SP	-211	-148	-33	-59	-108		60SP	188	-128	-36	-82	-115
2/4/02	1		100VP	33	-115	211	170	195		80SP	-201	-139	-16	-58	-141	0		225	-112	-23	-69	-101
2/21/02	0		100VP	653	539	455	580	432		100P	-150	-143	-34	1	-109	0		183	-114	-56	-80	-106
3/6/02	0	40VP		704	532	639	620	614		100VP	179	163	113	638	-135	0		225	-109	-25	-66	-100
3/21/02	0	0		692	566	674	595	618		100VP	549	616	460	549	206	0		240	-125	-45	129	-118
4/9/02	0	0		520	229	450	615	369	0		525	572	472	574	562	0		394	402	494	550	308
4/22/02	0	0		619	570	681	576	598	0		546	595	470	529	567	0		466	447	520	590	409
5/6/02	0	0		656	618	694	574	544	0		597	584	494	545	582	0		478	444	548	605	484
6/10/02	0	0		714	685	718	584	611	0		609	595	514	555	628	0		542	499	580	651	494
6/20/02	0	0		702	675	707	664	644	0		573	592	492	544	599	0		526	501	568	625	489
7/2/02	0	0		608	664	689	565	632	0		553	535	484	546	484	0		479	452	532	563	434
7/17/02	0	0		645	634	724	729	604	0		-91	647	324	454	402	0		414	444	504	544	424
7/30/02	0	0		681	710	729	674	639	0		534	589	500	534	596	0		499	519	544	609	454
8/21/02	0		100VP	644	694	669	694	699	2P		469	604	504	564	604	0		449	454	514	569	449

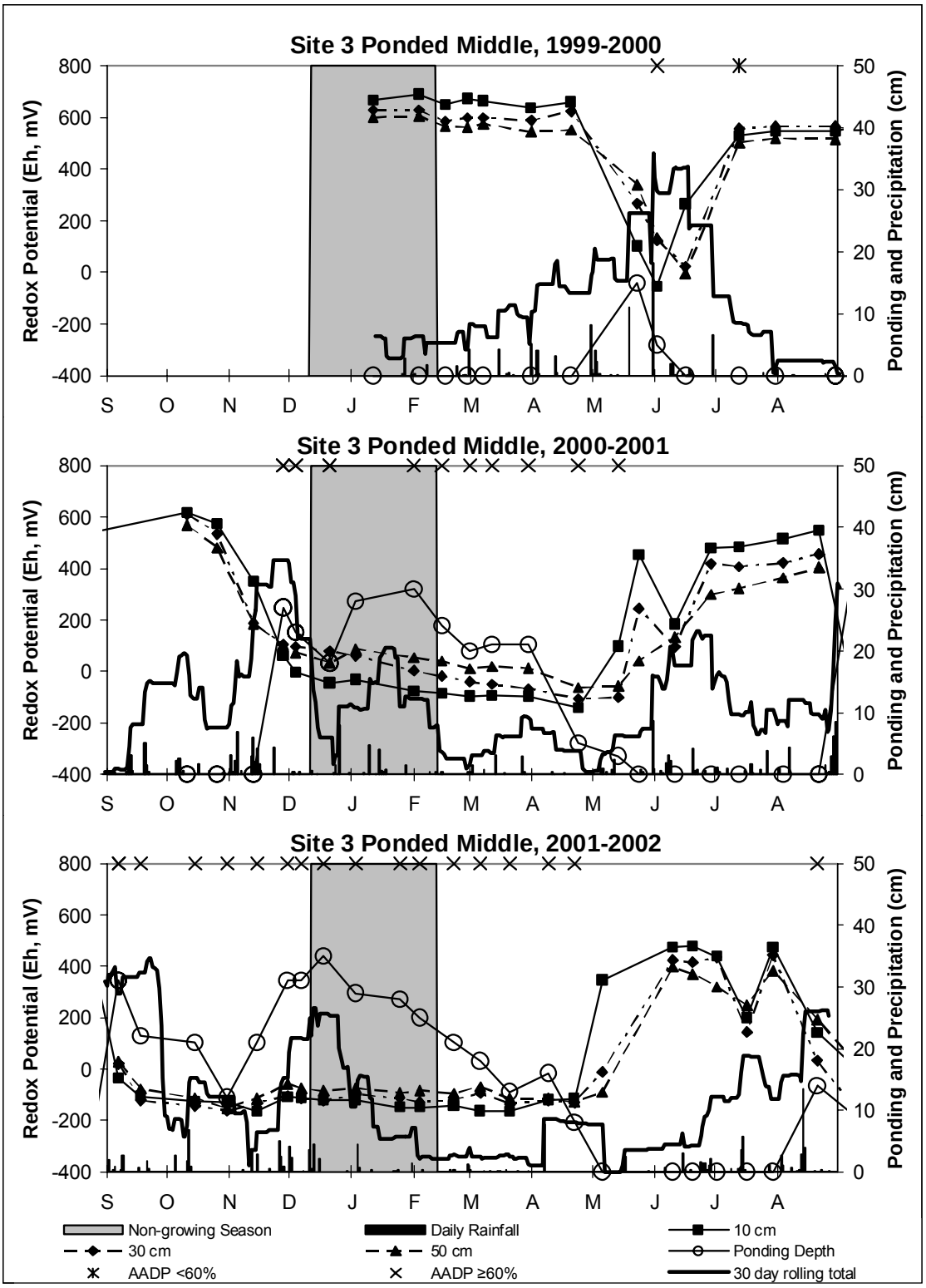


Fig. H6. Site 3 ponded middle, measurements during a 3-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H15. Site 3 ponded middle: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000 – Aug. 2000.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
1/12/00	0	0		707	740	725	439	718	0		685	672	544	635	605	0		446	654	603	644	647
2/4/00	0	0		687	757	754	528	722	0		679	646	535	624	657	0		451	582	627	685	682
2/17/00	0	0		614	718	708	540	668	0		643	609	501	616	550	0		424	566	579	621	630
2/28/00	0	0		642	733	721	599	666	0		628	605	510	626	616	0		382	602	579	630	621
3/7/00	0	0		628	733	723	572	663	0		623	626	534	633	572	0		394	622	584	640	637
3/31/00	0	0		591	729	738	498	631	0		590	612	523	625	590	0		344	589	541	619	622
4/11/00	-	0		-	-	-	-	-	0		-	-	-	-	-	0		-	-	-	-	-
4/20/00	0	0		618	717	730	572	658	0		652	648	554	640	613	0		345	629	544	632	601
5/23/00	15	0		53	264	24	128	44	0		292	425	225	275	113	0		277	597	129	580	112
6/2/00	5		100VP	27	-2	-113	-147	-38	40VP		242	108	167	228	-126	0		230	140	158	101	48
6/16/00	0	20SP		345	-42	518	361	142	20SP		143	-28	119	37	-158	0		208	-78	29	-46	-124
7/13/00	0	0		489	658	678	392	427	0		604	626	534	607	413	0		364	591	421	580	560
7/31/00	0	0		450	675	695	435	480	0		616	633	538	622	423	0		379	610	444	593	572
8/30/00	0	0		475	683	678	429	468	0		612	648	535	623	413	0		390	613	422	605	551

Table H16 Site 3 ponded middle: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 – Aug. 2001.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/27/00	0	0		567	733	657	530	508	0		629	657	548	532	422	0		399	638	434	610	584
10/11/00	0	0		594	776	696	447	569	0		670	575	574	721	514	0		387	656	458	736	598
10/26/00	0	0		575	641	609	401	638	0		585	604	529	560	397	0		344	560	375	585	540
11/13/00	0	0		343	453	445	247	268	0		413	-82	221	231	158	0		299	151	207	212	57
11/28/00	27		100SP	123	131	122	-144	66	20SP		283	-59	200	165	-67	0		262	85	207	78	-124
12/4/00	23		100VP	42	20	28	-110	1	2SP		285	-51	182	140	-80	0		274	48	218	0	-175
12/21/00	18		100VP	-7	-4	-33	-147	-30	5P		340	-33	89	86	-98	5P		326	-60	113	-30	-176
1/3/01	28		100VP	39	-18	-56	-82	-43	10VP		334	-33	40	70	-107	0		326	84	221	-44	-152
2/1/01	30		100VP	-48	-46	-72	-156	-72	30P		229	-99	-4	25	-138	10P		276	-12	213	-100	-116
2/15/01	24		100VP	-62	-83	-98	-104	-82		60VP	184	-111	-7	-3	-152	1P		263	-24	203	-115	-127
3/1/01	20		100VP	-70	-38	-133	-166	-75		80VP	58	-98	-12	-10	-137	1P		243	-79	109	-108	-119
3/12/01	21		100VP	-78	-45	-120	-154	-74	25VP		4	-97	-13	-2	-138	0		231	-93	200	-107	-133
3/30/01	21		100VP	-86	-23	-126	-174	-78	30VP		-21	-107	-41	-31	-136	0		186	-93	197	-104	-130
4/24/01	5		100VP	-109	-103	-185	-200	-111	40VP		-85	-119	-79	-87	-156	5P		148	-138	-19	-151	-159
5/14/01	3		100VP	130	27	207	107	19	2VP		-69	-134	-29	-83	-189	2VP		156	-128	-48	-127	-137
5/24/01	0	0		357	647	586	313	352	0		287	-11	333	366	244	0		175	78	92	-8	-140
6/11/01	0	0		222	269	144	196	88	0		24	36	143	149	119	0		165	204	164	40	99
6/29/01	0	0		382	699	572	316	422	0		355	355	511	572	300	0		333	317	250	302	293
7/13/01	0	0		391	686	590	316	433	0		378	372	486	511	288	0		372	368	255	317	297
8/4/01	0	0		494	669	649	324	439	0		407	389	493	524	300	0		380	399	296	398	344
8/22/01	0	0		548	700	685	354	449	0		463	444	497	558	316	0		382	472	312	462	386

Table H17 Site 3 ponded middle: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2001 – Aug. 2002.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/7/01	31		100VP	-67	-58	-82	74	-36	2SP		30	-74	129	-61	74	1SP		17	-111	169	108	-46
9/18/01	22		100VP	-120	-87	-129	-86	-109	20SP		-114	-131	-120	-146	-97	0		117	-186	-117	-54	-148
10/15/01	21		100VP	-129	-83	-96	-177	-147		60VP	-194	-126	-137	-132	-126	0		-133	-136	-91	-66	-139
10/31/01	12		100VP	-149	-28	-133	-186	-154		100VP	-144	-261	-130	-131	-141	5P		-107	-156	-120	-183	-196
11/15/01	21		100VP	-375	-78	-156	-34	-172		100VP	-97	-133	-125	-145	-158		100VP	-96	-131	-101	-81	-160
11/30/01	31		100VP	-141	-65	-140	-43	-146		100VP	-82	-112	-88	-107	-130		100VP	-46	-68	-69	-31	-70
12/7/01	31		100VP	-155	-71	-133	-37	-158		100VP	-97	-128	-99	-102	-145		100VP	-68	-72	-88	-37	-110
12/18/01	35		100VP	-168	-88	-147	-26	-176		90VP	-106	-130	-117	-112	-156		100P	-70	-67	-93	-48	-151
1/3/02	29		100VP	-106	-107	-154	-53	-170		100VP	-69	-48	-126	-102	-149		100VP	-22	-100	-78	-23	-148
1/25/02	28		100VP	-171	-120	-166	-113	-174		100VP	-101	-127	-104	-131	-103		100P	-33	-128	-93	-51	-156
2/4/02	25		100VP	-163	-123	-175	-110	-172		100P	-132	-119	-117	-125	-152		100VP	-11	-129	-92	-28	-154
2/21/02	21		100VP	-176	-121	-189	-42	-183		100VP	-122	-108	-120	-87	-160		80VP	-29	-133	-98	-47	-163
3/6/02	18		100VP	-129	-122	-193	-174	-191		100VP	-136	24	-123	-73	-162		100VP	39	-126	-89	-2	-159
3/21/02	13		100VP	-183	-114	-182	-170	-175		100VP	-177	-133	-113	-100	-157		100SP	-98	-143	-101	-78	-156
4/9/02	16		100VP	-176	-113	-178	33	-156		100VP	-170	-125	-84	-89	-148		100VP	-137	-131	-95	-73	-138
4/22/02	8		100SP	-181	-104	-155	45	-180		100SP	-179	-130	-94	-93	-150		100VP	-139	-133	-101	-94	-170
5/6/02	0	0		291	596	450	101	296	20VP		-181	-123	174	-101	176	2VP		15	-9	-95	-182	-186
6/10/02	0	0		372	697	548	384	368	0		425	419	462	492	327	0		418	402	429	383	353
6/20/02	0	0		361	678	610	364	378	0		460	392	444	474	308	0		407	405	319	381	344
7/2/02	0	0		352	625	516	351	347	0		486	351	415	454	470	0		315	361	263	362	300
7/17/02	0	0		251	279	214	250	9	0		-7	144	204	174	204	0		194	374	234	274	164
7/30/02	0	0		389	694	550	364	384	0		527	398	464	513	318	0		394	434	312	430	344
8/21/02	14		100VP	249	169	240	-166	216	5VP		-156	-46	170	204	-8	0		199	214	219	148	184

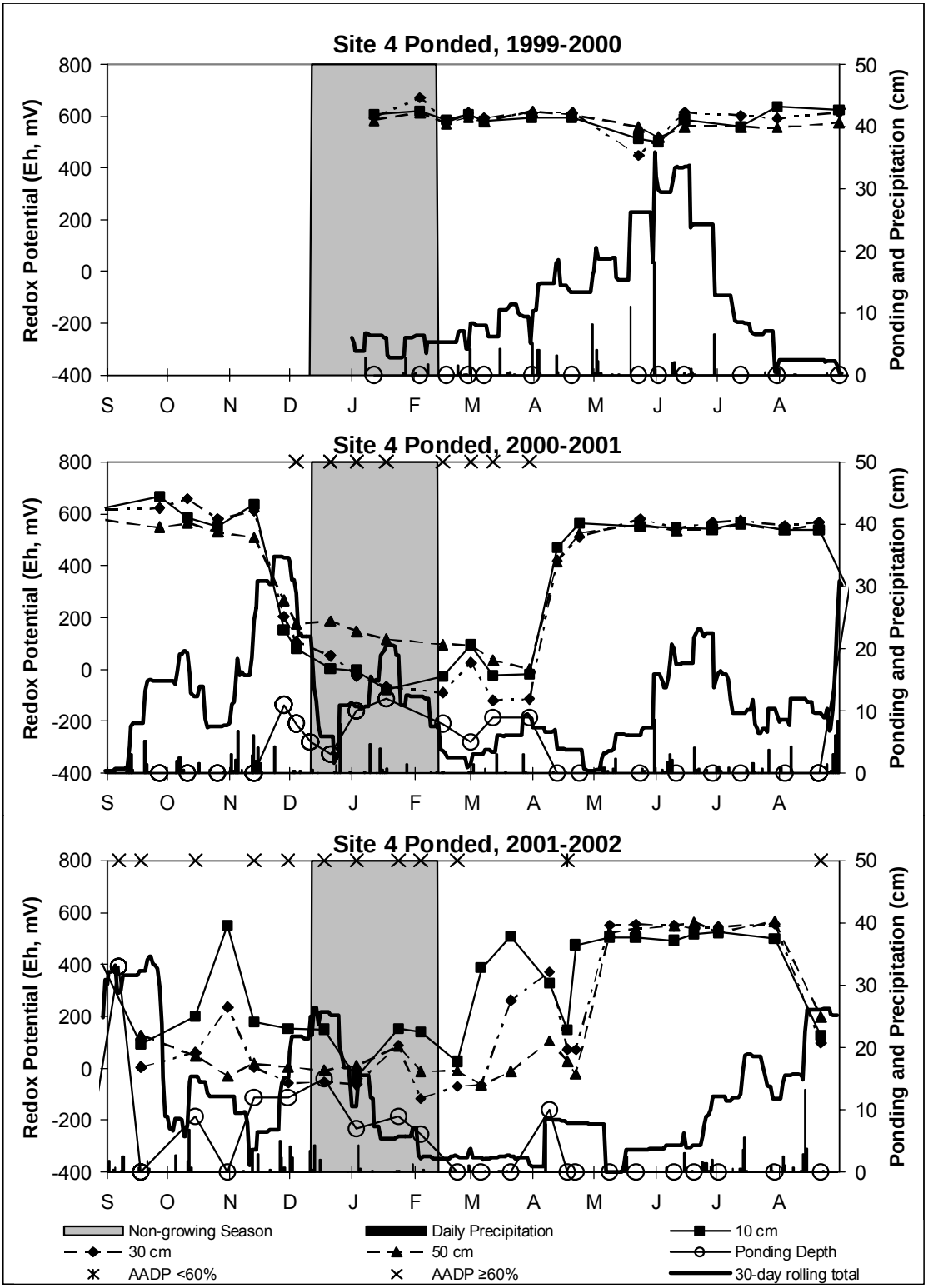


Fig. H7. Site 4 ponded, measurements during a 3-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H18. Site 4 ponded: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000 – Aug. 2000.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
1/12/00	0	0		618	600	583	606	623	0		604	635	520	607	614	0		599	623	602	474	623
2/4/00	0	0		598	669	608	594	621	0		667	679	781	626	597	0		643	640	653	482	660
2/17/00	0	0		564	601	574	568	612	0		612	584	484	614	571	0		608	633	577	490	550
2/28/00	0	0		607	664	566	614	577	0		683	648	629	577	523	0		623	637	502	620	594
3/7/00	0	0		570	588	561	568	608	0		586	669	524	599	579	0		591	599	583	521	600
3/31/00	0	0		613	634	584	512	620	0		636	626	529	633	642	0		651	698	563	562	614
4/11/00	0	0		-	-	-	-	-	0		-	-	-	-	-	0		-	-	-	-	-
4/20/00	0	0		611	640	594	506	613	0		642	626	517	633	645	0		636	680	548	554	608
5/23/00	0	0		560	596	504	384	522	0		249	525	418	533	511	0		517	534	590	553	600
6/2/00	0	0		519	523	504	384	573	0		513	521	512	532	499	0		522	520	528	523	492
6/15/00	0	0		533	674	567	562	596	0		644	612	541	630	644	0		615	624	590	353	614
7/13/00	0	0		520	588	529	558	598	0		627	602	524	622	631	0		590	608	576	459	560
7/31/00	0	0		644	708	613	584	631	0		592	595	532	618	615	0		572	597	561	444	597
8/31/00	0	0		649	666	580	605	614	0		632	634	553	625	630	0		562	587	607	483	641

Table H19. Site 4 ponded: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 – Aug. 2001.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/27/00	0	0		690	704	635	617	673	0		673	627	538	635	633	0		571	591	567	414	598
10/11/00	0	0		568	609	579	582	581	0		655	694	544	654	740	0		577	606	585	416	636
10/26/00	0	0		544	574	518	538	571	0		624	594	515	566	595	0		555	581	562	379	569
11/13/00	0	0		613	693	589	648	631	0		664	652	526	612	610	0		552	440	566	378	605
11/28/00	11	0		-31	267	198	221	99	0		218	-172	235	350	389	0		204	439	238	208	244
12/4/00	8		100VP	-95	223	193	208	-127	0		177	-139	198	241	61	0		179	209	204	200	95
12/21/00	3		100VP	-185	118	66	160	-155	20SP		26	213	181	147	-302	0		174	192	199	216	153
1/3/01	10		100VP	-78	-5	137	120	-194		100SP	-84	-225	154	144	-114	0		154	166	183	102	137
1/18/01	12		100VP	-92	-127	-131	66	-106		100P	-71	-176	92	-40	-131	30SP		140	51	161	169	64
2/15/01	8		100VP	-68	-120	56	34	-36		60P	-83	-198	47	-78	-136	2P		101	89	98	147	42
3/1/01	5		100VP	5	82	112	98	175	30P		149	-115	56	85	-52	0		73	96	104	142	58
3/12/01	9		100VP	-71	-129	131	58	-102		40SP	-127	-214	38	-140	-151	1P		65	-6	28	128	-42
3/30/01	9		100VP	-86	-99	110	95	-116	1SP		-132	-139	-7	-148	-146	0		47	-29	-50	109	-74
4/13/01	0	0		508	516	503	390	422	0		449	420	492	533	201	0		487	434	490	253	400
4/24/01	0	0		560	605	564	526	554	0		626	452	486	620	371	0		564	600	571	327	564
5/24/01	0	0		553	592	559	503	547	0		663	553	494	592	589	0		586	608	579	428	590
6/11/01	0	0		546	570	548	512	550	0		610	495	501	583	529	0		544	588	564	413	567
6/29/01	0	0		557	569	526	500	545	0		620	555	485	587	580	0		551	591	565	412	572
7/13/01	0	0		544	624	534	538	581	0		599	573	495	575	625	0		574	610	575	440	594
8/4/01	0	0		543	569	534	491	546	0		630	549	492	575	529	0		576	604	564	347	597
8/21/01	0	0		563	571	532	486	535	0		611	573	475	579	592	0		574	602	576	448	576

Table H20. Site 4 ponded: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2001 – Aug. 2002.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/7/01	33		100VP	161	141	177	164	-213	0		104	145	205	-165	52	0		184	204	225	224	204
9/18/01	0		100VP	135	154	200	184	-206	0		-87	144	191	-125	-95	0		177	123	25	202	107
10/15/01	9		100VP	293	320	285	235	-141	0		268	-132	256	61	-152	0		125	21	-57	200	-48
10/31/01	0	0		544	568	552	619	474	0		488	446	484	-69	-168	0		44	-118	-114	152	-116
11/13/01	12		100VP	244	279	253	233	-123	0		124	-166	220	5	-158	0		50	3	-72	178	-72
11/30/01	12		100VP	181	242	218	188	-74	0		-121	-166	208	-29	-172	0		42	-5	-106	169	-75
12/18/01	15		100VP	197	273	230	231	-179	2P		-136	-163	214	-37	-137	0		34	-27	-103	158	-99
1/3/02	7		100VP	-188	237	-189	169	-199	20P		-114	-161	213	-87	-160	1SP		47	-9	-79	166	-85
1/24/02	9		100VP	209	173	17	169	203	25P		126	-109	224	76	125	5P		40	129	-7	153	108
2/4/02	6		100VP	158	208	-33	160	204	50P		-122	-170	-32	-92	-165	10P		27	-52	-90	155	-96
2/22/02	0		100VP	178	199	-195	151	-209	20VP		-127	-169	206	-90	-166	5SP		29	-41	-92	147	-92
3/6/02	0	0		492	261	370	450	355	0		-130	-176	191	-40	-169	0		30	-37	-85	-135	-92
3/21/02	0	0		603	613	491	454	376	0		627	404	499	-60	-159	0		24	-37	-94	143	-99
4/9/02	10	0		271	446	313	247	366	0		504	264	506	452	127	0		87	223	-29	227	20
4/18/02	0	5P		234	175	44	221	66	1SP		179	-99	248	131	-91	0		30	39	-78	184	-45
4/22/02	0	0		519	616	395	457	391	0		232	-151	236	216	-174	0		2	-83	-106	164	-93
5/9/02	0	0		598	603	451	438	436	0		652	411	513	625	558	0		593	581	557	348	530
5/22/02	0	0		595	585	454	432	444	0		644	410	524	618	580	0		609	595	572	350	552
6/10/02	0	0		570	567	434	448	442	0		630	434	523	635	524	0		608	603	584	374	573
6/20/02	0	0		599	604	466	460	452	0		626	414	507	574	565	0		612	601	574	459	564
7/2/02	0	0		588	589	462	531	444	0		594	435	569	584	544	0		545	561	534	525	454
7/30/02	0	0		562	599	434	437	464	0		629	514	499	576	564	0		575	579	564	536	566
8/22/02	0		100VP	191	282	214	-206	159	0		245	-128	269	-194	296	0		274	-51	259	238	269

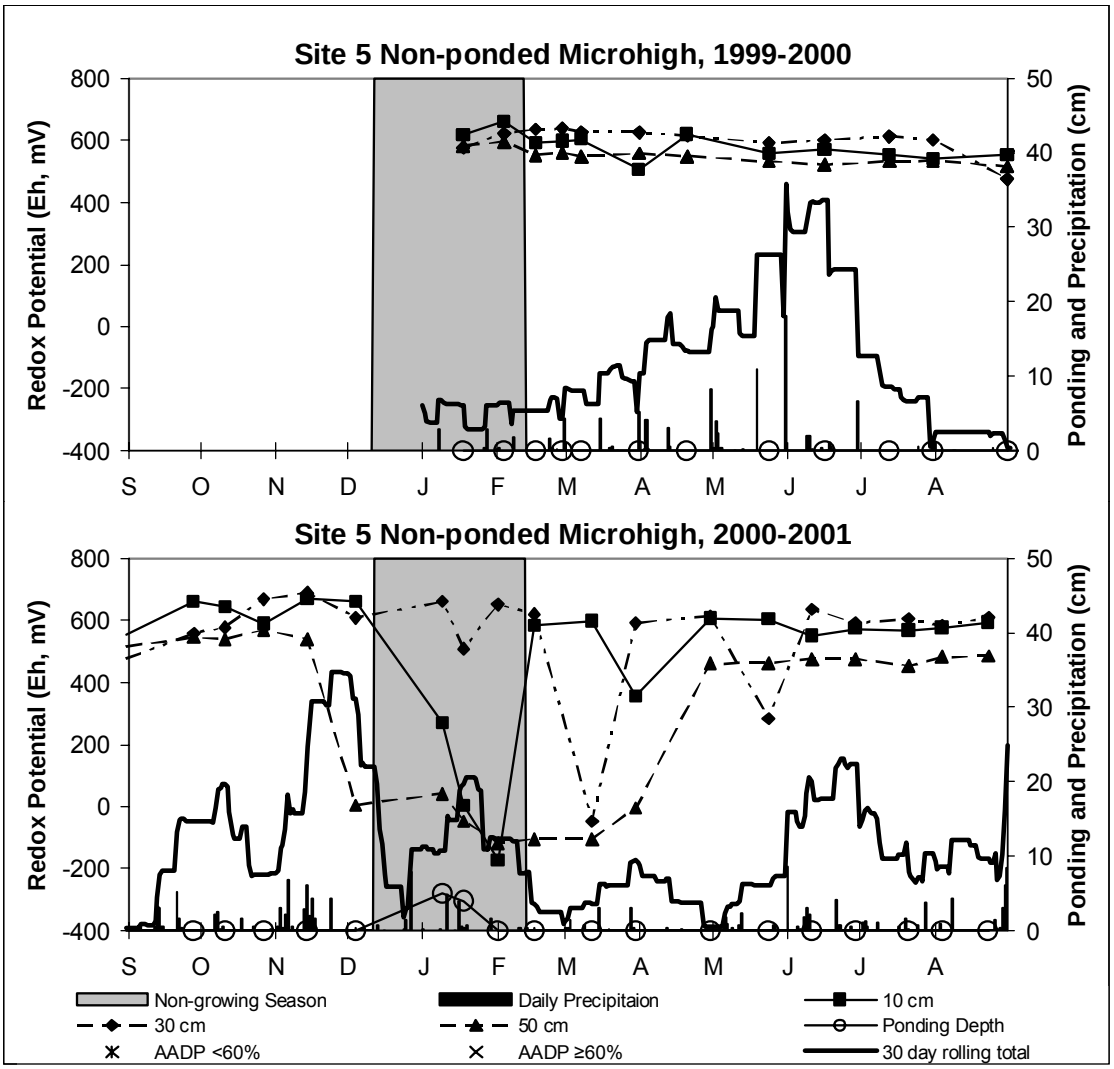


Fig. H8. Site 5 nonponded microhigh, measurements during a 2-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H21. Site 5 nonponded microhigh: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000 – Aug. 2000.). AADP reactions not observed. The double line represents non-growing season, approximately December 12 – February 12.

Date	**10 cm**					**30 cm**					**50 cm**				
	Eh					Eh					Eh				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1/18/00	620	631	618	621	604	509	597	619	566	597	613	614	527	602	559
2/4/00	671	663	675	669	624	572	627	636	638	641	642	583	639	599	519
2/17/00	542	602	604	601	608	649	619	643	639	624	561	582	577	574	470
2/28/00	572	612	580	626	603	633	634	621	655	651	565	586	576	600	472
3/7/00	552	611	620	615	619	631	633	616	622	624	551	566	587	567	465
3/31/00	557	619	60	633	662	625	599	624	646	634	560	574	607	573	481
4/20/00	598	638	459	721	685	607	585	614	637	628	555	565	601	555	472
5/24/00	506	524	605	568	593	581	561	588	628	606	527	545	579	537	474
6/16/00	531	529	620	561	612	590	567	599	632	619	524	541	563	523	453
7/13/00	510	515	574	586	583	606	577	608	648	622	558	560	569	484	494
7/31/00	535	544	550	544	539	604	566	588	640	612	544	552	566	544	474
8/31/00	524	543	569	544	589	474	475	469	498	460	570	530	463	521	496

Table H22. Site 5 nonponded microhigh: Eh Values from Five Pt Electrodes Installed at 10, 30, and 50 cm depths (Sept. 2000 –Aug. 2001). AADP dye reactions not observed. The double line represents non-growing season, approximately December 12 – February 12.

Date	10 cm					30 cm					50 cm				
	Eh					Eh					Eh				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
9/28/00	598	646	696	729	630	544	558	567	563	556	566	580	567	528	490
10/11/00	515	633	763	685	616	634	545	559	580	569	548	566	574	521	479
10/27/00	525	535	645	661	586	674	609	634	726	702	556	565	599	583	549
11/14/00	602	611	755	756	628	672	639	733	694	712	578	544	575	544	462
12/4/00	605	661	734	655	640	567	592	620	634	631	135	-94	-90	84	-12
1/9/01	-94	130	616	652	38	624	613	703	670	698	-3	-89	-191	438	56
1/18/01	-206	136	85	66	-69	288	475	540	627	613	8	-92	-146	63	-70
2/1/01	-293	-64	-149	-139	-222	609	618	681	710	646	-58	-131	-233	-52	-110
2/16/01	452	604	616	640	611	530	584	603	700	682	-52	-150	-200	-37	-82
3/12/01	498	610	625	634	626	-211	270	-381	55	30	-48	-163	-157	-66	-85
3/30/01	64	334	367	631	375	544	583	596	624	616	-58	-112	-113	328	-69
4/30/01	507	607	643	655	626	580	578	617	655	645	548	509	396	558	298
5/24/01	476	586	629	695	628	229	319	94	394	381	527	493	392	525	379
6/11/01	464	539	590	585	575	556	714	606	651	648	511	507	463	388	510
6/29/01	565	605	641	544	516	572	564	615	609	604	577	463	473	443	422
7/21/01	597	631	635	541	437	583	562	604	650	624	470	431	454	440	473
8/4/01	463	545	627	629	618	607	557	601	544	606	527	489	426	488	480
8/23/01	474	604	656	640	598	594	573	604	649	623	532	491	430	485	486

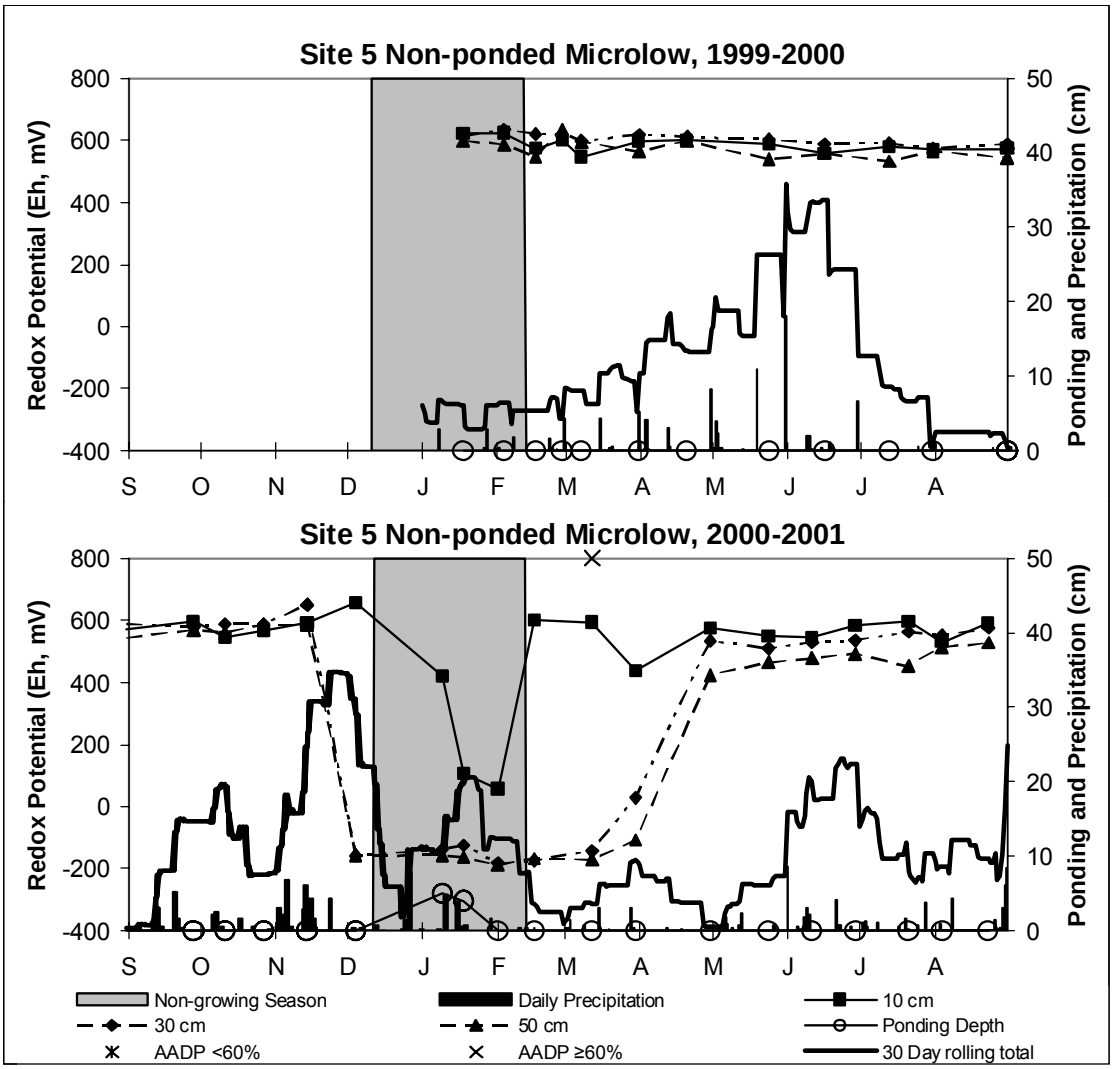


Fig. H9. Site 5 nonponded microlow, measurements during a 2-water-year period of climatic and soil properties, non-growing season, daily precipitation, 30-day rolling total of precipitation, ponding depth, Eh readings at 10, 30, and 50 cm depths, and AADP dye reaction in upper 10 cm of soil.

Table H23. Site 5 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Jan. 2000 – Aug. 2000.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
1/18/00	0	0		624	646	627	609	608	0		551	631	634	641	616	0		619	589	613	575	598
2/4/00	0	0		683	548	637	594	662	0		637	605	634	664	637	0		606	580	611	573	562
2/17/00	0	0		626	614	380	641	609	0		625	614	620	641	605	0		553	606	567	498	516
2/28/00	0	0		633	582	619	597	578	0		636	578	632	649	605	0		567	657	889	543	521
3/7/00	0	0		548	568	567	525	529	0		604	579	598	622	586	0		606	554	615	589	617
3/31/00	0	0		634	582	586	571	615	0		638	613	597	591	651	0		563	633	567	540	514
4/20/00	0	0		582	694	634	557	540	0		638	603	591	648	579	0		642	579	599	561	608
5/24/00	0	0		627	560	609	543	590	0		632	591	576	639	577	0		543	577	545	498	531
6/16/00	0	0		545	624	570	520	535	0		616	564	559	639	563	0		622	456	600	531	584
7/13/00	0	0		634	550	613	515	583	0		621	563	545	646	574	0		549	565	529	484	536
7/31/00	0	0		617	651	542	529	518	0		610	539	520	640	559	0		617	525	600	530	556
8/31/00	0	0		601	528	617	547	570	0		620	552	542	648	581	0		541	578	527	533	535

Table H24. Site 5 nonponded microlow: ponding depth, AADP dye reaction, and Eh values from five Pt electrodes installed at 10, 30, and 50 cm depths (Sept. 2000 – Aug. 2001.) * AADP is alpha, alpha dipyridyl dye reaction in a 5 cm thick layer within 10, 30, and 50 cm depths. Reactions are SP-slightly positive (faint pink); P-positive (distinct pink); and VP-very positive (distinct red). The double line represents non-growing season, approximately December 12 – February 12.

Date	Pnd	10 cm							30 cm							50 cm						
		AADP*		Eh					AADP*		Eh					AADP*		Eh				
	(cm)	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5	<60%	≥60%	1	2	3	4	5
9/28/00	0	0		594	728	589	524	541	0		607	523	533	650	586	0		628	531	614	510	568
10/11/00	0	0		509	574	651	484	503	0		617	597	522	613	595	0		638	546	529	510	576
10/27/00	0	0		561	624	620	508	529	0		626	563	541	645	571	0		644	551	632	534	574
11/14/00	0	0		535	608	703	538	574	0		674	588	596	736	659	0		662	524	679	568	504
12/4/00	0	0		630	770	695	598	588	0		-97	-181	-213	-132	-174	0		-95	-84	-209	-211	-197
1/9/01	5	0		160	604	582	560	190	0		-38	-159	-362	-39	-94	0		-115	-147	-212	-129	-177
1/18/01	0	0		88	-15	133	128	200	0		-108	-152	-163	-78	-124	0		-128	-144	-207	-194	-148
2/1/01	0	0		-20	74	-6	86	151	0		-151	-194	-235	-119	-212	0		-165	-178	-174	-226	-203
2/16/01	0	0		552	596	626	654	575	0		-145	-152	-244	-122	-202	0		-174	-164	-174	-154	-174
3/5/01	0	0		275	219	322	272	235	0		-63	-11	-204	-74	9	0		-221	-150	-52	-162	-181
3/12/01	0		100SP	595	611	623	568	576	0		-162	-157	-128	-136	-137	0		-199	-158	-149	-180	-176
3/30/01	0	0		538	501	422	265	458	0		87	177	-193	70	2	0		-206	-136	59	-104	-157
4/30/01	0	0		577	601	609	546	540	0		623	527	356	629	533	0		536	466	468	317	336
5/24/01	0	0		542	594	582	515	511	0		605	502	343	605	495	0		561	435	500	400	430
6/11/01	0	0		538	585	574	516	504	0		626	527	360	612	525	0		573	455	513	408	439
6/29/01	0	0		446	550	613	655	649	0		448	542	582	574	537	0		511	466	491	484	514
7/21/01	0	0		566	619	651	546	597	0		622	516	542	615	515	0		582	443	466	422	346
8/4/01	0	0		540	505	579	518	511	0		618	521	479	614	519	0		598	475	504	535	453
8/23/01	0	0		585	695	600	553	528	0		627	526	593	624	511	0		603	496	632	447	464

APPENDIX I. 150-M SOIL TRANSECTS ACROSS NONPONDED AND PONDED AREAS NEAR MONITORING SITES AT DANCE BAYOU

This appendix contains profile descriptions from 150-m long field transects at the Dance Bayou Monitoring sites. Profile descriptions were described every 5 meters to a depth of 50-cm in nonponded and adjacent ponded areas. In areas with distinct gilgai microrelief, microlows and adjacent microhighs were described.

Transect 1-1 was near Site 1 nonponded and Site 1 ponded.

Transect 3-2 was near Site 2 nonponded; Site 3 ponded edge and Site 3 ponded middle.

Transect 4-1 was near Site 4 ponded.

Table I1. Transect 1-1. Site 1 nonponded and Site 1 ponded, 150 m transect.
Field descriptions by W. L. Miller, P. R. Owens, R. Mersmann, April-August, 2000.
Transect started at NW-SE trail, direction E to W and slightly north of Site 1 nonponded, and through Site 1 ponded monitoring site.
Transect laid out, then profile sites marked every 5 m with engineer flagging; In gilgai areas "A" is microhigh and "B" is microlow. Microhigh and microlow selected nearest to 5 m site. Slickensides usually observed at ~ 30 to 50 cm in all pits. Field conditions very dry. Moist soil colors recorded.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; FeMn are iron manganese nodules; PL are pore linings; PF are coats on ped faces. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
1-1-0A	0-15	c	10YR 2/1	1	<1	1-3	FeMn	2	1-10	C/U	v. slight	Nonponded
	15-34	c	10YR 3/1	1	<1	1-3	FeMn	1	1-10	C/U	v. slight	$CaCO_3$ coatings very thin
	34-50	c	10YR 3/1	1	<1	1-3	FeMn	1	1-10	C/U	v. slight	few white coatings on ped faces; slickensides
1-1-0B	0-14	c	10YR 2/1	1	<1	1-3	FeMn	1	1-10	C/U	N	Nonponded
	14-30	c	10YR 3/1	1	<1	1-3	FeMn	1	1-10	C/U	N	0-50 cm, $CaCO_3$ coatings distinct
	30-50	c	10YR 3/2	1	<1	1-3	FeMn	3	1-10	C/U	v. slight	slickensides
1-1-1	0-14	c	10YR 2/1	1	<1	1-3	FeMn	3	1-10	C/U	v. slight	Nonponded
	14-33	c	10YR 3/2	1	<1	1-3	FeMn	2	1-10	C/U	slight	$CaCO_3$ with small voids in center
	33-50	c	10YR 3/2	1	<1	1-3	FeMn	3	1-10	C/U	slight	
1-1-2A	0-6	c	10YR 2/1	<1	<1	1	FeMn	<1	1-2	C/U	N	Nonponded
	6-21	c	10YR 3/1	<1	<1	1	FeMn	<1	1-3	C/U	N	0-21 cm, reddish Bw clay, 1-10 mm
	21-50	c	10YR 3/2	<1	<1	1	FeMn	1	1-3	C/U	N	
1-1-2B	0-10	c	10YR 2/1	1	<1	1	FeMn	<1	1-2	U	N	Nonponded
	10-50	c	10YR 2/1	1	<1	1	FeMn	N	N	N	N	
1-1-3A	0-21	c	10YR 2/1	1	N	N	N	<1	1-3	C/U	N	Nonponded
	21-38	c	10YR 3/1	1	N	N	N	1	1-5	C/U	slight	
	38-50	c	10YR 3/1	<1	N	N	N	2	1-5	C/U	strong	few slickensides
1-1-3B	0-10	c	10YR 2/1	1	<1	1	FeMn	<1	1-2	U	N	Nonponded
	10-50	c	10YR 2/1	1	<1	1	FeMn	N	N	N	N	

Table I1 (continued). Transect 1-1. Site 1 nonponded and Site 1 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm 7.5 YR 4/6; FeMn are iron manganese nodules; PL are pore linings; PF are coats on ped faces.
$CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
1-1-4A	0-18	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	C/U	v. slight	Nonponded
	18-31	c	10YR 3/2	<1	<1	1-3	FeMn	5	1-5	C	strong	reddish Bw clay, 1-5 mm
	31-50	c	7.5YR 4/4	<1	N	N	N	15	1-5	C	strong	18-31 cm, $CaCO_3$ concretions hollow
1-1-4B	0-10	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	10-50	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	C/U	v. slight	$CaCO_3$ coats very thick and distinct
1-1-5A	0-13	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	C/U	N	Nonponded
	13-37	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-5	U	strong	reddish Bw clay 10mm
	37-50	c	7.5YR 3/3	<1	<1	1-3	FeMn	10	1-5	U	violent	slickensides
1-1-5B	0-9	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	9-50	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	
1-1-6A	0-6	c	10YR 3/1	1	<1	1-3	FeMn	5	1-5	U	strong	Nonponded
	6-29	c	7.5YR 4/3	<1	<1	1-3	FeMn	15	1-5	U	violent	0-6 cm, 10-20%, 2-5 mm 7.5YR 4/2 Bw clay w/ sharp boundaries
	29-50	c	7.5YR 4/3	<1	<1	1-3	FeMn	15	1-10	U	violent	slickensides
1-1-6B	0-6	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Nonponded
	6-46	c	10YR 2/1	<1	<1	1-3	FeMn	<1	N	N	N	slickensides
	46-50	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	microlow much deeper than 1-1-6C
1-1-6-C	0-5	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Nonponded
	5-40	c	10YR 2/1	<1	<1	1-3	FeMn	<1	1-5	C	N	shallow microlow
	40-50	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	slickensides
1-1-7-A	0-6	c	10YR 3/2	<1	<1	1-3	FeMn	2	1-5	C/U	strong	Nonponded
	6-20	c	10YR 2/1	<1	<1	1-3	FeMn	2	1-5	C/U	strong	0-6 cm, 2% 1-10 mm 7.5YR 4/2 Bw clay w/sharp boundaries
	20-32	c	7.5YR 3/2	<1	<1	1-3	FeMn	5	1-5	C/U	violent	$CaCO_3$ 10YR 7/6 and predominately uncoated throughout
	32-50	c	7.5YR 4/2	<1	<1	1-3	FeMn	5	1-10	C/U	violent	

Table I1 (continued). Transect 1-1. Site 1 nonponded and Site 1 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; FeMn are iron manganese nodules; PL are pore linings; PF are coats on ped faces. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
1-1-7B	0-8	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Nonponded
	8-40	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	10-15 cm, 1% $CaCO_3$ uncoated concretions w/Mn centers; 30 cm, 1, $CaCO_3$ w/distinct coat
	40-50	c	10YR 2/1	<1	<1	1-3	FeMn	<1	1-3	C	N	slickensides
1-1-8A	0-2	c	10YR 3/1	1	1	1-3	FeMn	N	N	N	N	Nonponded
	2-15	c	10YR 2/1	1	<1	1-3	FeMn	<1	1-5	C/U	N	2-15 cm, 5% 3-5 mm, 7.5YR 4/6 Bw clay w/distinct boundaries
	15-50	c	10YR 2/1	<1	<1	1-3	FeMn	<1	1-5	C/U	N	
1-1-8B	0-7	c	10YR 2/1	<1	<1 <1	1-3	FeMn PL/PF	<1	1-5	C/U	N	Nonponded (edge of trail to Site 1 ponded characterization pit)
	7-24	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	C/U	N	0-7 cm, ped faces 7.5YR 3/4
	24-35	c	10YR 2/1	<1	<1	1-3	FeMn	5	1-5	C/U	N	
	35-50	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	
1-1-9	0-6	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Ponded
	6-50	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	about 4 m in from nonponded boundary
1-1-10A	0-6	c	10YR 3/1	1	<1	1-3	FeMn	1	2-5	C/U	v. slight	Nonponded
	6-17	c	10YR 3/1	1	<1	1-3	FeMn	1	3-6	C/U	v. slight	0-50 cm, 1% small masses Bw clay
	17-50	c	7.5YR 3/1	1	<1	1-3	FeMn	2	3-6	C/U	slight	$CaCO_3$ predominately coated & rinds are calcareous
1-1-10B	0-5	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Nonponded
	5-33	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	0-50 cm, 2% small masses Bw clay
	33-50	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	red masses 2-3 mm
1-1-11	0-8	c	10YR 2/1	<1	<1	2-3	PF	<1	1-5	C	N	Ponded (in Site1 ponded monitoring site) (no distinct gilgai in ponded areas)
	8-28	c	10YR 2/1	<1	<1	2-3	FeMn	<1	2-5	C/U	N	0-8 cm, ped faces 7.5YR 3/4 2% 10YR 3/2 Bw clay
	28-50	c	10YR 2/1	<1	N	N	N	<1	5-10	C/U	N	few slickensides
1-1-12	0-6	c	Spoil	-	-	-	-	-	-	-	-	Nonponded
	6-11	c	10YR 2/1	1	<1	1-2	FeMn	1	3-5	C/U	N	2% small masses 7.5YR 4/3 Bw clay
	11-17	c	N 2.5/	1	<1	1-2	FeMn	1	3-5	C/U	N	2% small masses 7.5YR 4/3 Bw clay
	17-50	c	N 2.5/	<1	<1	1-2	FeMn	1	3-5	C/U	N	2% small masses 7.5YR 4/3 Bw clay
1-1-13	-	-	-		-	-	-	-				Nonponded (disturbed area from characterization study)

Table I1 (continued). Transect 1-1. Site 1 nonponded and Site 1 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; FeMn are iron manganese nodules; PL are pore linings; PF are coats on ped faces. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
1-1-14	0-9	c	10YR 2/1	<1	<1	1-2	FeMn	1	2-5	U	strong	Nonponded
	9-32	c	10YR 2/1	<1	<1	1-2	FeMn	1	2-5	U	strong	0-9 cm, <1% 5-10mm 7.5YR 4/4 Bw clay
	32-50	c	N 2.5/	<1	<1	1-2	FeMn	1	2-5	U	v. slight	9-50 cm, <1% Bw clay
												$CaCO_3$ have voids
1-1-15A	0-5	c	10YR 2/1	<1	<1	1-2	FeMn	N	N	N	N	Nonponded (within 50 cm of ponded edge)
	5-45	c	N 2.5/	<1	<1	1-2	FeMn	N	N	N	N	Possible pit spoil area
	45-50	c	N 2.5/	<1	<1	1-2	FeMn	N	N	N	N	
1-1-15B	0-5	c	10YR 2/1	1	<1	1-2	FeMn	N	N	N	N	Ponded (microlow connected to ponded area)
	5-34	c	2.5Y 2.5/1	1	<1	1-2	FeMn	N	N	N	N	0-34 cm, <1% Bw clay
	34-50	c	N 2.5/	1	<1	1-2	FeMn	N	N	N	N	34-50 cm, <1% 1-2 mm, 7.5YR 4/2 Bw clay
												5-34 cm, soil color difficult to match
1-1-16A	0-4	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Nonponded (~ 50 cm from ponded edge)
	4-25	c	2.5Y 2.5/1	1	<1	1-3	FeMn	N	N	N	N	42-50 cm, coated $CaCO_3$ are 7.5YR 5/8, a few have white coats
	25-42	c	10YR 3/2	<1	<1	1-3	FeMn	N	N	N	N	
	42-50	c	7.5YR 3/2	<1	<1	1-3	FeMn	1	1-5	C/U	v. slight	
1-1-16B	0-7	c	10YR 2/1	1	<1	1-3	FeMn	<1	2-5	C/U	N	Nonponded (~ 40 cm from ponded edge)
	7-42	c	2.5Y 2.5/1	1	<1	1-3	FeMn	N	N	N	N	0-7 cm, coated $CaCO_3$, are 7.5YR 5/8
	42-50	c	2.5Y 2.5/1	1	<1	1-3	FeMn	N	N	N	N	
1-1-17A	0-4-	c	N 2.5/	1	<1	1-3	FeMn	<1	1-3	U	N	Nonponded
	4-26	c	N 2.5/	1	<1	1-3	FeMn	<1	1-3	U	N	0-4 cm, $CaCO_3$ with white rind
	26-50	c	7.5YR 3/2	<1	<1	1-3	FeMn	N	N	N	strong	
1-1-17B	0-5	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	5-40	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	40-50 cm, 2% 7.5YR 4/4 Bw calcareous clay w/sharp boundary
	40-50	c	See note	<1	<1	1-3	FeMn	<1	1-3	U	N	40-50 cm, color 80% 10YR 2/1 and 20% 10YR 3/1

Table I1 (continued). Transect 1-1. Site 1 nonponded and Site 1 ponded, 15 -m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; FeMn are iron manganese nodules; PL are pore linings; PF are coats on ped faces. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
1-1-18A	0-12	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	NR	N	Nonponded
	12-39	c	7.5YR 3/1	<1	<1	1-3	FeMn	1	1-3	NR	strong	12-39 cm, 5% 10YR 2/1 clay worm casts
	39-50	c	See note	<1	<1	1-3	FeMn	3	1-5	NR	violent	39-50 cm, color 60% 7.5YR 4/4 and 40% 7.5YR 2.5/1
												39-50 cm, has slickensides
1-1-18B	0-4	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	4-16	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	
	16-50	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	
1-1-19A	0-5	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	Nonponded
	5-35	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	5-35 cm, 1% 7.5YR 4/4 Bw clay worm casts
	35-50	c	7.5YR 4/4	<1	<1	1-3	FeMn	2	1-5	NR	violent	35 50 cm, 2% N 2.5/
1-1-19B	0-5	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	Outer edge of ponded area
	5-23	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	
	23-50	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	
1-1-20A	0-3	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Slight microhigh surrounded by ponded area
	3-14	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	
	14-40	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	
	40-50	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	40-50 cm, slickensides
1-1-20B	0-4	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	Shallow ponded area
	4-20	c	N 2.5/	1	<1	1-3	FeMn	N	N	N	N	
	20-50	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	
1-1-21	0-5	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Shallow ponded area (no distinct gilgai in ponded areas)
	5-18	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	
	18-44	c	N 2.5/	<1	<1	1-3	FeMn	N	N	N	N	18-44 cm, 1% 7.5YR 4/4 Bw clay worm casts
	44-50	c	See note	<1	<1	1-3	FeMn	N	N	N	N	44-50 cm, color 80% 7.5YR 4/4 and 20% 10YR 3/1

Table I1 (continued). Transect 1-1. Site 1 nonponded and Site 1 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; FeMn are iron manganese nodules; PL are pore linings; PF are coats on ped faces. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
1-1-22A	0-8	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	8-30	c	10YR 2/1	1	<1	1-3	FeMn	1	1-5	YR	N	8-30 cm, $CaCO_3$ hollow
	30-50	c	10YR 2/1	1	<1	1-3	FeMn	2	1-5	NR	strong	30-50 cm, $CaCO_3$ hollow; slickensides
1-1-22B	0-7	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	YR/NR	N	Nonponded
	7-19	c	10YR 2/1	2	<1 <1	1-3 1-3	PF FeMn	1	2-5	NR	N	0-7 cm, redox ped coats 2.5YR 3/4; 3% reddish Bw clay
	19-50	c	2.5Y 2.5/1	2	<1	1-3	FeMn	<1	1-5	NR/YR	N	7-19 cm, 1% reddish Bw clay
1-1-23A	0-15	c	10YR 2/1	1	<1	1-3	FeMn	2	1-5	WR/YR	slight	Nonponded
	15-24	c	10YR 2/1	<1	<1	1-3	FeMn	5	1-5	NR	violent	
	24-50	c	7.5YR 4/3	<1	<1	1-3	FeMn	2	1-5	NR	violent	24-50 cm, slickensides
1-1-23B	0-7	c	10YR 2/1	1	<1 <1	1-3 1-3	PF FeMn	<1	1-10	WR	N	Nonponded
	7-50	c	2.5Y 2.5/1	1	<1	1-3	FeMn	N	N	N	N	0-7 cm, redox ped coats 2.5YR 3/4
1-1-24A	0-14	c	10YR 2/1	1	<1	1-3	FeMn	<1	1-5	NR	v. slight	Nonponded
	14-38	c	10YR 3/1	1	<1	1-3	FeMn	1	1-5	NR	slight	38-50 cm, 2% reddish Bw clay; slickensides
	38-50	c	2.5Y 2.5/1	<1	<1	1-3	FeMn	2	1-10	NR	slight	
1-1-24B	0-6	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	note	N	Nonponded
	6-24	c	10YR 2/1	<1	<1	1-3	FeMn	N	N	N	N	Note: 0-6 cm, $CaCO_3$ have NR, WR, YR rinds
	24-50	c	2.5Y 2.5/1	<1	<1	1-3	FeMn	N	N	N	N	
1-1-25	0-10	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	10-28	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	10-28 cm,<1% reddish Bw clay
	28-50	c	2.5Y 2.5/1	1	<1	1-3	FeMn	N	N	N	N	

Table I1 (continued). Transect 1-1. Site 1 nonponded and Site 1 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; FeMn are iron manganese nodules; PL are pore linings; PF are coats on ped faces. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
1-1-26A	0-12	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	12-27	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	
	27-50	c	2.5Y 2.5/1	1	<1	1-3	FeMn	<1	1-5	NR	N	27-50 cm, 2% reddish Bw clay; $CaCO_3$ coats are yellow
1-1-26B	0-11	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	11-32	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	
	32-50	c	2.5Y 2.5/1	1	<1	1-3	FeMn	N	N	N	N	32-50 cm, <1% reddish Bw clay
1-1-27	0-18	c	2.5Y 2.5/1	1	<1 <1	1-3 1-3	PF FeMn	N	N	N	N	Nonponded 0-18cm, redox ped coats 5YR 3/4
	18-37	c	2.5Y 2.5/1	1	<1	1-3	FeMn	<1	1-5	NR	N	18-50 cm, $CaCO_3$ coats are yellow
	37-50	c	10YR 3/2	1	<1	1-3	FeMn	1	1-5	NR	strong	
1-1-28	0-15	c	10YR 2/1	1	<1	1-3	FeMn	1	1-5	NR	N	Nonponded
	15-26	c	2.5Y 2.5/1	1	<1	1-3	FeMn	1	1-5	NR	slight	0-50 cm, $CaCO_3$ coats are yellow
	26-38	c	10YR 3/2/	1	<1	1-3	FeMn	2	1-5	NR	strong	
	38-50	c	10YR 3/3	1	<1	1-3	FeMn	3	1-5	NR	violent	
1-1-29	0-11	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	Nonponded
	11-31	c	10YR 2/1	1	<1	1-3	FeMn	N	N	N	N	
	31-50	c	2.5Y 2.5/1	1	<1	1-3	FeMn	N	N	N	N	31-50 cm, 1% reddish Bw clay
1-1-30	0-11	c	10YR 2/1	2	<1	1-3	FeMn	<1	1-5	NR	N	Nonponded
	11-26	c	2.5Y 2.5/1	2	<1	1-3	FeMn	1	1-5	NR	v. slight	0-50 cm, $CaCO_3$ coats are yellow
	26-50	c	10YR 3/1	2	<1	1-3	FeMn	2	1-5	NR	slight	11-50 cm, 1% reddish Bw clay

Table I2. Transect 3-2. Near Site 2 nonponded, Site 3 ponded edge, and Site 3 ponded middle, 150 m transect.
Field descriptions by W. L. Miller, P.R. Owens, R. Mersmann, April-August, 2000.
Transect south of monitoring sites, approximately east to west, started 3-2-0 at a PVC pipe marker on east side of ponded area.
Transect laid out, then profile sites marked every 5 m with engineer flagging; Field conditions very dry. Moist soil colors recorded.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows: C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
3-2-0	0-15	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded Slope from 3-2-0 to 3-2-5 is 1%; 3-2-5 to 3-2-6 is 2%
	15-35	c	N 2.5/	<1	N	N	N	N	N	N	N	15-35 cm, 5% 3-5 mm 7.5YR 4/3 Bw clay
	35-50	c	See note	N	N	N	N	N	N	N	violent	35-50 cm, color 70% 10YR 2/1; 30% 7.5YR 3/3 and 7.5YR 3/2
3-2-1	0-12	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	12-40	c	N 2.5/	N	N	N	N	N	N	N	N	Used bucket auger to 100 cm, observed a few pressure faces
	40-50	c	7.5YR 3/2	N	N	N	N	N	N	N	slight	
3-2-2	0-11	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	11-43	c	N 2.5/	<1	N	N	N	N	N	N	N	43-50 cm, color 70% 10YR 2/1; 30% 7.5YR 3/3 and 7.5YR 3/2
	43-50	c	See note	N	N	N	N	N	N	N	violent	43-50 cm, 2% 3-5 mm 5YR 4/4 Bw clay
3-2-3	0-10	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	10-36	c	N 2.5/	<1	N	N	N	N	N	N	N	
	36-50	c	7.5YR 5/6	N	N	N	N	N	N	N	violent	36-50 cm, 2% 3-5 mm 5YR 4/4 Bw clay
3-2-4	0-10	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	10-33	c	N 2.5/	<1	N	N	N	N	N	N	N	
	33-50	c	7.5YR5/6	N	N	N	N	N	N	N	violent	33-50 cm, 2% 3-5 mm 5YR 4/4 Bw clay
3-2-5	0-9	c	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	9-31	c	10YR 2/1	<1	N	N	N	N	N	N	N	gilgai, microlow
	31-40	c	10YR 3/1	N	N	N	N	N	N	N	slight	
	40-50	c	10YR 4/3	N	N	N	N	2	5-10	U	slight	40-50 cm, $CaCO_3$ pitted

Table I2 (continued). Transect 3-2. Near Site 2 nonponded, Site 3 ponded edge, and Site 3 ponded middle, 150 m transect
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows: C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
3-2-6	0-13	c	10YR 4/2	<1	N	N	N	1	2-5	C	slight	Nonponded
	13-50	c	7.5YR 5/4	N	N	N	N	5	3-5	U	slight	gilgai, microhigh; blackish clay mixed at 40-50 cm at 40 cm, <1% hard 1 mm FeMn nodules
3-2-7	0-5	c	10YR 2/1	N	N	N	N	N	N	N	N	Ponded (no distinct gilgai in ponded area)
	5-13	c	10YR 2/1	<1	<1 5	1-3 5-10	FeMn PF	N	N	N	N	5-13 cm, redox ped coats 5YR 4/6;
	13-50	c	N 2.5/	<1	5	2	PF/PL	N	N	N	N	13-50 cm, redox ped coats and pore linings 7.5YR 4/4 and 7.5YR 4/3
3-2-8	0-9	c	10YR 2/1	N	2	-	PL	N	N	N	N	Ponded
	9-19	c	10YR 3/1	N	1 2	1-3 -	PF PL	N	N	N	N	0-9 cm, pore linings 7.5YR 4/6 9-19 cm, redox ped coats 7.5YR 4/6, pore linings 5YR 4/4
	19-34	c	10YR 3/1	<1	10 5	1-3 -	PF PL	N	N	N	N	19-34 cm, redox ped coats, pore linings 7.5YR 4/6
	34-50	c	10YR 3/1	N	1	5-10	RMF/PI	N	N	N	N	34-50 cm, RMF soft masses , 2mm center 7.5YR 4/6, rest 7.5YR 4/4
3-2-9	0-5	c	10YR 2/1	N	2	-	PL	N	N	N	N	Ponded
	5-19	c	10YR 3/1	N	1 2	1-3 -	PF PL	N	N	N	N	0-5 cm, pore linings 7.5YT 4/6 5-19 cm redox ped coats 7.5YR 4/6, pore linings 5YR 4/4
	19-32	c	10YR 3/1	<1	10	-	PF/PL	N	N	N	N	19-32 cm, redox ped coats, pore linings 7.5YR 4/6
	32-50	c	10YR 3/1	N	1	5-10	RMF/PI	N	N	N	N	32-50 cm, RMF soft masses , 2mm center 7.5YR 4/6, rest 7.5YR 4/4
3-2-10	0-2	peat	-	-	-	-	-	-	-	-	-	Ponded
	2-10	c	10YR 2/1	N	2	-	PL	N	N	N	N	0-2 cm, blackened leaf and woody material
	10-31	c	N 3/	N	5	-	PF/PL	N	N	N	N	10-31 cm, redox ped coats 7.5YR 4/6, pore linings 5YR 4/4
	31-50	c	10YR 3/1	N	1	5-10	RMF/PI	N	N	N	N	31-50 cm, RMF soft masses, 2mm center 7.5YR 4/6, rest 7.5YR 4/4

Table I2 (continued). Transect 3-2. Near Site 2 nonponded, Site 3 ponded edge, and Site 3 ponded middle, 150 m transect
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows: C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
3-2-11	0-4-	peat	-	-	-	-	-	-	-	-	-	Ponded
	4-10	c	10YR 2/1	N	2	5-10	PF/PL	N	N	N	N	0-4 cm, blackened leaf and woody material 4-10 cm, redox ped coats, pore linings 7.5YR 4/6
	10-20	c	N 3/	N	5	5-10	PF/PL	N	N	N	N	10-32 cm, mainly pore linings, and redox ped coats 7.5YR 4/6
	20-32	c	N 3/	N	10	5-10	PF/PL	N	N	N	N	
	32-50	c	N 3/	N	1	5-10	RMF/PI	N	N	N	N	32-50 cm, RMF soft masses, 2mm center 7.5YR 4/6, rest 7.5YR 4/4
3-2-12	0-12	c	10YR 2/1	N	1	-	PL	N	N	N	N	Ponded
	12-26	c	N 3/	N	3	2-10	PF/PL	N	N	N	N	0-12 cm, redox ped coats, pore linings 7.5YR 4/6
	26-50	c	N 3/	N	1	1-3	RMF/PI	N	N	N	N	12-26 cm, redox ped coats, pore linings 7.5YR 4/4
												26-50 cm, RMF soft masses 7.5YR 4/6
3-2-13	0-5	peat	-	-	-	-	-	-	-	-	-	Ponded
	5-15	c	10YR 2/1	N	1	-	PL	N	N	N	N	0-5 cm, blackened leaf and woody material
	15-30	c	N 3/	N	5	5-10	PF/PL	N	N	N	N	5-15 cm, pore linings 7.5YR 4/6
	30-50	c	N 3/	N	1	1-3	RMF/PI	N	N	N	N	15-30 cm, redox ped coats, pore linings 7.5YR 4/4
												30-50 cm, RMF soft masses 7.5YR 4/6
3-2-14	0-2	peat	-	-	-	-	-	-	-	-	-	Ponded
	2-9	c	10YR 2/1	N	1	-	PL	N	N	N	N	0-2 cm, blackened leaf and woody material
	9-20	c	N 3/	N	3	-	PL	N	N	N	N	2-20 cm, pore linings 7.5YR 4/6
	20-29	c	N 2.5/	N	5	3-5	PF/PL	N	N	N	N	20-29 cm, redox ped coats, pore linings 7.5YR 4/4
	29-50	c	N 2.5/	N	1	1-3	RMF/PI	N	N	N	N	29-50 cm, RMF soft masses 7.5YR 4/6
3-2-15	0-5	c	10YR 2/1	N	5	3-5	PF/PL	N	N	N	N	Ponded
	5-21	c	10YR 2/1	N	2	3-5	PF/PL	N	N	N	N	0-21 cm, redox ped coats, pore linings 2.5YR 4/6
	21-50	c	10YR 2/1	N	<1	1-2	FeMn	< 1	3-5	U	N	21-50 cm, redox ped coats, pore linings 5YR 4/6
												40-50 cm, had $CaCO_3$, some with dark interiors that reacted with H_2O_2 (weak hydrogen peroxide)

Table I2 (continued). Transect 3-2. Near Site 2 nonponded, Site 3 ponded edge, and Site 3 ponded middle, 150 m transect
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows: C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
3-2-16	0-3	peat										Ponded
	3-5	c	10YR 2/1	1	5	2-3	RMF/PI	N	N	N	N	0-3 cm, blackened leaf and woody material
	5-45	c	10YR 2/1	2	5	3-5	PF	N	N	N	N	3-5 cm, RMF soft masses 7.5YR 4/4
	45-50	c	10YR 2/1	N	2	1-2	RMF/PI	3	10	C/U	N	5-45 cm, redox ped coats 7.5YR 3/4
												45-50 cm, RMF soft masses 5YR 4/6 2 cm wide crack from bottom peat layer to past 50 cm
3-2-17	0-3	peat	-	-	-	-	-	-	-	-	-	Ponded
	3-5	c	10YR 2/1	1	5	2-3	PF	N	N	N	N	0-3 cm blackened leaf and woody material
	5-16	c	10YR 2/1	N	3	1-2	RMF/PI	N	N	N	N	3-5 cm, redox ped coats 7.5YR 4/4
	16-42	c	10YR 2/1	N	15	5-10	PF	N	N	N	N	5-16 cm, RMF soft masses 7.5YR 3/4 ped interiors
	42-50	c	10YR 2/1	N	3	1-3	RMF/PI	N	N	N	N	16-42 cm, redox ped coats 2-3 mm center 5YR 4/4, rest 7.5YR 4/4 and 7.5YR 4/6. 42-50 cm, RMF soft masses 5YR 4/6 ped interiors
												ped interior RMF have clear and sharp boundaries
3-2-18	0-3	peat	-	-	-	-	-	-	-	-	-	Ponded (edge microhigh near large tree)
	3-6	c	10YR 2/1	1	5	2-3	PF/PL					0-3 cm, blackened leaf and woody material
	6-15	c	10YR 2/1	N	3	1-2	RMF/PI					3-6 cm, , redox ped coats, pore linings 7.5YR 4/4
	15-42	c	10YR 2/1	N	15	5-30	PF					6-15 cm, RMF soft masses 7.5YR 3/4 ped interiors
	42-50	c	10YR 2/1	N	3	1-2	RMF/PI					15-42 cm, redox ped coats, 5-10 mm center 5YR 4/4, rest 7.5YR 4/4 and 7.5YR 4/6. 42-50 cm, RMF soft masses 5YR 4/6 ped interiors
												ped interior RMF have clear and sharp boundaries
3-2-19	0-1	peat	-	-	-	-	-	-	-	-	-	Nonponded-ponded transition edge
	1-6	c	10YR 2/1	N	1	2	PL	N	N	N	N	0-1 cm, blackened leaf and woody material
	6-15	c	2.5Y 3/1	N	2 5 2	2 2 1	PL PF RMF/PI	N	N	N	N	1-6 cm, pore linings 5YR 3/4 6-15 cm, redox ped coats, pore linings 5YR 3/4; RMF soft masses 5YR 4/6 ped interiors.
	15-50	c	2.5Y 3/1	N	2	2	RMF/PI	N	N	N	N	15-50 cm, RMF soft masses 5YR 4/6 ped interiors, ped interior RMF have clear and sharp boundaries

Table I2 (continued). Transect 3-2. Near Site 2 nonponded, Site 3 ponded edge, and Site 3 ponded middle, 150 m transect
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows: C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
3-2-20	0-1	peat	-	-	-	-	-	-	-	-	-	Nonponded transition edge
	1-3	c	10YR 2/1	N	3	2-3	PL	N	N	N	N	0-1 cm, blackened leaf and woody material
	3-20	c	10YR 2/1	N	1	1-3	PL	N	N	N	N	1-3 cm, pore linings 10YR 4/3 3-20 cm, pore linings 7.5YR 3/4
	20-50	c	2.5Y 2.5/1	<1	1	1-3	FeMn	N	N	N	N	No coatings on ped faces observed; predominat veg. cherokee sedge; slight microhigh
3-2-21	0-1	peat	-	-	-	-	-	-	-	-	-	Nonponded-ponded transition edge
	1-8	c	10YR 2/1	N	3 <1	2-3 1-3	RMF/PI FeMn	N	N	N	N	0-1 cm, blackened leaf and woody material 1-8 cm, RMF soft masses 2% 7.5YR 4/6 & 1% 5YR 4/6 ped interiors
	8-30	c	2.5Y 2.5/1	N	2 15	3-5 5-10	PI PF	N	N	N	N	8-30 cm, RMF soft masses 7.5YR 3/4 ped interiors and redox ped coats
	30-50	c	2.5Y 2.5/1	3	N	N	N	N	N	N	N	
3-2-22	0-1	peat	-	-	-	-	-	-	-	-	-	Nonponded transition edge
	1-6	c	10YR 2/1	N	1	-	PL	N	N	N	N	0-1 cm, blackened leaf and woody material 1-16 cm, pore linings 7.5YR 4/6
	6-19	c	2.5Y 2.5/1	<1	5 <1	3-5 1-2	PF/PL FeMn	N	N	N	N	6-19 cm, redox ped coats, pore linings 10YR 3/3 and 10YR 4/3
	19-50	c	2.5Y 2.5/1	<1	<1	1-2	FeMn	N	N	N	N	
3-2-23	0-10	c	10YR 2/1	<1	<1	1-2	FeMn	N	N	N	N	Nonponded
	10-50	c	2.5Y 2.5/1	<1	<1	1-2	FeMn	N	N	N	N	gilgai, microlow, woody understory
3-2-24	0-8	c	10YR 2/1	<1	N	N	N	N	N	N	N	Nonponded
	8-38	c	2.5Y 2.5/1	<1	<1	1-2	FeMn	N	N	N	N	gilgai, microlow
	38-50		7.5YR 3/2	2	<1	1-2	FeMn	1	3-5	U	strong	45-50 cm, $CaCO_3$ at this depth only
3-2-25	0-6	c	10YR 2/1	<1	N	N	N	N	N	N	N	Nonponded
	6-32	c	2.5Y 2.5/1	1	N	N	N	N	N	N	N	gilgai, microlow
	32-50		10YR 3/2	1	N	N	N	N	N	N	N	6-32 cm, 5-10 mm 7.5YR 4/4 Bw clay
3-2-26	0-6	l	10YR 3/1	N	N	N	N	N	N	N	N	Nonponded
	6-40	cl	2.5Y 2.5/1	1	N	N	N	N	N	N	N	No gilgai, Mollisol
	40-50	cl	7.5YR4/3	<1	N	N	N	2	2-3	U	strong	40-50 cm, $CaCO_3$ concretions pitted

Table I2 (continued). Transect 3-2. Near Site 2 nonponded, Site 3 ponded edge, and Site 3 ponded middle, 150 m transect
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows: C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
3-2-27	0-8	l	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	8-21	l	10YR 3/1	<1	N	N	N	N	N	N	N	Mollisol
	21-38	cl	10YR 3/1	<1	N	N	N	N	N	N	N	
	38-50	cl	7.5YR4/4	<1	N	N	N	N	N	N	strong	
3-2-28	0-12	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	12-24	cl	10YR 2/2	<1	N	N	N	N	N	N	N	Mollisol
	24-48	c	10YR 3/1	<1	N	N	N	N	N	N	N	
	48-50	c	7.5YR4/4	<1	N	N	N	2	2-3	U	violent	
3-2-29	0-10	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	10-19	cl	10YR 2/2	<1	N	N	N	N	N	N	N	Mollisol
	19-38	c	10YR 3/1	<1	N	N	N	N	N	N	N	
	38-50	c	7.5YR4/4	<1	N	N	N	10	2-3	U	violent	
3-2-30	0-10	sicl	10YR 2/1	N	N	N	N	N	N	N	N	Nonponded
	10-50	c	10YR 2/1	N	N	N	N	15	3-5	U	violent	Mollisol

Table I3. Transect 4-1. Near Site 4 ponded, 150 m transect.
Field descriptions by W. L. Miller, P.R. Owens, R. Mersmann, April-August, 2000.
Transect southeast of monitoring site, 4-1-30 located just east of monitoring site, transect approximately parallel to trail in southeast to northwest direction.
Transect laid out, then profile sites marked every 5 m with engineer flagging; Field conditions very dry. Moist soil colors recorded.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows: C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
4-1-0	0-9	c	10YR 2/2	<1	<1	1-3	FeMn	1	1-3	C/U	N	Nonponded
	9-27	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	
	27-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	
4-1-1	0-3	c	10YR 2/2	<1	<1	1-3	FeMn	1	1-3	C/U	N	Nonponded
	3-9	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	0-9 cm, 10YR 5/2 clean vfs ped coats
	9-24	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	
	24-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	
4-1-2	0-5	c	10YR 2/2	<1	<1	1-3	FeMn	1	1-3	C/U	N	Nonponded
	5-20	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	
	20-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	
4-1-3	0-8	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-3	C/U	violent	Nonponded
	8-29	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-4	C/U	strong	
	29-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	strong	29-50 cm, 5% 1-20 mm 10YR 5/3 Bw clay w/violent reaction
4-1-4	0-9	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-3	C/U	violent	Nonponded
	9-30	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-3	C/U	strong	
	30-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	strong	30-50 cm, 5% 1-20 mm 10YR 5/3 Bw clay w/violent reaction
4-1-5	0-9	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-3	C/U	strong	Nonponded
	9-32	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-3	C/U	strong	
	32-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	strong	32-50 cm, 5% 1-20 mm 10YR 5/3 Bw clay w/violent reaction

Table I3 (continued). Transect 4-1. Near Site 4 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
4-1-6	0-8	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-3	C/U	strong	Nonponded
	8-30	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-5	C/U	strong	30-50 cm, 5% 1-20 mm 10YR 5/3 Bw clay w/violent reaction
	30-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	strong	
4-1-7	0-8	c	10YR 3/1	<1	<1	1-3	FeMn	<1	1-2	C/U	N	Nonponded
	8-29	c	10YR 2/1	<1	<1	1-3	FeMn	<1	1-3	C/U	N	8-29 cm, 2% 1-10 mm 10YR 4/2 Bw clay
	29-50	c	10YR 4/2	<1	<1	1-3	FeMn	3	1-3	C/U	violent	29-50 cm, $CaCO_3$ mostly uncoated
4-1-8	0-7	c	10YR 3/1	<1	<1	1-3	FeMn	<1	1-3	C/U	N	Nonponded
	7-31	c	10YR 2/1	<1	<1	1-3	FeMn	<1	1-3	C/U	N	7-31 cm, 2% 1-10 mm 10YR 4/2 Bw clay
	31-50	c	10YR 4/2	<1	<1	1-3	FeMn	3	1-3	C/U	violent	31-50 cm, $CaCO_3$ mostly uncoated
4-1-9	0-13	c	10YR 2/2	<1	<1	1-3	FeMn	1	1-5	C/U	slight	Nonponded
	13-27	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-5	C/U	strong	
	27-50	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-5	C/U	violent	
4-1-10	0-10	c	10YR 2/2	<1	<1	1-3	FeMn	1	1-5	C/U	slight	Nonponded
	10-20	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-5	C/U	strong	
	20-50	c	10YR 3/2	<1	<1	1-3	FeMn	1	1-5	C/U	violent	
4-1-11	0-5	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	Nonponded
	5-33	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	strong	15-33 cm, few snail shell fragments
	33-50	c	10YR 5/3	<1	1	1-3	FeMn	3	1-3	C/U	strong	
4-1-12	0-6	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-3	C/U	strong	Nonponded
	6-18	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-5	C/U	strong	0-18 cm, 3% vfs/si ped coats
	18-32	c	10YR 3/1	<1	1	1-3	FeMn	2	1-5	C/U	strong	
	32-50	c	10YR 2/1	<1	1	1-3	FeMn	2	1-3	C/U	strong	
4-1-13	0-4	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-3	C/U	slight	Nonponded
	4-21	c	10YR 2/1	<1	<1	1-3	FeMn	2	1-3	C/U	slight	0-4 cm, 5% 10YR 5/3 vfs/si ped coats
	21-48	c	10YR 3/1	<1	1	1-3	FeMn	2	1-4	C/U	strong	
	48-50	c	10YR 2/1	<1	1	1-3	FeMn	2	1-5	C/U	strong	

Table I3 (continued). Transect 4-1. Near Site 4 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
4-1-14	0-5	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-3	C/U	slight	Nonponded
	5-22	c	10YR 2/1	<1	<1	1-3	FeMn	2	1-3	C/U	slight	0-1 cm, blackened leaf and woody material and 5% 10YR 5/3 vfs/si ped coats l
	22-39	c	10YR 3/1	<1	1	1-3	FeMn	2	1-3	C/U	strong	***NOTE***: ponded -nonponded PVC pipe boundary marked midway between 4-1-14 and 4-1-15
	39-50	c	10YR 2/1	<1	1	1-3	FeMn	2	1-3	C/U	slight	
4-1-15	0-4	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	Ponded
	4-17	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	0-4 cm, 5% 10YR 5/3 vfs/si ped coats
	17-48	c	10YR 3/1	<1	1	1-3	FeMn	1	1-3	C/U	strong	***NOTE***: on ponded side of ponded -nonponded PVC pipe boundary bench mark
	48-50	c	10YR 3/1	<1	1	1-3	FeMn	1	1-3	C/U	strong	
4-1-16	0-4	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	Ponded
	4-25	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-3	C/U	slight	0-4 cm, 5% 10YR 5/3 vfs/si ped coats
	25-40	c	10YR 3/1	<1	1	1-3	FeMn	1	1-3	C/U	strong	Gilgai in area
	40-50	c	10YR 3/1	<1	1	1-3	FeMn	1	1-3	C/U	strong	
4-1-17	0-3	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	C/U	slight	Ponded
	3-23	c	10YR 2/1	<1	<1	1-3	FeMn	1	1-5	C/U	strong	0-3 cm, 5% 10YR 5/3 vfs/si ped coats
	23-50	c	10YR 3/1	<1	1	1-3	FeMn	1	1-5	C/U	strong	slickensides
4-1-18	0-4	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	slight	Ponded
	4-22	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	strong	4-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 and 2-10 mm 7.5YR 5/6 Bw clay, w/violent reaction
	22-50	c	10YR 3/1	1	1	1-3	FeMn	2	1-3	C/U	strong	
4-1-19	0-6	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	slight	Ponded
	6-22	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	strong	6-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	22-50	c	10YR 3/1	1	1	1-3	FeMn	2	1-3	C/U	strong	
4-1-20	0-4	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	slight	Ponded
	4-22	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	strong	4-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	22-50	c	10YR 3/1	1	1	1-3	FeMn	2	1-3	C/U	strong	

Table I3 (continued). Transect 4-1. Near Site 4 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
4-1-21	0-5	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	slight	Ponded
	5-26	c	10YR 2/1	1	<1	1-3	FeMn	2	1-4	C/U	strong	4-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	26-50	c	10YR 3/1	1	1	1-3	FeMn	2	1-2	C/U	strong	
4-1-22	0-4	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	slight	Ponded
	4-23	c	10YR 2/1	1	<1	1-3	FeMn	2	1-4	C/U	strong	
	36-50	c	10YR 3/1	1	1	1-3	FeMn	2	1-2	C/U	strong	
4-1-23	0-4	c	10YR 3/1	1	N	N	N	2	1-3	C/U	v. slight	Ponded
	4-14	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	v. slight	4-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	14-40	c	10YR 3/1	1	1	1-3	FeMn	2	1-2	C/U	strong	29-30 cm, 30% 2-5 mm 5YR 4/6 Bw clay, w/violent reaction
	40-50	c	10YR 3/1	1	1	1-3	FeMn	2	1-2	C/U	strong	more $CaCO_3$ coated than uncoated;
4-1-24	0-4	c	10YR 3/1	1	<1	1-3	FeMn	2	1-3	C/U	v. slight	Ponded
	4-14	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	v. slight	4-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	14-50	c	10YR 3/1	<1	<1	1-3	FeMn	2	1-3	C/U	strong	
4-1-25	0-4	c	10YR 3/1	1	N	N	N	2	1-3	C/U	v. slight	Ponded
	4-15	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	v. slight	4-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	15-41	c	10YR 3/1	1	<1	1-3	FeMn	2	1-5	C/U	slight	
	41-50	c	10YR 2/1	<1	<1	1-3	FeMn	3	1-3	C/U	slight	more $CaCO_3$ coated than uncoated
4-1-26	0-5	c	10YR 3/1	1	N	N	N	2	1-3	C/U	v. strong	Ponded
	5-15	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	v. strong	5-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	15-43	c	10YR 3/1	1	<1	1-3	FeMn	2	1-5	C/U	v. strong	
	43-50	c	10YR 2/1	<1	<1	1-3	FeMn	3	1-5	C/U	v. strong	more $CaCO_3$ coated than uncoated
4-1-27	0-6	c	10YR 2/1	N	<1	1-3	FeMn	5	1-2	C/U	strong	Ponded
	6-20	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	v. strong	6-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	20-50	c	10YR 3/1	1	<1	1-3	FeMn	2	1-3	C/U	v. strong	
4-1-28	0-7	c	10YR 2/1	N	<1	1-3	FeMn	5	1-2	C/U	v. slight	Ponded
	7-18	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	v. slight	7-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	18-50	c	10YR 3/1	1	<1	1-3	FeMn	2	1-3	C/U	v. slight	

Table I3 (continued). Transect 4-1. Near Site4 ponded, 150 m transect.
Redox features described as follows: Red Masses are soft, 1-2 mm masses, 7.5 YR 4/6; RMF are masses of oxidized iron; FeMn are iron manganese nodules; PI are ped interiors; PF are coats on ped faces; PL are pore linings. $CaCO_3$ concretions noted as follows; C is coated (reddish or blackish color); U is uncoated; YR is yellow rind in soil; RR is red rind in soil; WR is white rind; NR is coated but no rind
No observed feature is N.

Profile No.	Depth cm	Texture	Color	Red Masses %	Redox Features			$CaCO_3$				Additional Notes
					%	Size mm	Kind	%	Size mm	Kind	Efferves.	
4-1-29	0-5	c	10YR 2/1	N	<1	1-3	FeMn	5	1-2	C/U	N	Ponded
	5-22	c	10YR 2/1	1	<1	1-3	FeMn	2	1-3	C/U	N	5-50 cm, 2-3 mm 7.5YR 4/2 and 7.5YR 4/3 Bw clay, w/violent reaction
	22-50	c	10YR 3/1	1	<1	1-3	FeMn	2	1-3	C/U	N	
4-1-30	0-6	c	10YR 2/1	N	<1	1-3	FeMn	1	3-5	C/U	N	Ponded
	6-20	c	10YR 2/1	1	<1	1-3	FeMn	1	1-3	C/U	N	0-6 CM, $CaCO_3$ coated
	20-26	c	10YR 2/1	1	<1	1-3	FeMn	1	1-3	C/U	N	
	26-50	c	10YR 3/1	<1	<1	1-3	FeMn	1	1-3	C/U	v. slight	

APPENDIX J. SITE LOCATION NUMBERS AND FIELD NOTES

This appendix shows site locations (shown on Figures with digital orthophotos), field notes describing soils and nonponded and ponded areas, soil transect numbers, and relative monitoring site elevations (based on 41.7 ft elevation at culvert on FM 524), and GPS coordinates.

Table J1. Site 1 nonponded and Site 1 ponded; field notes describing nonponded and ponded areas, soil transects, elevations (based on 41.7 ft elevation at culvert on FM 524), and GPS coordinates.

ID	Field Notes	Elev.		Latitude	Longitude
		ft	m		
Site 1 Nonponded					
1-CP	Soil characterization pit location	43.20	13.17	29º 7' 13.55”N	95º 46' 54.42”W
1-MS	Monitoring site location; south end ponded area approximately 10 m north.	43.20	13.17	29º 7' 12.80”N	95º 46' 54.90”W
1-T1	Soil transect (ST) 1-2-0 starting point, west end near northwest-southeast trail	42.90	13.07	29º 7' 13.51”N	95º 46' 58.56”W
1-T2	ST 1-2-4, approximate midway between west end of transect and west side ponded area	43.60	13.29	29º 7' 13.26”N	95º 46' 56.04”W
1-T3	ST 1-2-9, west edge of ponded area [1]	42.70	13.02	29º 7' 13.26”N	95º 46' 55.15”W
1-T4	ST 1-2-30, east end of transect			29º 7' 13.45”N	95º 46' 51.49”W
Site 1 Ponded					
1P-CP	Soil characterization pit location	42.40	12.92	29º 7' 13.55”N	95º 46' 55.05”W
1P-MS	Monitoring site location	42.40	12.92	29º 7' 13.51”N	95º 46' 54.03”W
1P-1	West side main ponded area [1]	43.60	13.30	29º 7' 14.20”N	95º 46' 55.12”W
1P-2	PVC pipe bench mark; middle of main ponded area	42.40	12.92	29º 7' 13.82”N	95º 46' 54.91”W
1P-3	East side of main ponded area [1]	42.70	13.02	29º 7' 14.03”N	95º 46' 54.38”W
1P-4	North end of main ponded area [1]	42.70	13.02	29º 7' 15.80”N	95º 46' 54.22”W
1P-5	East edge of main ponded area [1]			29º 7' 15.18”N	95º 46' 54.03”W
1P-6	West to northwest edge of main ponded area [1]			29º 7' 15.05”N	95º 46' 54.94”W
BM42	Bench mark (BM) 41.7 feet at culvert on FM 524; west side of study area (west of Site 4)	41.70	12.71	29º 6' 43.02”N	95º 46' 59.18”W
BC36	Bottom of culvert, ground level at BM 42 on FM 524; east side of road	36.10	11.00	29º 6' 42.20”N	95º 46' 58.63”W

[1] At the vegetation change between ponded and nonponded areas

Table J2. Site 2 nonponded, Site 3 ponded edge, Site 3 ponded middle, Site 4 ponded, and Site 5 nonponded; field notes describing nonponded and ponded areas, soil transects, elevations (based on 41.7 ft elevation at culvert on FM 524), and GPS coordinates.

ID	Field Notes	Elevation		Latitude	Longitude
		ft	m		
Site 2 Nonponded					
2-CP	Soil characterization pit location	42.40	12.92	29º 7' 6.42" N	95º 46' 55.63" W
2-MS	Monitoring site location	42.40	12.92	29º 7' 7.20" N	95º 46' 54.88" W
Site 3 Ponded Edge					
3PE-CP	Soil characterization pit location	41.10	12.52	29º 7' 6.03" N	95º 46' 55.15" W
3PE-MS	Monitoring site location [1] (Platinum electrode)	41.10	12.52	29º 7' 6.55" N	95º 46' 54.99" W
3PE-1	North side [1]	40.90	12.46	29º 7' 7.01" N	95º 46' 53.77" W
3PE-2	At trail to site, northeast side [1]	40.90	12.46	29º 7' 7.41" N	95º 46' 51.84" W
3PE-3	East side [1]	40.90	12.46	29º 7' 5.57" N	95º 46' 52.52" W
3PE-4	East side [1]	40.90	12.46	29º 7' 6.57" N	95º 46' 55.11" W
3PE-5	West side [1]			29º 7' 5.81" N	95º 46' 55.17" W
3PE-6	Middle of piezometers, at upper limit of ponding, vegetation change			29º 7' 6.80" N	95º 46' 54.74" W
Site 3 Ponded Middle					
3PM-CP	Soil characterization pit location	40.00	12.26	29º 7' 5.52" N	95º 46' 54.07" W
3PM-MS	Monitoring site location	40.00	12.26	29º 7' 6.30" N	95º 46' 53.97" W
3PM-T1	East end of 150 m soil transect ST 3-2-0 at PVC pipe BM. Two soil profiles, mollic c / cl to 50 cm, then reddish clay			29º 7' 4.00" N	95º 46' 51.52" W
3PM-T2	East side of 150 m soil transect, [1] ST 3-2-7			29º 7' 4.39" N	95º 46' 53.03" W
3PM-T3	Site 3 Pnd Middle, approximate middle of ponded area, ST 3-2-15			29º 7' 4.64" N	95º 46' 54.18" W
3PM-T4	West side, [1] ST 3-2-23			29º 7' 4.84" N	95º 46' 55.68" W
3PM-T5	Site 3, west end 150 m soil transect, ST 3-2-30			29º 7' 5.06" N	95º 46' 56.91" W
3PM-1	North end opening in natural levee [2]			29º 7' 1.41" N	95º 46' 48.50" W
3PM-2	South end opening in natural levee [2]			29º 7' 0.68" N	95º 46' 47.96" W
Site 4 Ponded					
4P-CP	Soil characterization pit location			29º 6' 53.62" N	95º 46' 35.89" W
4P-MS	Monitoring site location			29º 6' 53.39" N	95º 46' 36.42" W
4P-T1	North end of soil transect, ST 4-1-30			29º 6' 53.72" N	95º 46' 36.31" W
4P-T2	1st PVC pipe w / red top going south from Site 4			29º 6' 59.87" N	95º 46' 32.93" W
4P-T3	South from Site 4, 2nd PVC pipe, Fish and Wildlife Service estimated boundary [1]			29º 7' 2.14" N	95º 46' 31.43" W
4P-T4	South end of soil transect, ST 4-1-1			29º 6' 50.53" N	95º 46' 32.02" W
Site 5 Nonponded					
5-CP & MS	Soil characterization pit location (5CP) and monitoring site location (5MS).	34.00	10.36	29º 3' 11.00" N	95º 47' 16.00" W

[1] At the vegetation change between ponded and nonponded areas

[2] The natural levee opening allows ponded water to flow from Site 3 southeast toward Site 4 when the water level is high enough (approximately 25 to 30 cm at Site 3 Ponded Middle).

Table J3. Field observations concerning ponded and nonponded areas, vegetation changes, soil morphology, and GPS coordinates in vicinity of and west of Site 4 ponded.

ID	Field Notes	Latitude	Longitude
P1	Area 60 m west of Site 4; interconnected with ponded water 5 to 10 cm deep	29º 6' 51.81"N	95º 46' 39.00”W
P3	In ponded area 5 to 10 cm deep; soil pit to 50 cm, 10YR 4/2, no redox features (RMF), <1% CaCO3, coated, no rind in soil	29º 6' 45.67"N	95º 46' 58.69”W
P4	In ponded area; vegetation change, between ponded and nonponded areas, open understory changes to underbrush	29º 6' 39.80"N	95º 46' 55.82”W
P-5	In ponded area 1 to 5 cm deep; soil pit to 50 cm, 10YR 4/2, no RMF, <1% CaCO3, coated, no rind in soil	29º 6' 43.11"N	95º 46' 56.77”W
P6	In ponded area 5 to 10 cm deep; soil pit to 30 cm, 10YR 4/2, no RMF, <1% CaCO3, coated, no rind in soil	29º 6' 44.53"N	95º 46' 55.23”W
P7	In ponded area; vegetation change between ponded and nonponded areas is 30 to 60 m east this location.	29º 6' 42.12"N	95º 46' 53.37”W
P8	Open vegetation from P7; area not ponded, but soil surface wet satiated; no black leaves on surface; marginally wet area; soil pit to 30 cm, 10YR 4/2, no RMF, <1% CaCO3, coated, no rind in soil	29º 6' 45.18"N	95º 46' 53.37”W
P9	Edge of ponded area and boundary of Cherokee sedge	29º 6' 46.73"N	95º 46' 52.25”W
P10	Followed flowing water upstream; found old well pond (dike about 3 m tall); water was 5 to 50 cm deep around south side dike	29º 6' 50.55"N	95º 46' 47.64”W
P11	Followed flowing/ponded water upstream (water flowing northeast to east) to natural open area; flowing water 2 to 3 m wide and 2 to 5 cm deep	29º 6' 50.32"N	95º 46' 45.74”W
P12	Open area ponded 5 to 10 cm	29º 6' 48.81"N	95º 46' 43.64”W
P13	Large open area; vegetation/landscape similar to Site 3 Ponded; water 25 to 30 cm deep	29º 6' 46.47"N	95º 46' 39.54”W
P14	Near southeast end of ponded area noted in P13; area abandoned channel (long and narrow) similar to area at Site 3 only not as deep	29º 6' 43.47"N	95º 46' 37.19”W
P15	Followed ponded water boundary along east edge of narrow ponded area from P14	29º 6' 49.77"N	95º 46' 40.35”W
P16	Followed ponded water/wet satiated soil surface northeast to ponding at Site 4; ponded water dimensions about 2 m wide and 5 to 10 cm deep	29º 6' 50.63"N	95º 46' 39.72”W
P17	Approximate edge of ponding and vegetation change between ponded and nonponded areas	29º 6' 51.09"N	95º 46' 38.95”W
P18	Followed ponded low northwest from P17; ponded area about 4 to 5 m wide and ponded <5 cm deep	29º 6' 52.42"N	95º 46' 39.61”W
P19	Followed ponded low south-southwest from P18, 1 to 2 m wide and 1 to 2 cm deep; slight high (< 5 cm) to west that might block flow to west-southwest from Site 4	29º 6' 50.60"N	95º 46' 40.77”W
P20	Very large open palmetto area flat from here to 3PM-2	29º 6' 58.73"N	95º 46' 46.92”W
P21	In same open palmetto flat area; continues from P20.	29º 6' 55.77"N	95º 46' 45.54”W
P23	In open palmetto flat; surface wet satiated; soil pit to 30 cm, 10YR 2/1, no RMF, 3% coated/pitted carbonates at 15 to 30 cm; one more soil pit nearby, same as first	29º 6' 52.44"N	95º 46' 43.20”W
P24	Ponded open palmetto flat; soil pit to 30 cm, 10YR 3/1, < 1% FeMn 1 -2 mm concretions	29º 6' 59.87"N	95º 46' 32.91”W
P25	Out of ponded area; about 35 m into nonponded underbrush	29º 7' 2.14"N	95º 46' 31.41”W
P26	Surface wet satiated; soil pit to 50 cm, 10YR 3/1, <1% FeMn 1-2 mm concretions	29º 7' 1.33"N	95º 46' 31.78”W
P27	Nonponded with gilgai microrelief; soil pit in microlow to 50 cm, 10YR 2/1, no redoximorphic features	29º 7' 5.31"N	95º 46' 31.07”W

APPENDIX K. CUMULATIVE PERCENT PONDING AND REDUCING CONDITIONS, AND BI-WEEKLY DURATION OF EVENTS

This appendix contains cumulative percent ponding and reducing conditions, number and duration of bi-weekly ponding and reducing condition events based on water-years and growing season water-years, 1996-2002 and 2000-2002.

Table K1. Site 1 nonponded microlow, cumulative percent ponding, number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
11	13, <2wk	11	8	4, <2wk	8
Growing Season Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
7	7, <2wk	7	5	2, <2wk	5

Table K2. Site 1 nonponded microlow, reducing conditions at 10, 30, and 50cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0	15	3, <2 wk	6
								2, 2wk	8
30	0	0	0	0	0	0	17	4, <2wk	8
								2, 2wk	8
50	0	0	0	0	0	0	14	3, <2wk	6
								2, 2wk	8
Growing Season Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0	10	2, <2wk	5
								1, 2wk	5
30	0	0	0	0	0	0	12	3, <2wk	7
								1, 2wk	5
50	0	0	0	0	0	0	10	4, <2wk	10

Table K3. Site 1 nonponded microhigh, cumulative percent ponding[1], number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Ponding[1]					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
11	13, <2wk	11	8	4, <2wk	8
Growing Season Water-Year Ponding[1]					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
7	7, <2wk	7	5	2, <2wk	5

Table K4. Site 1 nonponded microhigh, reducing conditions at 10, 30, and 50 cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	4	2, <2wk	4
50	0	0	0	0	0	0	10	2, <2wk	4
								1, 4wk	6
Growing Season Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	2	1, <2wk	2
50	0	0	0	0	0	0	7	1, <2wk	2
								1, 2wk	5

[1] Ponding data from microlow; microhigh did not pond

Table K5. Site 1 ponded, cumulative percent ponding, number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 2000-2002.

Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
-	-	-	17	4, <2wk	8
				1, 6wk	8
Growing Season Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
-	-	-	15	3, <2wk	7
				1, 4wk	7

Table K6. Site 1 ponded, reducing conditions at 10, 30, and 50cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 2000-2002.

Water-Year Reducing Conditions						
	AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	8	4, <2wk	8	2	1, <2wk	2
30	0	0	0	2	1, <2wk	2
50	0	0	0	8	1, 6wk	8
Growing Season Water-Year Reducing Conditions						
	AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	5	2, <2wk	5	0	0	0
30	0	0	0	0	0	0
50	0	0	0	0	0	0

Table K7. Site 2 nonponded, reducing conditions at 10, 30, and 50 cm depths measured with AADP dye and Pt electrodes, cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 2000-2002.

Water-Year Reducing Conditions						
	AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0
30	0	0	0	14	3, <2wk	6
					2, 2wk	8
50	0	0	0	17	3, <2wk	6
					1, 2wk	4
					1, 4wk	6
Growing Season Water-Year Reducing Conditions						
	AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0
30	0	0	0	10	4, <2wk	10
50	0	0	0	10	4, <2wk	10

Table K8. Site 3 ponded edge, cumulative percent ponding, number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
22	8, <2wk	7	21	2, <2wk	4
	4, 2wk	3		1, 2wk	4
	3, 4wk	3		1, 10wk	13
	1, 8wk	4			
	1, 10wk	5			
Growing Season Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
15	5, <2wk	5	10	2, <2wk	5
	4, 2wk	4		1, 2wk	5
	6, 4wk	6			

Table K9. Site 3 ponded edge, reducing conditions at 10, 30, and 50 cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	25	6, <2wk	5	35	1, <2wk	2	40	1, 4wk	6
		3, 2wk	5		1, 4wk	6		1, 12wk	15
		1, 4 wk	3		1, 8wk	10		1, 16wk	19
		1, 8wk	4		1, 14wk	17			
		1, 14wk	7						
30	8	3, <2wk	2	21	3, <2wk	6	42	1, 4 wk	6
		1, 12wk	7		1, 12wk	15		1, 14wk	17
								1, 16wk	19
50	7	4, <2wk	3	2	1, 2wk	2	42	1, 4 wk	6
		2, 2wk	3					1, 14 wk	17
								1, 16 wk	19
Growing Season Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	19	7, <2wk	7	23	3, <2wk	7	22	3, 2wk	15
		3, 2wk	6		2, 4wk	15		1, 4wk	7
		2, 4 wk	6						
30	6	3, <2wk	3	14	3, <2wk	7	30	3, 2wk	15
		1, 4wk	3		1, 4wk	7		2, 4wk	15
50	0	0	0	0	0	0	32	2, 2wk	10
								3, 4wk	22

Table K10. Site 3 ponded middle, cumulative percent ponding, number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
67	1, <2wk	1	56	1, 22wk	25
	1, 4wk	3		1, 28wk	31
	1, 22wk	10			
	2, 28wk	25			
	1, 30wk	14			
	1, 32wk	14			
Growing Season Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
72	1, 2wk	2	47	1, 2wk	5
	1, 4wk	3		1, 6wk	10
	1, 6wk	4		1, 10wk	15
	1, 8wk	5		1, 12wk	17
	3, 10wk	18			
	4, 12wk	29			
	1, 20wk	11			

Table K11. Site 3 ponded middle, reducing conditions at 10, 30, and 50 cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	64	3, <2wk	3	56	1, 20wk	23	64	2, <2wk	4
		1, 20wk	9		1, 30wk	33		1, 24wk	27
		1, 24wk	11					1, 30wk	33
		2, 30wk	27						
		1, 32wk	14						
30	36	1, <2wk	<1	33	1, 2wk	4	67	2, <2wk	4
		1, 2wk	2		1, 26wk	29		1, 24wk	27
		2, 14wk	14					1, 32wk	35
		1, 16wk	8						
		1, 26wk	12						
50	14	4, <2wk	3	27	1, 24wk	27	67	2, <2wk	4
		1, 24wk	11					1, 24wk	27
								1, 32wk	35
Growing Season Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	58	3, <2wk	3	47	1, 2wk	5	57	2, <2wk	5
		1, 2wk	2		2, 8wk	25		1, 4wk	7
		2, 8wk	10		1, 12wk	17		1, 8wk	12
		3, 10wk	18					1, 10wk	15
		2, 12wk	14					1, 12wk	17
		1, 18wk	10						
30	32	1, <2wk	1	25	2, 8wk	25	60	2, <2wk	5
		2, 8wk	10					1, 4wk	7
		2, 10wk	12					2, 10wk	30
		1, 14wk	8					1, 12wk	17
50	8	4, <2wk	4	22	1, 6wk	10	60	2, <2wk	5
		1, 6wk	4		1, 8wk	12		1, 4wk	7
								2, 10wk	30
								1, 12wk	17

Table K12. Site 4 ponded, cumulative percent ponding, number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
44	5, <2wk	4	38	3, <2wk	6
	1, 2wk	2		1, 12wk	15
	2, 4wk	5		1, 14wk	17
	1, 12wk	6			
	1, 14wk	7			
	1, 20wk	9			
	1, 24wk	11			
Growing Season Water-Year Ponding					
Ponding 1996-2002			Ponding 2000-2002		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
35	6, <2wk	6	27	3, <2wk	7
	2, 2wk	4		1, 2wk	5
	4, 4wk	4		2, 4wk	15
	2, 10wk	12			

Table K13. Site 4 ponded, reducing conditions at 10, 30, and 50 cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 1996-2002 and 2000-2002.

Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	38	2, <2wk	2	44	1, 4wk	7	44	1, <2wk	2
		1, 4wk	2		2, 14wk	37		1, 2wk	4
		2, 14wk	14					1, 6wk	8
		1, 20wk	9					2, 12wk	29
		1, 24wk	11						
30	3	1, 6wk	3	9	1, 6wk	9	44	1, <2wk	2
								1, 4wk	6
								1, 14wk	17
								1, 16wk	19
50	0	0	0	0	0	0	46	1, 16wk	19
								1, 30wk	33
Growing Season Water-Year Reducing Conditions									
	AADP 1996-2002			AADP 2000-2002			Eh 2000-2002		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	30	2, <2wk	2	27	2, <2wk	5	30	2, <2wk	5
		2, 2wk	4		1, 2wk	5		2, 2wk	10
		2, 4wk	6		2, 4wk	16		2, 4wk	15
		1, 12wk	7						
		1, 18wk	10						
30	1	1, <2wk	1	2	1, <2wk	2	30	2, <2wk	5
								2, 2wk	10
								2, 4wk	15
50	0	0	0	0	0	0	33	1, 2wk	5
								1, 8wk	13
								1, 10wk	15

Table K14. Site 5 nonponded microlow, cumulative percent ponding, number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 1996-2001 and 2000-2001.

Water-Year Ponding					
Ponding 1996-2001			Ponding 2000-2001		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
13	10, <2wk	11	9	1, 2wk	9
	1, 2wk	2			
Growing Season Water-Year Ponding					
Ponding 1996-2001			Ponding 2000-2001		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
8	6, <2wk	8	0	0	0

Table K15. Site 5 nonponded microlow, reducing conditions at 10, 30, and 50 cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 1996-2001 and 2000-2001.

Water-Year Reducing Conditions									
	AADP 1996-2001			AADP 2000-2001			Eh 2000-2001		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	2	2, <2wk	2	4	1, <2wk	4	9	1, 2wk	9
30	0	0	0	0	0	0	30	1, 12wk	30
50	0	0	0	4	1, <2wk	4	26	1, 10wk	26
Growing Season Reducing Conditions									
	AADP 1996-2001			AADP 2000-2001			Eh 2000-2001		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	10	1, <2wk	1	5	1, <2wk	5	0	0	0
30	0	0	0	0	0	0	16	1, <2wk	5
								1, 2wk	11
50	0	0	0	0	0	0	5	1, <2wk	5

Table K16. Site 5 nonponded microhigh[2], cumulative percent ponding, number and duration of bi-weekly ponding events, and percent duration of bi-weekly ponding events based on water-year and growing season water-year, 1996-2001 and 2000-2001.

Water-Year Ponding					
Ponding 1996-2001			Ponding 2000-2001		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
13	10, <2wk	11	9	1, 2wk	9
	1, 2wk	2			
Growing Season Water-Year Ponding					
Ponding 1996-2001			Ponding 2000-2001		
Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
8	6, <2wk	8	0	0	0

Table K17. Site 5 nonponded microhigh, reducing conditions at 10, 30, and 50 cm depths measured with AADP dye and Pt electrodes (Eh), cumulative percent reducing conditions, number and duration of bi-weekly reducing condition events, and percent duration of bi-weekly reducing condition events based on water-year and growing season water-year, 1996-2001 and 2000-2001.

Water-Year Reducing Conditions									
	AADP 1996-2001			AADP 2000-2001			Eh 2000-2001		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0	13	1, 4wk	13
30	0	0	0	0	0	0	26	1, <2wk	4
								1, 8wk	22
50	0	0	0	0	0	0	26	1, <2wk	4
								1, 8wk	22
Growing Season Reducing Conditions									
	AADP 1996-2001			AADP 2000-2001			Eh 2000-2001		
Depth (cm)	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %	Cumulative %	No. of Events, Duration	Duration %
10	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	5	1, <2wk	5
50	0	0	0	0	0	0	16	1, <2wk	5
								1, 2wk	11

[2] Ponding data from microlow; microhigh did not pond.