FINAL MITIGATION BANKING INSTRUMENT
SUGAR CAMP CREEK WETLAND AND STREAM MITIGATION BANK

Illinois Department of Transportation
Bureau of Design and Environment
2300 S. Dirksen Parkway
Springfield, IL 62764-0002

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Table of Contents

I) Introduction 1

A) Bank goals and objectives 1

B) Ownership and legal description of bank lands 1

C) Service area and suitable impacts for compensation 3

II) Description of baseline conditions at the bank site 5

A) Endangered and threatened species 5

B) Site soils and topography 5

C) Site hydrology 7

D) Existing wetland and upland habitats 11

E) Cultural resources 11

III) Site development plan 11

A) Bank size and classes of wetland and aquatic resources 14

B) Work phases 17

C) As-built report 17

D) Specifications 20

IV) Accounting, performance standards, and monitoring methods 27

A) Accounting procedures 27

B) Performance standards for credit availability and bank success 28

C) Reporting protocols and monitoring plan 29

D) Adaptive management 30

E) Schedule of credit availability 32

V) Financial assurances and long-term bank management 32

VI) Signatories 34

VII) References 39

Figures

Figure 1. Proposed wetland and stream mitigation bank site and vicinity 2
Figure 2. Geographic service area of the bank site 4
Figure 3. Soils map 6
Figure 4. Site topography and work phases 8
Figure 5. History of land-use modifications 9
Figure 6. Hydrologic alterations and surface-water features 10
Figure 7. Site development plan – proposed habitat classes 12
Figure 8. Site development plan – hydrologic restoration activities 13
Figure 9. Site development plan – floodplain profile 18
Figure 10. Proposed implementation schedule 19
Figure 11. Hydrologic monitoring network 22

Tables

Table 1. Existing and proposed classes of wetlands 14
Table 2. Common native herbaceous hydrophytes at or adjacent to the Sugar Camp Creek bank site 15
Table 3. Proposed work phases, work items, and time frame for bank establishment 20
Table 4. Native species of grasses for seeding in planned wetlands 26
Table 5. Native species of trees and shrubs for planting in planned wetlands 26
Table 6. Native species of forbs and grasses for seeding in non-wetlands 27
Table 7. Native species of trees and shrubs for planting in non-wetlands 27
Table 8. Performance standards for wetland, riparian, and upland resource areas 28

Appendices

Appendix A. NRCS wetland determination 41
Appendix B. INHS wetland determination 42
Appendix C. Archeological report 43
Appendix D. Stream mitigation bank credit assessment 44
Appendix E. Work specifications supplement 46

I. Introduction

This wetland and stream mitigation banking instrument has been prepared in accordance with the Final Rule for 33 CFR 332 and 40 CFR 230 Compensatory Mitigation for Losses of Aquatic Resources (Federal Register 2008). This instrument shall document agency concurrence on the objectives and administration of the Sugar Camp Creek Wetland and Stream Mitigation Bank proposed by the Illinois Department of Transportation (IDOT). The proposed mitigation bank is located along Sugar Camp Creek in Franklin County, IL, approximately 8 miles northeast of the city of Benton (Figure 1). The property is bounded by Hen Lane and Santor Road on the north; adjacent floodplain property, under separate ownership, to the east and south; and adjacent uplands, under separate ownership, to the west. This document describes the physical and legal characteristics of the proposed wetland and stream mitigation bank and how it will be established and operated. The wetland and stream mitigation bank site will be referred to subsequently as the bank site, or the mitigation bank.

The IDOT proposes that all activities regulated under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act will be eligible for compensation at the bank site if impacts to wetlands and/or aquatic resources are unavoidable. Credits from the mitigation bank may also be used to compensate for environmental impacts authorized under the Interagency Wetland Policy Act of 1989. In no case will the same credits be used to compensate for more than one activity; however, the same credits may be used to compensate for an activity which requires authorization under more than one program.

Under the existing requirements of Sections 10 and 404, all appropriate and practicable steps will be undertaken by the IDOT to first avoid and then minimize adverse impacts to aquatic resources prior to authorization of credit use from the mitigation bank.

A. Bank goals and objectives

The goals of the mitigation bank are to restore and create wetlands, to enhance existing wetland areas, to restore riparian habitat along Sugar Camp Creek and to establish upland plant communities in non-wetland buffer areas. To achieve these goals, the IDOT will remove the property from agricultural use, naturalize the local hydrologic regime and establish native plant communities. The result will be a contiguous tract of various habitats including a combination of forested, scrub-shrub, and emergent wetlands, as well as riparian and upland forest and grassland. The mitigation bank will provide habitat for wildlife and recreational opportunities for people.

The objectives of the mitigation bank are to: 1) reforest former agricultural land with native hydrophytic trees, 2) establish native hydrophytic plants (e.g. emergent and scrub-shrub wetland communities) on land not suited for tree survival, 3) improve riparian habitat in the area along the streambanks of Sugar Camp Creek, and 4) provide flood, sediment, and nutrient storage for the Sugar Camp Creek and Big Muddy River watersheds. Site improvements for human use will be low-impact and may include items such as paths for site access and interpretive signs.

B. Ownership and legal description of bank lands

The IDOT has acquired the land and holds fee-simple interest to the land. The legal description of the bank site is given as:

The Southeast Quarter of the Northeast Quarter, the Northeast Quarter of the Southeast

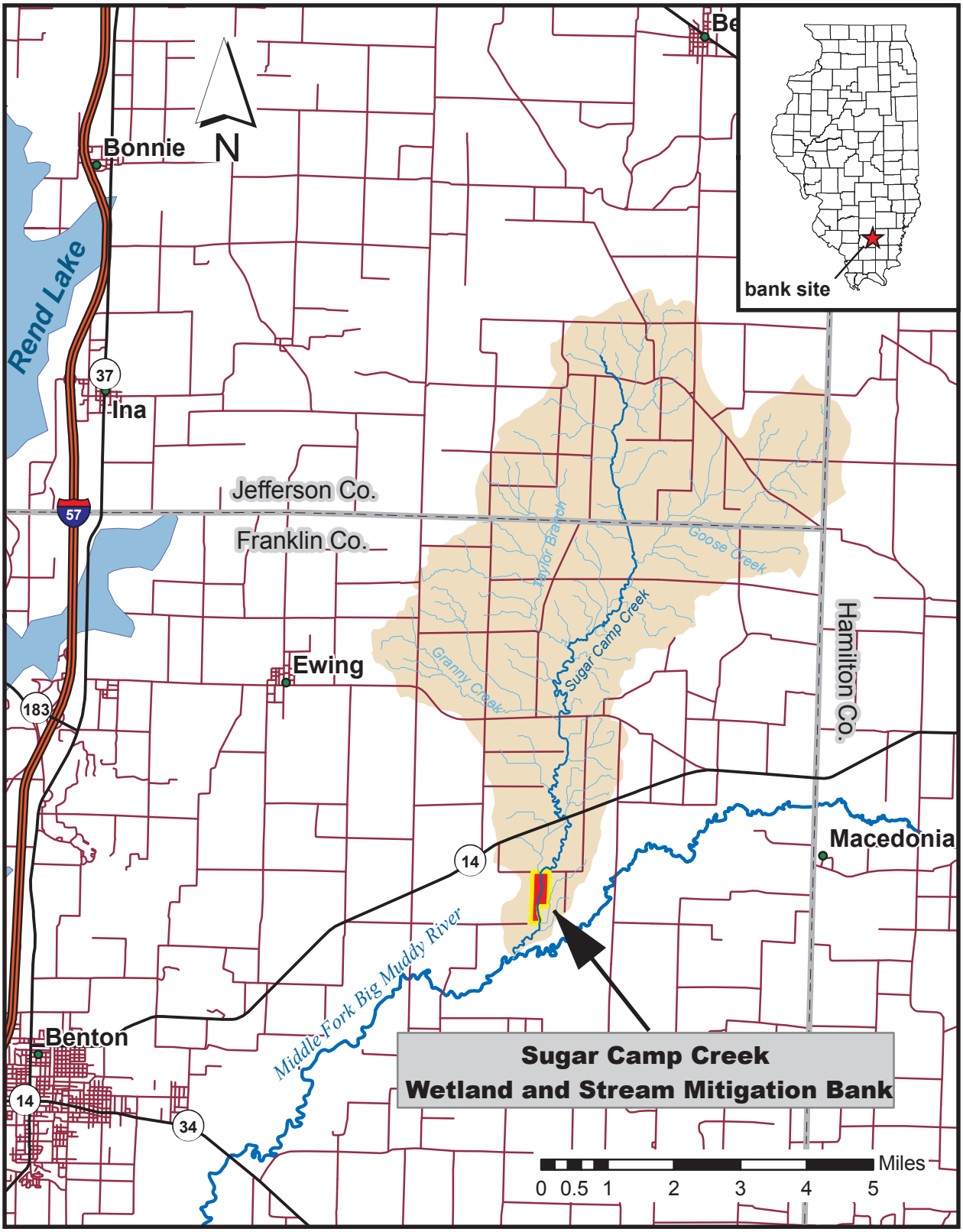


Figure 1. Proposed wetland and stream mitigation bank site and vicinity. The site is located along Sugar Camp Creek in northeastern Franklin County, IL. The migitation bank site is highlighted in red; the Sugar Camp Creek watershed is shaded in tan.

Quarter, and the Southeast Quarter of the Southeast Quarter, all in Section Thirty-Two (32), Township Five (5) South, Range Four (4) East of the Third Principal Meridian, Franklin County, Illinois. More particularly described as follows:

Commencing at an iron rod found at the Northeast Corner of the Northeast Quarter of the Northeast Quarter of Section Thirty Two (32), Township Flve (5) South, Range Four (4) East of the Third Principal Meridian, Franklin County, Illinois; thence South 00 Degrees 36 Minutes 34 Seconds West a distance of 1371.07 feet along the East line of said Northeast Quarter of the Northeast Quarter to an iron rod set at the Northeast Corner of the Southeast Quarter of the Northeast Quarter of said Section Thirty Two (32), said point being the point of beginning; thence South 00 Degrees 36 Minutes 34 Seconds West a distance of 1371.07 feet along the East line of said Southeast Quarter of the Northeast Quarter to an iron rod set at the Northeast Corner of the Northeast Quarter of the Southeast Quarter of said Section Thirty Two (32) thence South 01 Degrees 54 Minutes 23 Seconds West a distance of 1347.92 feet along the East line of said Northeast Quarter of the Southeast Quarter to a t-post set at the Northeast Corner of the Southeast Quarter of the Southeast Quarter of said Section Thirty Two (32); thence South 01 Degrees 54 Minutes 23 Seconds West a distance of 1347.92 feet along the East line of said Southeast Quarter of the Southeast Quarter to an iron rod set at the Southeast Corner of said Southeast Quarter of the Southeast Quarter; thence South 88 Degrees 10 Minutes 23 Seconds West a distance of 1331.40 feet along the South line of said Southeast Quarter of the Southeast Quarter to a t-post set at the Southwest Corner of said Southeast Quarter of the Southeast Quarter; thence North 01 Degrees 22 Minutes 28 Seconds East a distance of 1353.02 feet along the West line of said Southeast Quarter of the Southeast Quarter to a t-post found at the Southwest Corner of the Northeast Quarter of the Southeast Quarter of said Section Thirty Two (32); thence North 01 Degrees 22 Minutes 28 Seconds East a distance of 1353.02 feet along the West line of said Northeast Quarter of the Southeast Quarter to a t-post set at the Southwest Corner of the Southeast Quarter of the Northeast Quarter of said Section Thirty Two (32); thence North 00 Degrees 43 Minutes 39 Seconds east a distance of 1365.79 feet along the West line of said Southeast Quarter of the Northeast Quarter to an iron rod set at the Northwest Corner of said Southeast Quarter of the Northeast Quarter; thence North 88 Degrees 26 Minutes 23 Seconds East a distance of 1353.25 feet along the North line of said Southeast Quarter of the Northeast Quarter to the point of beginning.

Said parcel to contain 125.703 acres, more or less, per survey by Mitchell R. Garrett, IL Professional Land Surveyor no. 3085, dated 12/15/2004. Said parcel being subject to all rights-of-way and easements, recorded or otherwise. All situated in the County of Franklin, State of Illinois.

Except therein all mineral interests previously conveyed.

The 125.7 acres described above will hereafter be referred to as the parcel. An area of 20.5 acres within the parcel comprises the wetland compensation site for FAP 312 (IL 3) Union and Alexander Counties (IDOT seq. no. 9282) and will not be included in the Sugar Camp Creek wetland mitigation bank site. Therefore, the area of the parcel remaining for the proposed bank site is 105.2 acres.

C. Service area and impacts suitable for compensation

The service area of the mitigation bank is the Big Muddy River watershed (HUC 07140106; Figure 2). This service area falls entirely within the St. Louis District of the U.S. Department of the Army, Corps of Engineers. Impacts to wetlands and streams of ephemeral, intermittent, or perennial classification within the service area will be eligible for compensation at the mitigation bank. Compensation for impacts to wetlands and streams that occur outside the service area of the mitigation bank will also be eligible for compensation at the bank site but will be offset at a higher

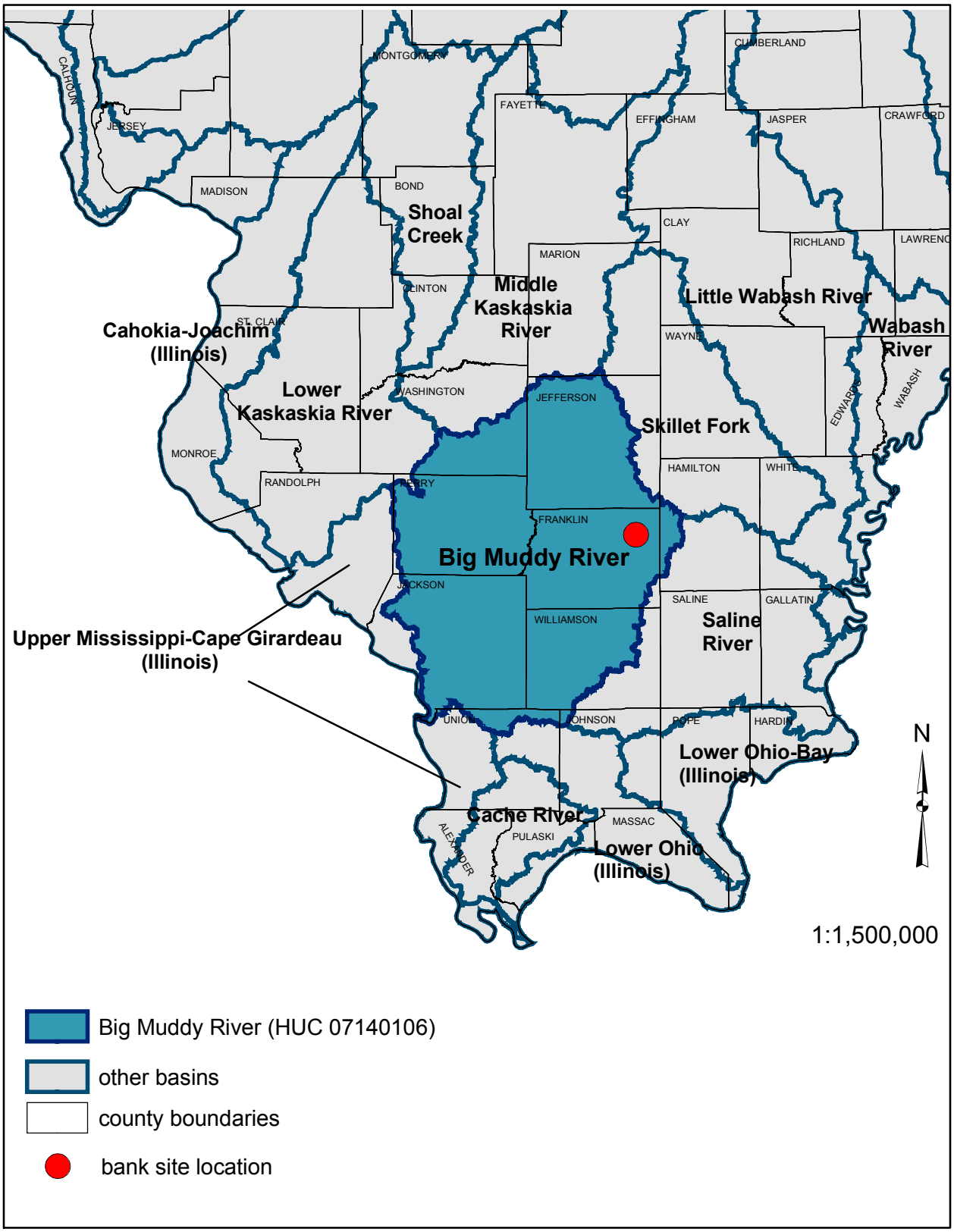


Figure 2. Geographic service area of the Sugar Camp Creek wetland bank site. The proposed service area encompasses the Big Muddy River Watershed (shaded in blue). Map based on GIS data from the USGS (Steeves and Nebert 1994) and the ISGS (1998).

compensation ratio to be determined by the Corps when processing Department of the Army permit authorizations. Per the Interagency Wetland Policy Act of 1989, wetland compensation that is provided for out-of-basin impacts shall be debited from the mitigation bank at a ratio of 2:1, 3:1, or 5.5:1 depending on the size and category (programmatic or standard review actions) of the impact. Out-of-basin compensation ratios for streams will be determined by the Corps pending approval of the State of Illinois Stream Assessment Method (U.S. Army Corps of Engineers, *in progress*).

II. Description of baseline conditions at the bank site

In December 2004, the Illinois Natural History Survey (INHS) and the Illinois State Geological Survey (ISGS) conducted on-site assessments of vegetation, soils, and hydrology (Plocher and Weisbrook 2004, Pociask et al. 2004). The following subsections give the results from these baseline assessments as well as information provided by the U.S. Fish and Wildlife Service, the U.S. Department of Agriculture-Natural Resources Conservation Service (NRCS), the Illinois Department of Natural Resources (IDNR), and University of Illinois archaeologists.

A. Endangered and threatened species

The U.S. Fish and Wildlife Service Region 3 list of threatened or endangered species in Illinois (http://midwest.fws.gov/index.html) lists the Indiana bat (*Myotis sodalis*), Prairie bush clover (*Lespedeza leptostachya*) and Eastern prairie fringed orchid (*Platanthera leucophaea*) as potentially occurring in Franklin County. Appendix 1 of the Agency Draft Indiana bat (*Myotis sodalis*) Recovery Plan lists no range-wide distribution records for *Myotis sodalis* in Franklin County. The IDOT has determined that there is no suitable habitat for any federally-listed species within the bank site.

The Illinois Endangered Species Protection Board lists a number of species as occurring in Franklin and adjacent counties. The IDNR Natural Heritage Database has no records of listed species, natural areas or nature preserves within the bank site (IDNR Wetland Impact Review Tool, report dated 09-28-07).

B. Site soils and topography

Soils mapped by the Franklin County Soil Survey at the bank site are shown in Figure 3 (Preloger 2003). Hydric soil map units as listed by the Soil Survey include frequently flooded Bonnie silt loam and frequently flooded Wynoose silt loam (U.S. Department of Agriculture 1991, 1995). These soils comprise 90.0 acres of the proposed bank site. Non-hydric soil map units include Belknap silt loam, Bluford silt loam, and Rend silt loam. Very poorly drained (Bonnie silt loam) and poorly drained (Wynoose silt loam) soils mapped at the site are reported to exhibit a seasonal high water table within one foot of land surface and frequent flooding making conditions conducive for ponding and surface saturation. Also, the Soil Survey rates the Wynoose and Bonnie units as having ‘good’ potential for wetland plants (Preloger 2003). The native vegetation under which all soils at the site formed was deciduous hardwood forest (U.S. Department of Agriculture 2006).

INHS personnel verified the soil map unit boundaries by conducting ground traverses over the bank site. Topography and soil properties including soil color, parent material, drainage class, and soil texture were used to evaluate the NRCS soil boundaries. After inspection, the INHS adjusted the soil map unit boundaries (see Figure 3). The INHS delineated 53.7 acres of hydric soil (Bonnie and Wynoose silt loams combined) within the bank site boundary. The remainder of the bank site was mapped as either non-hydric soil (Belknap, Bluford, and Rend silt loams) or creek.

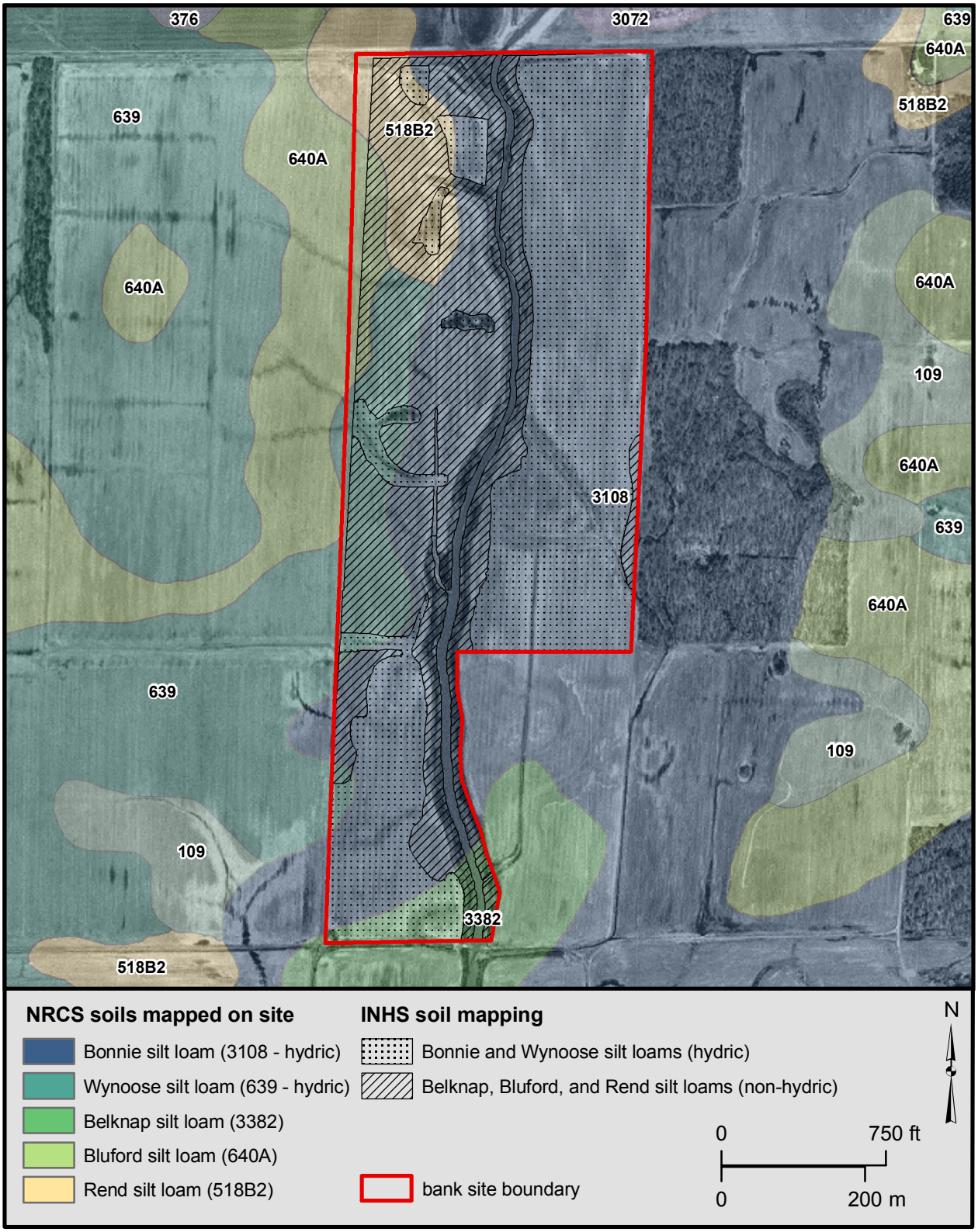


Figure 3. Soil map of the proposed wetland mitigation bank site and vicinity, showing Soil Survey (Preloger 2003) and INHS soil map units. Map based on USGS digital orthophotography, Ewing SE quarter-quadrangle, from 1998 aerial photography (ISGS 2001).

The hydrologic conditions that formed the hydric soils at the bank site have changed due to hydrologic alterations both at the site and regionally. At the site, the channelized creek and ditches expedite drainage and levees prevent moderate and lower floods from reaching portions of the site. Regionally, the channelization and incision of streams and conversion of wetlands and forests to farmland has likely caused significant changes to the hydrology of the Sugar Camp Creek watershed. Therefore, restoration of wetlands within the areas of mapped hydric soil will require hydrologic modifications beyond reversal of the existing hydrologic alterations in order to replicate the hydrologic conditions that formed the hydric soil.

Figure 4 shows the topography of the bank site. Sugar Camp Creek is incised and its streambanks are steep (slopes > 30%) and relatively high (up to 10 feet). The general landscape at the site consists of low-relief floodplain areas (0 to 2% slopes) that lie along Sugar Camp Creek and extend to the east perimeter of the property, and sloping upland areas (up to 5% slopes) along the west perimeter. The low-relief areas contain shallow closed depressions mostly scattered within the northeast portion, deeper depressions (abandoned stream meanders bisected by ditches) in the southeast and west-central portions, and an intermittent stream located in the east-central portion of the site. Additional depressions in the northeast, northwest, and southwest portions are enclosed partially by levees. The sloping areas west of the creek are dissected by several natural drainage features that flow east toward Sugar Camp Creek.

C. Site hydrology

As shown in historic aerial photographs (Figure 5), the channel of Sugar Camp Creek meandered through the site until the late 1960's when the property was extensively modified: forests were cleared, Sugar Camp Creek was channelized, former meander bends were back-filled, levees were constructed, and ditches were excavated. Further, regional changes in hydrology such as forest clearing, agricultural improvements, and ditch dredging likely led to increased peak-flow discharge and incision of Sugar Camp Creek. At the bank site, the creek bed is now approximately 10 feet below the surrounding floodplain. Although brief floods are common, channelization and incision of the creek has expedited drainage and likely changed the local hydrologic conditions under which the hydric soils formed.

Hydrologic alterations at the bank site include approximately one mile of levees along the creek, 5000 feet of shallow ditches, a culvert with a flapper valve through the levee at the northwest corner of Phase 1, and a culvert through the levee in the east-central portion of Phase 2 (Figure 6). Although the existing levees do not exclude floodwater from all portions of the site, depressions and swales appear to be drained effectively by ditches, as evidenced by successful row-crop agriculture prior to the purchase of the property by the IDOT. The possibility that drainage tile exists at the site was previously reported in the initial site evaluation. However, hand-auger borings revealed buried logs (used as fill material in the former meanders of Sugar Camp Creek) in locations of suspected drainage tiles.

A tile search was conducted in July 2007. The streambanks were inspected by canoe search for drainage tile outlets and traverses were walked along the levee on both sides of Sugar Camp using a magnetic locator to locate steel culverts. No drainage tiles were found during this inspection and the locations of two culverts through the levee were verified. Also, an interview with the current tenant farmer, who has worked this property for several years, confirmed the locations of culverts through the levee and he conveyed that it is unlikely that a drainage tile system exists at the site. Further, no drainage tile system is evident from inspection of historical aerial photography (see Figure 5).

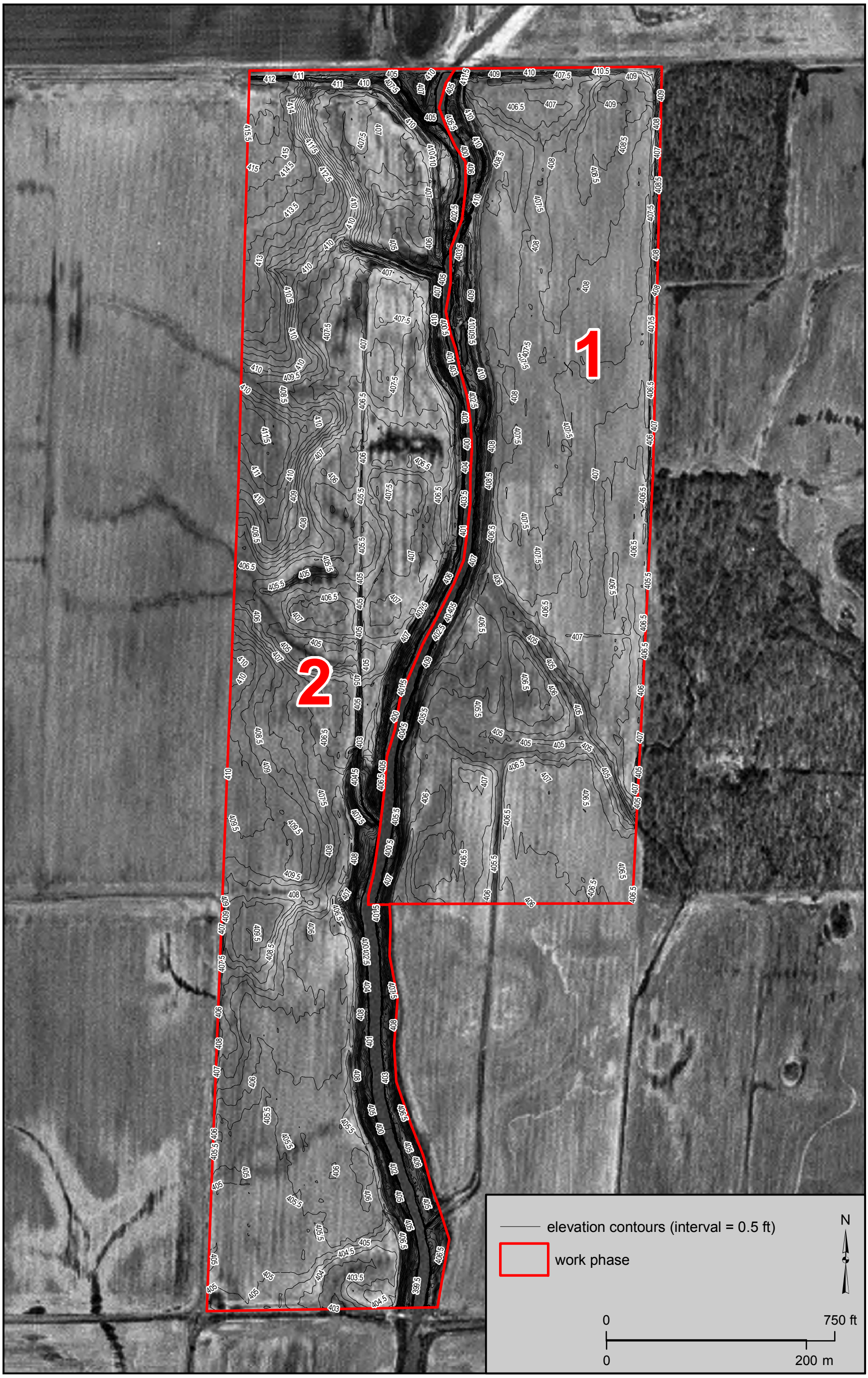


Figure 4. Site topography and work phases. The topographic contours are based on photogrammetry by IDOT. Elevation is referenced to NAVD88.

Photo taken 6 July, 1938. Sugar Camp Creek meandered through the site. Forest covered most of the eastern part of the site and provided a vegetated riparian corridor for the creek. Aerial photographs taken in 1952, 1959, and 1965 (not presented here) show essentially the same land use as in 1938.

Photo taken 21 September, 1971. Alterations include channelization of the creek, construction of ditches in southeast part of the site, and filling of former meanders. Most of the forest was cleared leaving short segments of riparian corridor. Alterations appear to have been made just prior to photography.

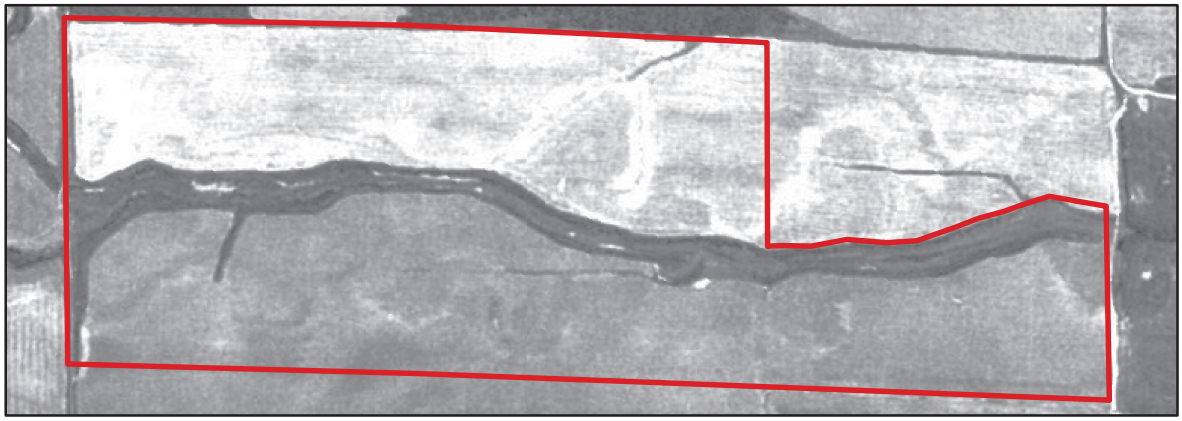


Photo taken 8 October, 1980. Remaining forest, evident on the 1971 photo, was removed, and an additional ditch was created in the west-central part of the site.

N

0 1,000 ft

0 300 m

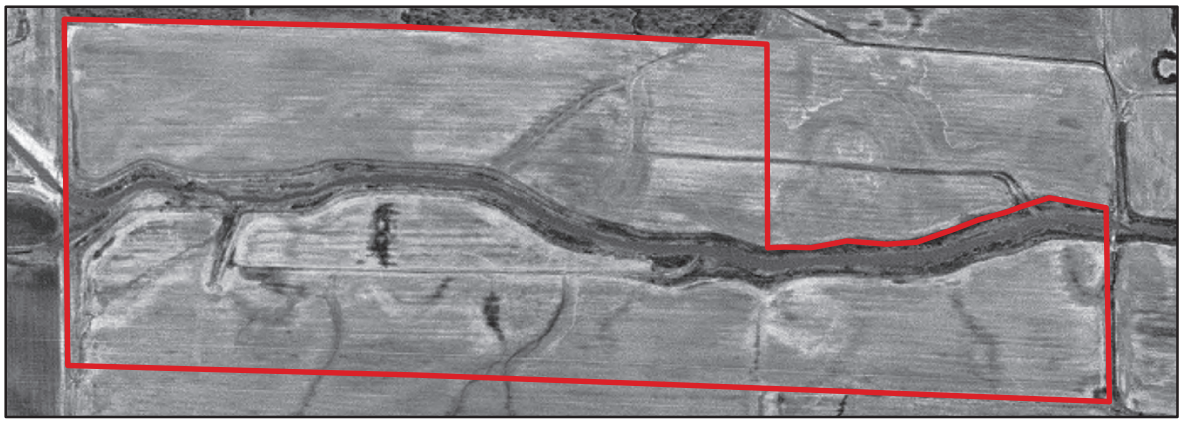


Photo taken 6 April, 1998. Condition of the site prior to acquisition by IDOT. It shows essesentially the same land use in the 1980 photograph, although ditches were extended to drain depressions remaining in filled

Figure 5. History of land-use modifications. Historical aerial photography showing land-use changes and hydrologic alterations at the proposed Sugar Camp Creek wetland and stream mitigation bank.

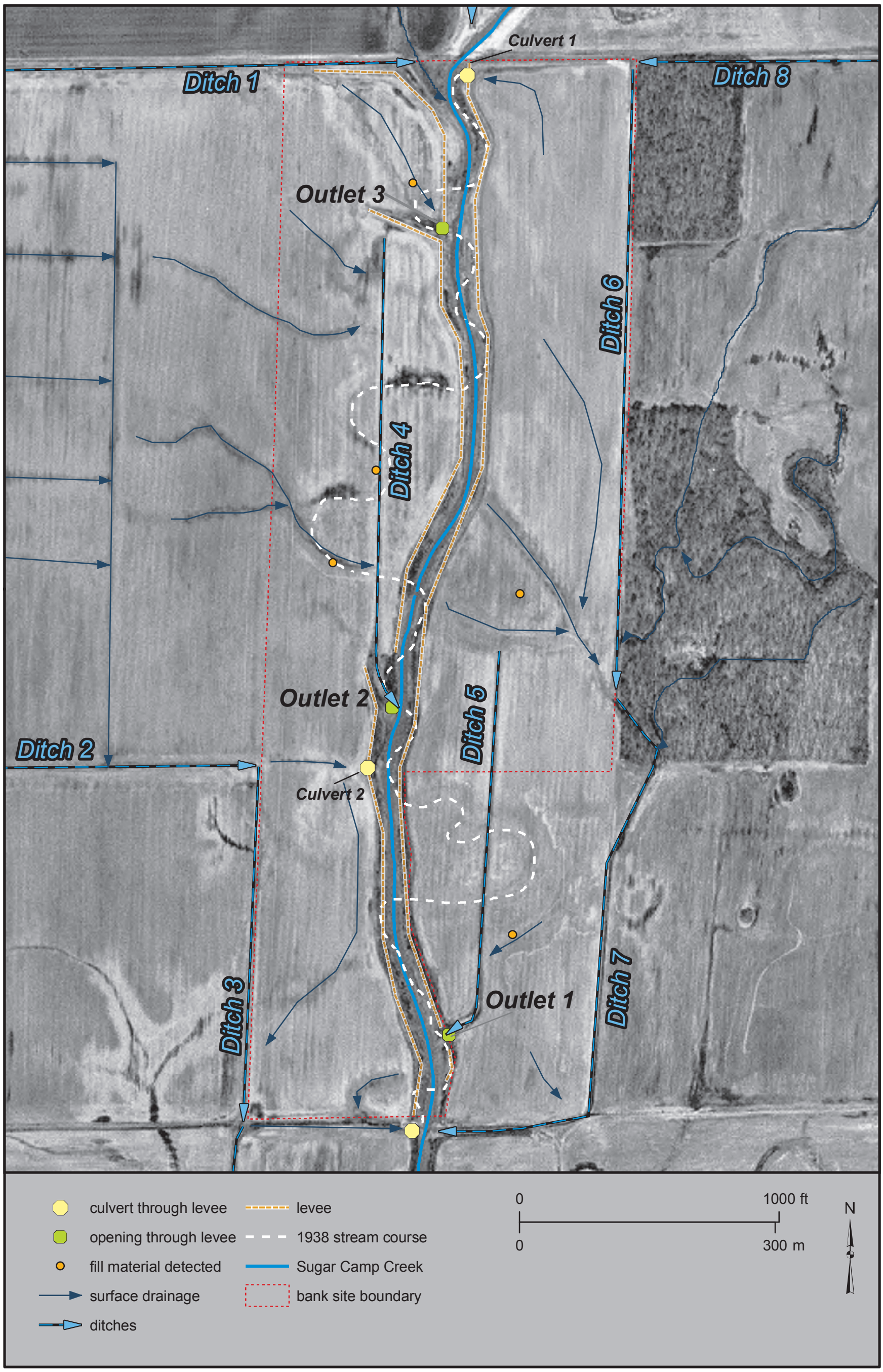


Figure 6. Hydrologic alterations and surface-water features. The 1938 stream course was digitized from 1938 historical aerial photography (U.S. Department of Agriculture 1938). Map based on USGS digital orthophotography, Ewing SE quarter-quadrangle produced from 4/6/1998 aerial photography (Illinois State Geological Survey 2001).

The geologic materials at the site are mostly lacustrine deposits overlain by alluvial silt and clay (Pociask and Shofner 2007). These fine-grained materials generally limit water movement through the unconfined upper unit, and water tends to pond at land surface in localized depressions. Also, the geologic materials promote ponding and relatively slow infiltration over a large portion of the site, particularly after intense rainfall or floods. These observed hydrologic characteristics generally correspond to the reported hydrologic properties of poorly and very poorly drained soils (Wynoose and Bonnie silt loams) that have been mapped over much of the site which are reported to exhibit moderate to very slow permeability and slow to very slow runoff (Preloger 2003; Figure 3).

Monitoring wells and surface-water gauges were installed at the site by the ISGS in the spring of 2005. Preliminary data and on-site observations indicate that there are multiple water sources for the bank site (Pociask et al. 2004, Pociask and Shofner 2007). Closed depressions collect precipitation and runoff leading to brief, localized inundation after storm events. However, surface water is supplied to the site primarily by flooding from Sugar Camp Creek with lesser inputs from perimeter ditches runoff and precipitation during extreme local rain events. Also, the water table rises to within 1 foot of land surface over a significant portion of the site as a result of seasonal precipitation patterns, at least for brief durations. Seasonal ground-water discharge also occurs along the terrace slope west of Sugar Camp Creek leading to localized surface saturation.

D. Existing wetland and upland habitats

Nearly the entire 105.2-acre site was cultivated for corn or soybeans in the 2004 growing season. Besides cropland, other habitats include approximately six acres of stream channel and 10 acres of levees, primarily vegetated with reed canary grass (*Phalaris arundinacea*).

Certified wetland determinations were conducted by the Natural Resources Conservation Service (NRCS) on agricultural land within the bank site. The NRCS determined that 92 acres are prior converted cropland (PC) (Appendix A). Only the stream channel was delineated W (wetland).

Routine on-site wetland determinations were conducted by the INHS on all lands within the bank site. Wetlands were delineated according to the Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987). Two routine on-site wetland determinations were performed and at one site, a total of one acre was determined to be a wetland (Appendix B).

E. Cultural resources

An archeological survey of the bank site resulted in the location of one site. This historic period surface scatter was found to contain 20th century materials and is not eligible for the National Register (see Appendix C). On January 10, 2006, the IDOT received the concurrence of the State Historic Preservation Officer in their determination that no cultural properties which are subject to protection under Section 106 of the National Historic Preservation Act of 1966, as amended, will be impacted by the establishment of the wetland mitigation bank site.

III. Site development plan

The IDOT proposes to develop the mitigation bank according to the site development plan outlined in the following section (see Figures 7 and 8). Bank performance standards, reporting and monitoring protocols, and contingency or remedial action measures are discussed in Section IV (D).

Figure 7. Site development plan - proposed habitat classes. The extent of habitat areas and associated acreage estimates (see Table 1.), particularly those for wetland and non-wetland forest, are subject to revision based on pending determinations of hydrology. Stream channel, roads, and levees, are encompassed within the area of the bank site that is not color-coded.

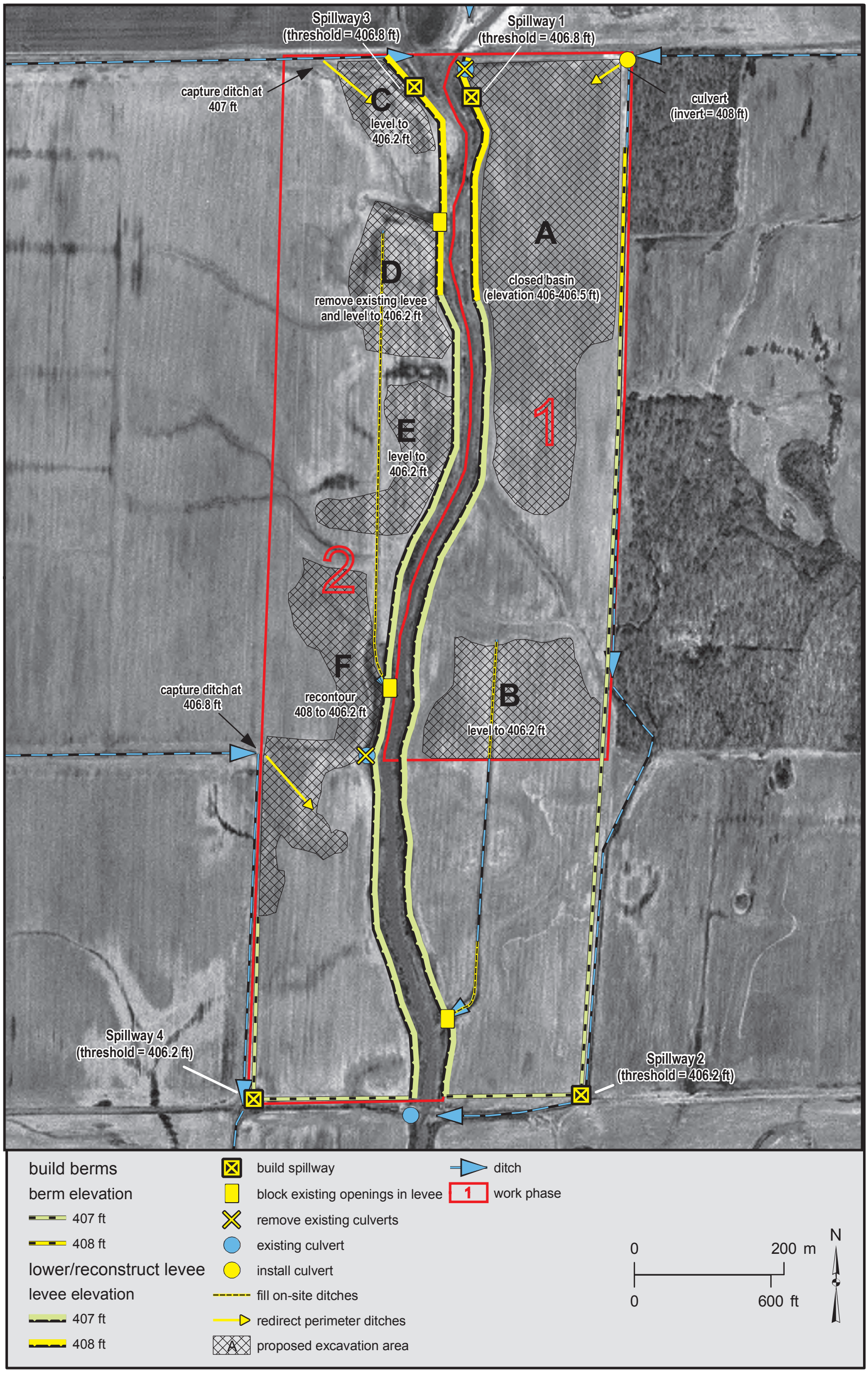


Figure 8. Site development plan - hydrologic restoration activities. Planned hydrologic modifications to restore wetland hydrology at the proposed Sugar Camp Creek wetland mitigation bank. Map based on USGS digital orthophotography, Ewing SE quarter-quadrangle produced from 4/6/1998 aerial photography (Illinois State Geological Survey 2001).

A. Bank size and classes of wetland and aquatic resources

The proposed bank site is approximately 105.2 acres and currently includes the various wetland and non-wetland communities outlined in Table 1 and Figure 7. After the mitigation bank is complete, the IDOT anticipates that approximately 103.2 acres of habitat will be restored, created, or enhanced including 58.2 acres of combined forested and scrub-shrub wetlands, 11 acres of emergent wetlands, and 34 acres of non-wetland areas consisting of lower perennial stream, riparian forest, and upland forest. Proposed credit values listed in Table 1 account for the conversion of cropland or existing degraded habitats into the proposed habitats. As such, although the total site area is approximately 105.2 acres, there will be an estimated 70.25 acres of credits generated and approximately 69.2 physical acres of wetlands in existence upon completion of the mitigation bank development plan.

Table 1. Existing and proposed classes of wetlands.

Class	Existing habitat	Proposed habitat[1]	Proposed hydrologic zone[2]	Credit ratio	Area (acres)[1]	Credits (acres)
Wetland enhancement	wet meadow	emergent wetland	IV	1:0.25	1	0.25
Wetland restoration[3]	agricultural land	emergent wetland	IV	1:1	7.5	7.5
	agricultural land	forested/scrub-shrub wetland	V	1:1	17.5	17.5
Wetland creation	agricultural land	emergent wetland	IV	1:1	2.5	2.5
	agricultural land	forested/scrub-shrub wetland	V	1:1	40.7	40.7
Non-wetland restoration	lower perennial stream	lower perennial stream[4]	II	0:0	6	0
	agricultural land	upland forest non-wetland	VI	1:0.1	18	1.8
	degraded riparian buffer (levees)	riparian buffer forest[4,5]	VI	0:0	10	0
Other	agricultural land	berms/roads	VI	0:0	2	0
TOTAL					105.2	70.25

[1]Due to variations in hydrology within the levee perimeter, these proposed habitats and acreage estimates, particularly those for forested wetland and upland forest restoration, may be subject to revision.

[2]Representative zone as listed in Table 5 of the 1987 Wetland Delineation Manual (Environmental Laboratory 1987).

[3]Restoration areas are those that have hydric soil, have been designated by the NRCS as 'PC', and will not be excavated during initial site development.

[4]No wetland mitigation bank credits will be requested for riparian buffer forest. Instead the IDOT will request stream mitigation bank credits for riparian buffer restoration described under 'Stream mitigation bank credits' below.

[5]Stream credits may be adjusted pending approval of the State of Illinois Stream Assessment Method.

The IDOT will restore, create, and enhance wetlands at the bank site by 1) reversing or modifying

existing hydrologic alterations and excavating to promote wetland hydrology, 2) controlling invasive vegetation, 3) planting native hydrophytic trees in planned forested and scrub-shrub wetlands, and 4) allowing natural regeneration of native hydrophytic plants. Site modifications will include the following: fill all on-site ditches and block their outlets to Sugar Camp Creek, lower the existing levees along Sugar Camp Creek, build low berms at the perimeter of the bank site, remove culverts within the site, excavate portions of the site, and install four fixed-threshold spillways. The goal of implementing these modifications is to promote wetland hydrology over most of the site.

Wetland enhancement

Approximately 1 acre of the bank site was determined to be wetland (Plocher and Weisbrook 2004, Appendix B). Because it is degraded and has a predominance of weedy species, this area will be seeded to native grasses (Table 4). The weedy species that dominate this area are annuals that should diminish as volunteer (Table 2) and planted species become established. The proposed habitat for this area is emergent wetland. A credit ratio of 1:0.25 will result in 0.25 acres of wetland credit generated for the existing wetland area.

Table 2. Common (non-weedy) native herbaceous hydrophytes that are at or adjacent to the bank site (Plocher and Weisbrook 2004) and that are likely to colonize planned wetlands.

Forest	
Agrimonia parviflora	swamp agrimony
Aster simplex	panicled aster
Boehmeria cylindrica	false nettle
Carex grayi	Gray's sedge
Carex normalis	sedge
Chasmanthium latifolium	river oats
Cinna arundinacea	Wood reed
Elymus virginicus	Virginia wild rye
Geum canadense	white avens
Emergent	
Asclepias incarnata	swamp milkweed
Carex spp.	sedges
Cephalanthus occidentalis	buttonbush
Cyperus pseudovegatus	flat sedge
Hibiscus lasiocarpus	rose mallow
Panicum rigidulum	Munro grass
Paspalum floridanum	giant beadgrass
Paspalum leave	smooth beadgrass
Rumex verticillatus	swamp dock
Scirpus atrovirens	dark green bulrush

Wetland restoration

Approximately 92 acres of the 105.2-acre proposed bank site were designated by the NRCS as prior-converted wetlands, and hydric soils as mapped by the Soil Survey (Preloger 2003) cover

90 acres. However, verification of soil boundaries by the INHS (Wiesbrook 2007) showed only 53.7 acres of hydric soils are present at the site. The IDOT proposes to restore wetlands on only 25 acres of the hydric soil area because complete restoration of the geomorphic and hydrologic conditions that supported wetlands and formed the hydric soils prior to agricultural use is not possible due to regional changes in hydrology and incision of Sugar Camp Creek relative to the surrounding floodplain. Thus, the area available for wetland restoration is substantially smaller than the area of mapped hydric soil.

When work is complete the bank site will contain restored areas consisting of a combination of emergent (7.5 acres), scrub-shrub, and forested wetlands (17.5 acres combined). Planned emergent wetlands will be seeded to native species of grasses (Table 4). Planned scrub-shrub and forested wetlands will be seeded to native species of grasses (Table 4) and planted to native species of shrubs and trees (Table 5). The groundcover species composition of emergent, scrub-shrub and forested wetlands will be augmented through natural colonization (Table 2).

Wetland creation

Wetlands will be created on 43.2 acres of the site. Wetland creation activities will entail excavating a large, shallow basin in the northeast portion of the site, removal of a segment of the levee that currently divides the floodplain in the northwest portion of the site, and grading several areas throughout the site to an elevation at or slightly below the level of spillway thresholds.

When work is complete the bank site will contain created areas consisting of a combination of emergent (2.5 acres), scrub-shrub, and forested wetlands (40.7 acres combined). Planned emergent wetlands will be seeded to native species of grasses (Table 4). Planned scrub-shrub and forested wetlands will be seeded to native species of grasses (Table 4) and planted to native species of shrubs and trees (Table 5). The groundcover species composition of emergent, scrub-shrub and forested wetlands will be augmented through natural colonization (Table 2).

Non-wetland restoration

Approximately 18 acres of non-wetlands will be seeded to native species of forbs and grasses (Table 6) and planted to native species of shrubs and trees (Table 7). For this effort, 1.8 acres of wetland credits will be generated. Non-wetland areas often provide important habitat and hydrologic functions complementary to those provided by wetlands. Many biological processes require both wetland and non-wetland areas. For example, the life history of most amphibians includes both aquatic and terrestrial stages. Of the 41 amphibian species that occur in Illinois, 37 use non-wetlands at least part of the time (Illinois Department of Natural Resources 1994).

Other

Approximately two acres of the bank site will be used for the creation of low berms. These berms will function to control site hydrology and may also be used as field access roads.

Stream mitigation bank credits

The IDOT will request 22,680 stream mitigation bank credits based on riparian habitat restoration along the streambanks of Sugar Camp Creek. The existing condition of Sugar Camp Creek is considered functionally impaired according to U.S. Army Corps of Engineers guidance for compensatory stream mitigation (U.S. Army Corps of Engineers 2007); the reach has been channelized and both banks have little or no deep-rooted vegetation. The current riparian area

ranges from 20 to 70 feet wide with low-quality habitat consisting of levees that are primarily vegetated with reed canary grass (*Phalaris arundinacea*) and small discontinuous stands of primarily silver maple (*Acer saccharinum*) along the streambanks. On both sides of Sugar Camp Creek, the IDOT proposes to improve habitat along the near-bank riparian zone by flattening and widening the existing levees and planting native trees on and along the naturalized levee. The proposed changes to the levee profile are depicted in Figure 9. The width of the naturalized levee and tree plantings will be at least 50 feet measured from the top of the creek bank. These improvements will allow lower floods onto the floodplain and replace undesirable species along the stream banks with native trees which will benefit habitat in both the planned wetlands and the stream. No in-stream work to restore the channel planform is proposed; however, tree plantings in the near-bank area will provide added stability for stream banks and shade the channel as trees mature and canopies close. Like the wetland restoration and creation areas, the near bank buffer areas will be seeded to native species of grasses (Table 4) and planted to native species of shrubs and trees (Table 5). The stream mitigation bank credits requested were calculated using the worksheet provided in Appendix D.

B. Work phases

The bank will be developed in two separate work phases (Figure 4, Table 3). Phase 1 will be implemented within the 44.2 acres east of Sugar Camp Creek and Phase 2 will take place within the 61 acres west of the creek. Also, some of the work required for development of Phase 1 will occur outside of the bank site within an adjacent wetland compensation site also owned by the IDOT. During the development of each work phase, hydrology and vegetation will be monitored by the ISGS and INHS. Results from monitoring will be reviewed on an annual basis by the IDOT. If modification of the initial site development plan is required, the IDOT will implement appropriate action in consultation with the Interagency Review Team (IRT).

As of May 2006, the IDOT initiated wetland restoration activities in the southern portion of Phase 1 (24.1 acres) because a large number of trees that required immediate planting were received at no cost from the Illinois Department of Natural Resources. Therefore, the IDOT commenced with blocking drainage at the east perimeter of the site to provide hydrologic conditions appropriate for wetland restoration and planted the trees that were provided. The IDOT plans further work in this portion of Phase 1 as part of the bank development. For subsequent wetland bank development activities, the general approach will be to first reverse or modify hydrologic alterations to provide conditions suitable for hydrophytic species and then plant native, non-weedy wetland tree and plant species as well as allow native plant community to naturally regenerate in selected areas. The remainder of Phase 1 and all of Phase 2 are currently leased for row-crop agriculture. Farming will continue in these areas until their scheduled mitigation bank implementation start dates. The IDOT plans to implement the site development plan according to the schedule as outlined Table 3 and Figure 10 of this document.

C. As-built report

IDOT will submit to the IRT Chair an as-built report within 90 days following the completion of construction for each phase of the mitigation bank. The as-built report for the original construction will describe in detail any deviation from the mitigation plan and include drawings showing finished grades and completed planting scheme. Any approved modification to the mitigation bank following construction will likewise be submitted within 90 days following completion.

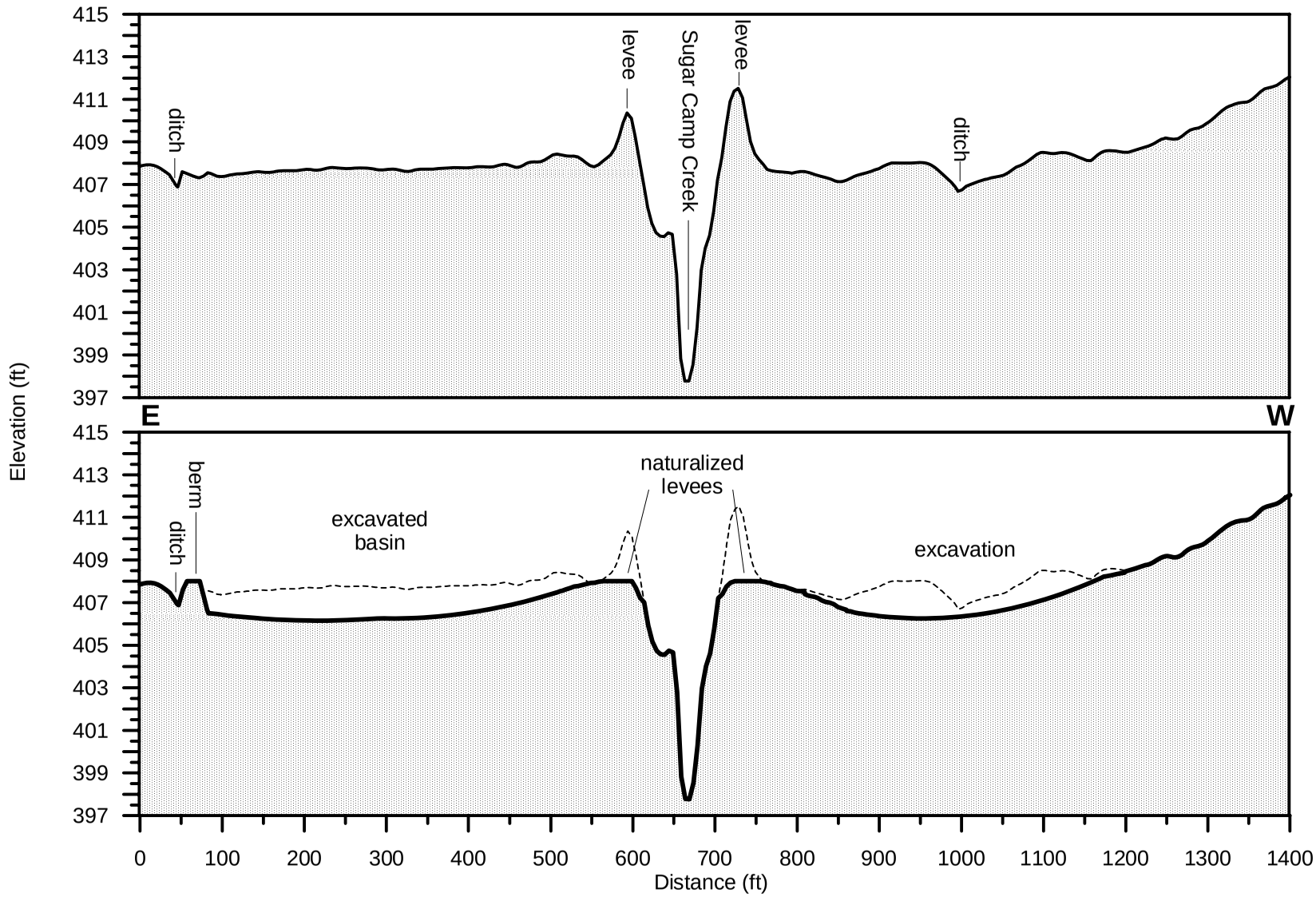
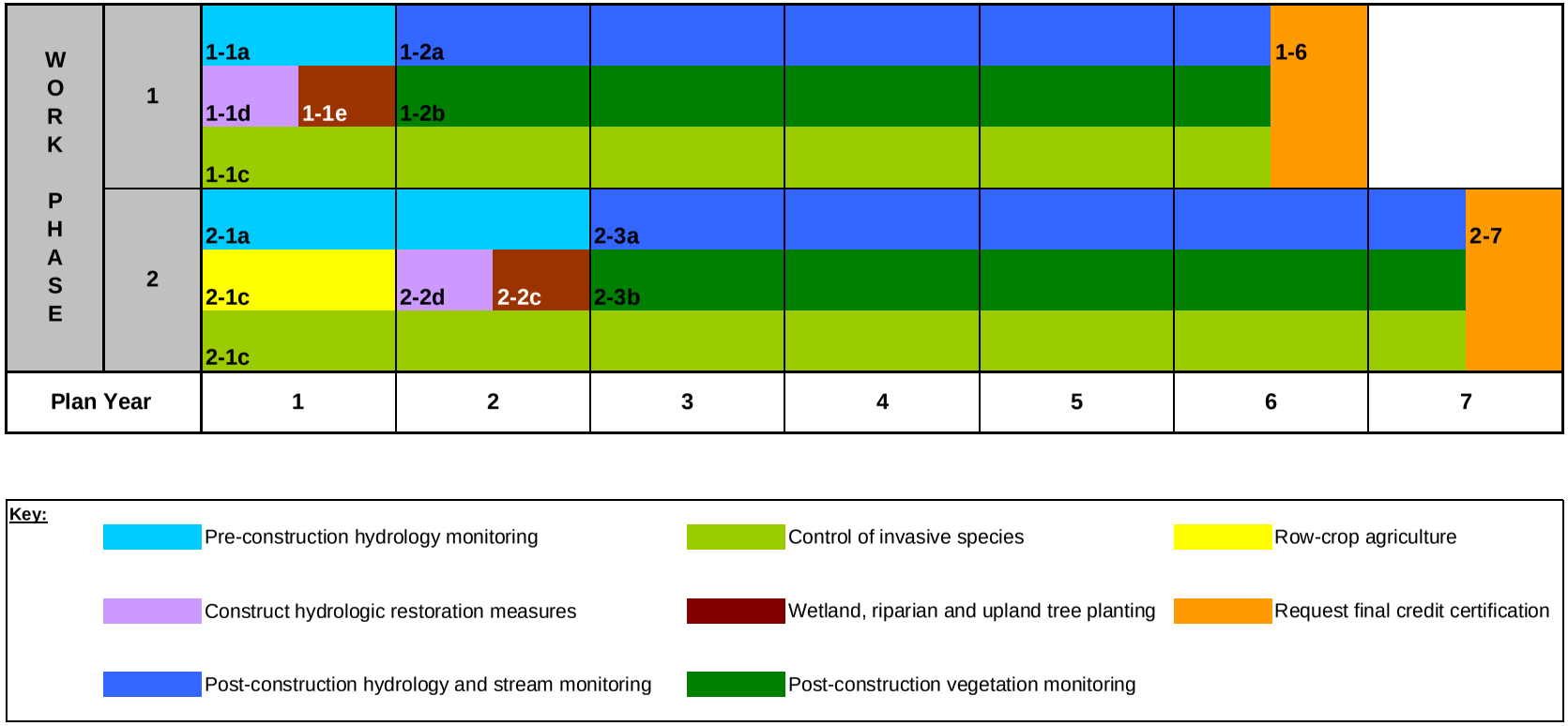


Figure 9. Site development plan - floodplain profile. Existing (top) and proposed (bottom) cross section of the floodplain at the Sugar Camp Creek proposed wetland mitigation bank. In the bottom cross section, existing land surface is represented by the dashed line and the planned land surface after excavation on the floodplain and reconfiguration of the levees is represented by the solid black line..



Key:

- Pre-construction hydrology monitoring
- Construct hydrologic restoration measures
- Post-construction hydrology and stream monitoring
- Control of invasive species
- Wetland, riparian and upland tree planting
- Post-construction vegetation monitoring
- Row-crop agriculture
- Request final credit certification

Figure 10. Proposed implementation schedule for the Sugar Camp Creek wetland bank. The work items corresponding to the index numbers shown in this figure are listed in Table 3.

D. Specifications

The following sections describe each work item listed in Table 3 and general guidelines that will be used to implement the mitigation plan.

Table 3. Proposed work phases, work items and time frames for establishment of the Sugar Camp Creek wetland mitigation bank site.

Phase (acres)	Work Items	Time frame
1 (44.2)	1-1a. Pre-construction hydrology monitoring	underway-year 1
	1-1b. Drainage tile/culvert search	completed
	1-1c. Control weedy and invasive vegetation	underway-year 6
	1-1d. Excavate wetland creation areas and levees	year 1
	1-1d. Block and fill ditches	year 1
	1-1d. Culvert removal	year 1
	1-1d. Levee reconstruction	year 1
	1-1d. Berm/road construction	year 1
	1-1d. Spillway installation	year 1
	1-1d. Ditch capture and re-routing	year 1
	1-1e. Seeding, tree and shrub planting	year 1
	1-2a. Post-construction hydrology monitoring	years 2-6
	1-2b. Post-construction vegetation monitoring	years 2-6
	1-6. Request final credit certification	year 6
2 (61)	2-1a. Pre-construction hydrology monitoring	underway-year 2
	2-1b. Drainage tile/culvert search	completed
	2-1c. Control weedy and invasive vegetation	underway-year 7
	2-2d. Excavate wetland creation areas	year 2
	2-2d. Block and fill ditches	year 2
	2-2d. Culvert removal	year 2
	2-2d. Levee reconstruction	year 2
	2-2d. Berm/road construction	year 2
	2-2d. Spillway installation	year 2
	2-2d. Ditch capture and re-routing	year 2
	2-2e. Seeding, tree and shrub planting	year 2
	2-3a. Post-construction hydrology monitoring	years 3-7
	2-3b. Post-construction vegetation monitoring	years 3-7
	2-7. Request final credit certification	year 7

Pre-construction hydrology monitoring

Hydrologic monitoring at the bank site was initiated in March 2005 and is on-going. The monitoring network was installed by the ISGS using standard methods described in Appendix E, Exhibit A and

includes a combination of shallow monitoring wells, stage gauges, electronic water-level data loggers, and a tipping-bucket rain gauge (Figure 11). The data collection schedule consists of biweekly measurements during the spring (early growing season) and monthly measurements during the remainder of the year. The data are used to characterize hydroperiod and to determine if the areal extent of wetland hydrology. Also, these monitoring data have been used to guide the site development plan for the mitigation bank. Monitoring will continue through each development phase.

Drainage tile/culvert search

See previous discussion in Section II. C. Site hydrology.

Control of weedy and invasive vegetation

Prior to development, the bank site will be farmed and weedy growth will be controlled through normal agricultural practices. Areas that are not farmed (e.g., levees and road embankments) may be periodically mowed.

During bank site development (i.e. seeding, tree and shrub planting) weedy and invasive vegetation will be controlled or eliminated as part of the site preparation for planting in accordance with IDOT Standard Specifications (Illinois Department of Transportation 2002).

In planned forested wetlands, vegetation between planted rows of trees and shrubs will be mowed for at least two growing seasons following the *period of establishment*—see Appendix E, Part K. Mowing will reduce competition from vegetation (planted and natural regeneration) and will assist in the growth and survivorship of planted trees and shrubs.

After the second growing season, weeds may be controlled by mowing or by spraying with herbicides. A pre-emergent herbicide, such as Oust or Simazine, or a post-emergent herbicide, such as Rodeo, may be used—see Appendix E, Part C. It is expected that some invasive species will diminish as the trees in reforested areas mature, canopies close, and the herbaceous layer becomes shaded.

Ten to fifteen years after planting, the forested wetlands may benefit from a timber stand improvement, such as a thinning or release cutting. Volunteer species of trees such as silver maple, cottonwood, and black willow may be selectively cut or treated with herbicide to favor higher quality pecan, and pin oak and swamp white oak which, due to slower growth rates, may otherwise be shaded out.

If the IDOT proposes any invasive or weedy vegetation control or timber stand improvement after construction is complete, the IDOT will submit its plans for such activity for approval from the Corps and the IRT.

Excavate wetland creation areas and levees

Earth will be excavated and removed to create wetlands and to lower existing levees where they exceed the target design elevations (see Figure 8). Excavation in these areas will occur before culverts are removed and ditches are blocked to allow drainage of the site during earthwork. Specifications for excavation and earthwork are given in Appendix E.

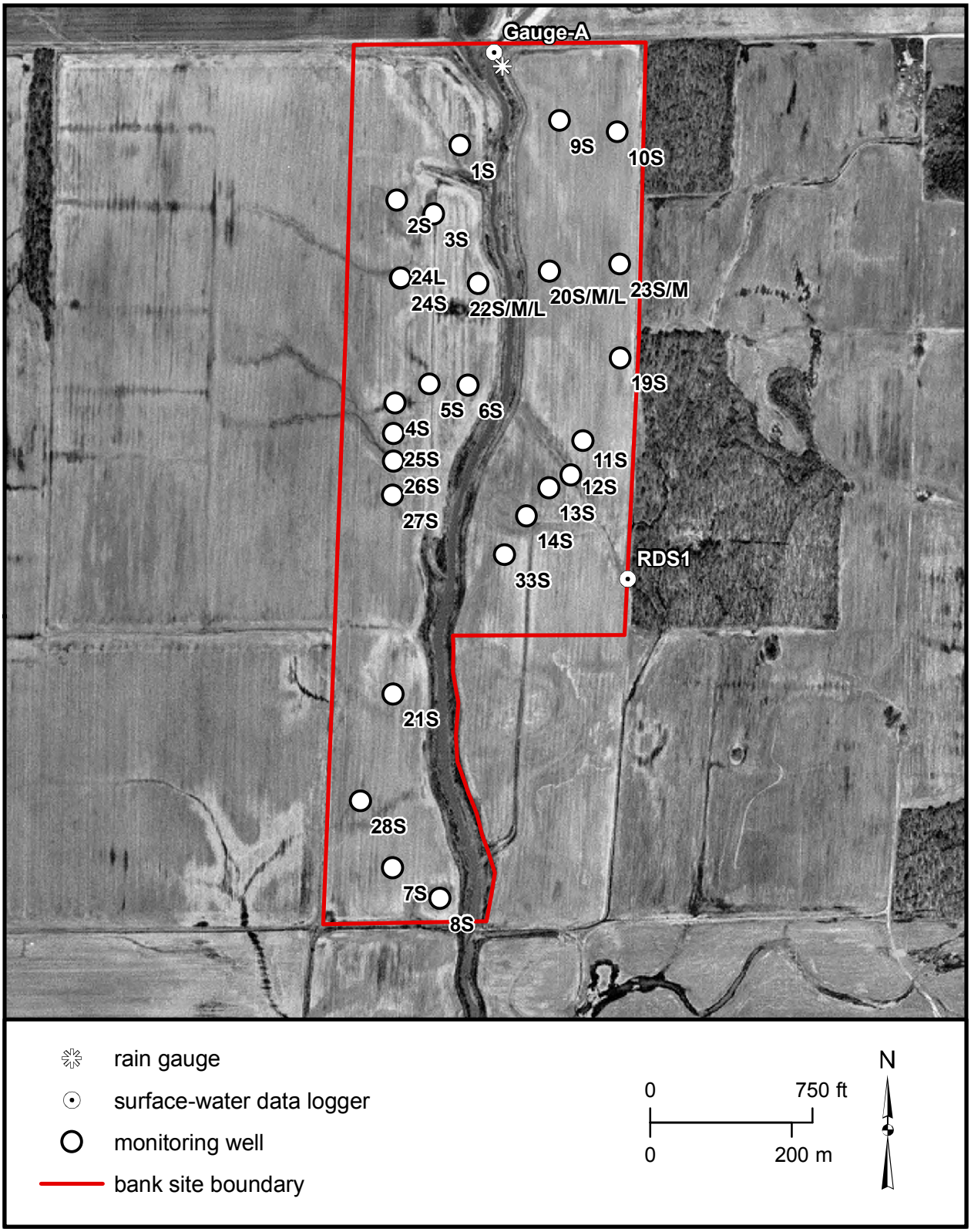


Figure 11. Locations of ISGS hydrologic monitoring equipment at the proposed bank site.

A 17.6-acre basin (area A in Figure 8) will be excavated in the north portion of Phase 1. The target design elevation for the bottom of this basin is 406.2 feet. Although a narrow deviation from the target elevation will be accepted to create topographic variability, the final grade in the basin will not be less than 406.0 feet and will not exceed 406.5 feet. The target elevation for the top rim of the basin along its south perimeter will be 406.8 feet. The basin will grade continuously into the reconstructed levee along the creek at no more than a 3% slope and the inside slope along the berm at the east perimeter will be graded to no more than 15%. The existing slope along the road grade at the north end of the basin will be maintained and carried down to 406.5 feet in the basin.

Area B in the south portion of Phase 1 and areas C, D, and E in Phase 2 will be excavated to a target elevation of 406.2 feet, graded flat, and tied-in continuously with the surrounding landscape without creating abrupt breaks in slope. Excavation in area D will include removal of an existing levee segment that crosses the floodplain.

Area F in the southern half of Phase 2 will be excavated to expand wetland area and increase connectivity on the floodplain. The minimum target elevation for this area is 406.2 feet which will be carried at least 75 feet westward from the base of the proposed reconstructed naturalized levee along Sugar Camp Creek to allow passage of flood water. The slope leading to the adjacent upland area will be re-contoured and graded to tie in continuously with the surrounding landscape.

Portions of existing levees along Sugar Camp Creek are substantially higher than the proposed design elevations and will be lowered and widened to increase flood frequency and duration on the floodplain. Representative cross sections of the existing and proposed levee profile are given in Figure 9. Material will be removed from these levee segments or relocated to widen the levees according to the grading plan. Levee reconstruction is discussed in further detail below.

Block and fill ditches

Ditches 4 and 5 are entirely within the site boundary and currently drain planned wetland restoration and creation areas. Deactivation of these ditches will include installing ditch checks along each ditch, blocking each ditch by patching the levee where ditches empty into Sugar Camp Creek (see *Levee reconstruction* below), and filling each ditch to the surrounding existing grade or excavating to the design grade in wetland creation areas. The ditches will be backfilled to surrounding grade and the fill will be reinforced by compacting material as it is placed. The procedures used for ditch blocking and filling are given in Appendix E.

Culvert removal

Two culverts pass through the levee and currently drain the site (see Figure 6). Culvert 1 is located in the east levee at the north end of the site. This culvert is outfitted with at flapper valve that prevents low to moderate floods from entering the north part of Phase 1 and drains the site after larger floods and storm events. Culvert 2 is located in the west levee just south out Outlet 2 and drains a small depression near the levee. Each of these culverts will be removed after work items involving excavation and ditch deactivation are complete, although culvert removal may be incorporated into these other work items if feasible and practical. The existing material covering each culvert will be excavated prior to culvert removal and reserved to patch the voids in the levee due to removal activities (see the following section describing levee reconstruction).

Levee reconstruction

Segments of the existing levees reduce flood frequency locally, particularly in the northernmost portion of Phase 1 and the southernmost portion of Phase 2. Also, ditch outlets through these levees allow drainage of floodwater back into the creek after floods recede. The IDOT will lower and/or widen levees to a more natural profile (Figure 9) and patch the levees where the ditches currently drain to Sugar Camp Creek (Figure 8). The goals of this activity are to increase flood frequency while preventing drainage of floodwater back into the creek to increase the duration of inundation and saturation in planned wetland areas and to improve riparian habitat near the creek.

The design elevation for the levees ranges from 408 feet along the northernmost segments to 407 feet at the south end of the site. However, in areas where added material is needed to reach the design elevation (e.g., where the levee must be patched at the existing ditch outlets) the levee will be constructed 0.5 feet higher than the local design elevation to allow for settling of material.

Beginning at the north end of the site and extending 1100 feet downstream, the levee top on both sides of the stream will be lowered or built up to 408 feet. As the levee construction continues downstream, the levee top will grade gradually (less than 1%) down to 407 feet. Thus, there will be a continuous levee with a naturalized profile (see Figure 9) running along the length of the creek on both sides. The final elevation along the top of the reconstructed naturalized levee will not be lower than 407 feet at any location. After reconstruction of the naturalized levee is complete, it will be seeded with nurse crop grasses and subsequently planted with trees. Additional details of levee reconstruction are given in Appendix E.

Berm/road construction

Low berms will be constructed along the east perimeter of Phase 1 and along the west and south perimeter in the southernmost portion of Phase 2 (see Figure 8). Phase 1 work will also include constructing segments of the berm along the east and south perimeter of the IDOT property adjacent to the south. The goal of this activity is to prevent all surface drainage to the perimeter ditches below the design threshold elevation of spillways (as described in the next section) and thereby increase the duration of inundation and saturation over most of the site. Like the levees, the design elevation for the berm along the east perimeter of the property will range from 408 feet along the northernmost segment to 407 feet at the south end of the site. However, along its entire length berm will be constructed 0.5 feet higher than the local design elevation to allow for settling of material. Further details of the proposed berm design are given in Part H. of Appendix E.

Spillway installation

A total of four straight-drop type spillways will be constructed at the site to promote appropriate flood frequency and retention for wetland restoration and creation areas.

- Spillway 1 will be constructed in northernmost portion of the levee in Phase 1 and have a threshold elevation of 406.8 feet.

- Spillway 2 will be constructed in the berm near the southeast corner of the adjacent wetland compensation site and will have a threshold elevation of 406.2 feet.

- Spillway 3 will be constructed in the northernmost portion of the levee in Phase 2 and will have a threshold elevation of 406.8 feet.

- Spillway 4 will be constructed in the berm at the southwest corner of Phase 2 and have a threshold elevation of 406.2 feet.

The locations and threshold elevations of the spillways also are shown in Figure 8. Specifications for spillway construction are described in Appendix E, Part I.

Ditch capture and re-routing

Several perimeter ditches currently bypass the bank site and drain to Sugar Camp Creek (see Figure 6). Ditches 1, 2, and 8 will be captured and re-routed to supply additional water to wetland restoration and creation areas (see Figure 8). Ditches 3, 6, and 7 are generally lower in elevation than the planned wetland areas and/or provide drainage for adjacent properties and their current configuration will not be modified.

- Flow in Ditch 1 currently bypasses the site along the north perimeter of Phase 2. Flow from this ditch will be captured and redirected by reconstructing the existing levee to tie-in with the road embankment along the north perimeter of the site. The proposed grade of the re-routed ditch will be constructed so the flow is captured at the 407-foot contour of the existing ditch bed and re-directed into the planned wetland creation area so that the current rate of drainage of the ditch upstream of this elevation is not interrupted.

- Flow in Ditch 2 currently approaches the central portion of Phase 2 from the west, is captured by Ditch 3, and routed south along the west perimeter of the south portion of Phase 2. Flow will be captured by excavating a broad shallow swale between the 406.8-foot elevation contour in the bed of the existing ditch and the final grade of the planned wetland creation area and by blocking a small segment of the uppermost portion of Ditch 3.

- Flow in Ditch 8 currently approaches the northeast corner of Phase 1 from the east, is captured by Ditch 6, and routed south along the east perimeter of Phase 1. Flow from Ditch 8 will be captured where Ditch 8 meets Ditch 6 by installing an 18-inch culvert that passes through the berm at the northeast corner of Phase 1 and by blocking flow from Ditch 8 to Ditch 6 and re-routed by excavating a broad shallow swale between the 408-foot elevation contour on the inside of the berm (on the site) and the final grade of the planned wetland creation area.

Seeding, tree and shrub planting

In planned wetlands and riparian buffer areas along Sugar Camp Creek, the ground cover will be seeded according to the species and quantities specified in Table 4. All work, materials and equipment shall conform to Sections 250 and 1081 of the IDOT Standard Specifications. Trees and shrubs will be planted using either bare-root seedlings or 3-gallon containerized saplings. Species for planting will be selected from Table 5. Approximately equal numbers of each species will be planted. At least five different species of trees will be planted and at least two of those will be hard-mast producing (i.e. species of oak or hickory). If bare-root seedlings are specified, they will be planted on 10 X 10 foot centers (436 seedlings/acre); if containerized saplings are specified they will be planted on 20 X 20 foot centers (109 saplings/acre). Both containerized saplings and bare-root seedlings shall be planted in the fall—from October 15 through December 15.

In non-wetlands, the ground cover will be seeded according to the species and quantities specified in Table 6. All work, materials and equipment shall conform to Sections 250 and 1081 of the IDOT

Standard Specifications. Trees and shrubs will be planted in the non-wetland upland buffer areas using either bare-root seedlings or 3-gallon containerized tree and shrub saplings. Species for planting in non-wetland upland buffer areas will be selected from Table 7. At least five different species of trees and one species of shrub and approximately equal numbers of each will be planted. Bare-root seedlings will be planted on 10 X 10 foot centers (436 seedlings/acre). Containerized saplings will be planted on 30 X 30 foot centers (50 saplings/acre). Trees and shrubs will be planted in the fall—from October 15 through December 15.

Vegetation between planted rows of trees and shrubs will be mowed for at least two growing seasons following the *period of establishment*—see Appendix E, Part K. Mowing will reduce competition from vegetation (planted and natural regeneration) and will assist in the growth and survivorship of planted trees and shrubs.

Table 4. Native species of grasses for seeding in planned wetlands.

Common name	Scientific name	Wetland indicator status	Pounds/acre Pure live seed
Redtop	*Agrostis alba*	FACW	3
Stout wood reed	*Cinna arundinacea*	FACW	0.5
Virginia wild rye	*Elymus virginicus*	FACW-	2
Timothy[1]	*Phleum pretense*	UPL	3
Annual rye grass[1]	*Secale cereale*	UPL	50

[1]nurse species

Table 5. Native species of trees and shrubs for planting in planned wetlands and riparian buffer.

Common name	Scientific name	Wetland indicator status
Red maple	*Acer rubrum*	FAC
River birch	*Betula nigra*	FACW
Bitter-nut hickory	*Carya cordiformis*	FAC
Pecan	*Carya illinoensis*	FACW
Buttonbush*	*Cephalanthus occidentalis*	OBL
Persimmon	*Diospyros virginiana*	FAC
Black walnut	*Juglans nigra*	FACU
Sweet gum	*Liquidambar styraciflua*	FACW
Sycamore	*Platanus occidentalis*	FACW
Swamp white oak	*Quercus bicolor*	FACW+
Overcup oak	*Quercus lyrata*	OBL
Pin oak	*Quercus palustris*	FACW
Willow oak	*Quercus phellos*	FACW
Shumard oak	*Quercus shumardii*	FACW-

* Shrub plantings will occur along the fringes of proposed emergent wetland areas.

Table 6. Native species of forbs and grasses for seeding in non-wetlands.

Common name	Scientific name	Pounds/acre Pure live seed
Black-eyed Susan	*Rudbeckia hirta*	3
Coneflower	*Ratibida pinnata*	3
Little bluestem	*Schizachyrium scoparium*	5
Canada wild rye	*Elymus canadensis*	2
Annual rye grass[1]	*Lolium multiflorum*	50
Oats[1]	*Avena sativa*	64

[1]nurse species

Table 7. Native species of shrubs and trees for planting in non-wetlands.

Common name	Scientific name
Shagbark hickory	*Carya ovata*
Hackberry	*Celtis occidentalis*
Hazelnut	*Corylus americana*
Black walnut	*Juglans nigra*
Sycamore	*Platanus occidentalis*
Black cherry	*Prunus serrotina*
American plum	*Prunus americana*
White oak	*Quercus alba*
Bur oak	*Quercus macrocarpa*

IV. Accounting, performance standards, and monitoring methods

A. Accounting procedures

The IDOT will not use a wetland functional assessment methodology to determine credits or debits, but will use acreage as a surrogate for measuring function. All planned wetlands (i.e., restorations or enhancements) will qualify for certification only after attainment of the approved performance standards (see Section IV [B]). The IRT Chair will be responsible for certifying wetland credits.

Different wetland compensation ratios are used for Federal and State purposes. Since the State ratios will generally require compensation amounts equal to or greater than the Federal ratios, the State ratios will be applied for purposes of determining the amount of credits needed to provide the required compensation on highway projects allowed to use the bank. Applicable State ratios will be determined in accordance with 17 Illinois Administrative Code 1090.20 (Implementing Procedures for the Illinois Interagency Wetland Policy Act of 1989). Credits used to mitigate an activity regulated under the Illinois Interagency Wetland Policy Act of 1989 can also be used to mitigate the same activity regulated under Section 404 of the Clean Water Act. Credits may not be used to mitigate more than one activity.

When debiting the bank, the IDOT will notify the Corps of Engineers during the Section 404 permit application process and the IDNR in accordance with the IDOT Wetlands Action Plan. Notification will include a copy of the bank ledger and a line item indicating the proposed debit. The bank ledger will be used to track all transactions at the bank site, showing credits, debits and available balances. Credits, debits and balances will be broken down by habitat and wetland type; i.e.,

stream and wetland, and emergent, scrub-shrub and forested. The BDE will hold and maintain the bank ledger, recording all transactions.

B. Performance standards for credit availability and bank success

Two primary performance standards will be used to judge success of the planned wetlands and provide the basis for credit availability at the bank site.

1) Each planned wetland should meet jurisdictional wetland criteria as outlined in the Midwest Regional Supplement to the 1987 U.S. Army Corps of Engineers Wetland Delineation Manual (U.S. Army Corps of Engineers 2008, Environmental Laboratory 1987) in year 2 and in year 5 of post-construction monitoring.
   a) Predominance of hydrophytic vegetation. More than 50% of the dominant plant species must be hydrophytic at each sampling location.
   b) Presence of hydric soils. Hydric soil characteristics should be present, or conditions favorable for hydric soil formation should persist. Favorable conditions include inundation or saturation to within 12 inches of the surface.
   c) Presence of wetland hydrology. The planned wetlands must be inundated at average depths less than 6.6 feet or have soils that are saturated to the surface for at least 14 consecutive days of the growing season in at least 5 of 10 years on average.

2) All planned resource areas (i.e. wetlands, upland buffers, and riparian buffers) should meet standards for planted species survival and floristic composition as outlined in Table 8.

Table 8. Performance standards for wetland, riparian, and upland resource areas.

Parameter	**2-year performance standards**		**5-year performance standards**	
	Wetlands and riparian buffer	**Uplands**	**Wetlands and riparian buffer**	**Uplands**
Tree stocking	At least 217 live bare-root seedlings/acre or 54 saplings/acre should be established and living.	At least 217 live bare-root seedlings/acre or 25 saplings/acre should be established and living.	At least 217 live bare-root seedlings/acre or 54 saplings/acre should be established and living.	At least 217 live bare-root seedlings/acre or 25 saplings/acre should be established and living.
Native species composition	At least 50% of the plants present should be non-weedy, native, perennial and annual species.		At least 90% of the plants present should be non-weedy, native, perennial and annual species.	
Percent Cover	At least 30% of the plants present should be native, non-weedy species.		At least 60% of the plants present should be native, non-weedy species.	
Dominant herbaceous species	It is expected that weedy species will remain dominant after 2-years; however, data from first 2-years of monitoring shall show a trajectory toward reduction in the percentage of non-native or weedy species.		None of the three most dominant plant species in any stratum may be non-native or weedy species, such as cattails (*Typha latifolia*), sandbar willow (*Salix interior*), reed canary grass (*Phlaris arundinacea*), giant ragweed (*Ambrosia trifida*), or giant reed (*Phragmites australis*).	
Floristic Quality	FQI>10		FQI>20*	

*FQI in forested areas is expected to decrease after canopy closure and recover thereafter as shade-tolerant species colonize the herbaceous and shrub layers.

C. Reporting protocols and monitoring plan

Planned wetlands will be monitored for attainment of each of the above stated performance standards annually for five years. Monitoring will occur late in the growing season—at this time of the year the greatest diversity of plants can be observed. The start of yearly monitoring will depend on the date of completion of a work phase—see Figures 4 and 8. Work phases completed before June 1st will be monitored that year; those completed after June 1st, the following year.

Annual monitoring reports will be submitted to the IRT Chair by February 14th of the following year. Shortly after, the IRT Chair will notify the bank sponsor of needed remediation—see section IV. D. The bank sponsor and IRT may opt to expedite the reporting and remediation process with annual meetings at the end of each growing season in order to present the preliminary results of monitoring and to discuss plans for remediation to be implemented the following growing season.

The goal for attainment of performance standards and certification of credit areas is five years from the date of completion of restoration activities. Monitoring may be extended where it appears remedial measures may lead to attainment of the performance standards or shortened where attainment is reached in less than five years. Monitoring may be discontinued where it appears attainment of performance standards may never be realized and where remedial measures may be ineffective. A brief description of the methods to be used for monitoring each of the three parameters is given in the following paragraphs in this section.

Hydrology will be monitored by the ISGS. A combination of shallow monitoring wells, surface-water staff gauges, and surface- and ground-water data loggers will be employed to monitor depth and duration of inundation and saturation (Figure 11). Monitoring wells are constructed and installed according to Miner and Simon (1997) (see Appendix E, Exhibit A). Water levels will be measured at frequencies and during time periods appropriate for determining whether wetland hydrology criteria as defined in the Midwest Regional Supplement to the 1987 U.S. Army Corps of Engineers Wetland Delineation Manual has been satisfied (U.S. Army Corps of Engineers 2008).

Vegetation will be monitored by the INHS. Using visual estimation, the dominant species of vegetation in each stratum will be determined. Dominance is based on Importance Value, a numerical average of a species' relative frequency, density and aerial coverage (or basal area) (Cox 1985). In each stratum, dominant species include, starting with the most abundant, those species whose Importance Values, when summed in descending order, immediately exceed 50%, as well as any additional species whose Importance Values are 20% or greater (Federal Interagency Committee for Wetland Delineation 1989). Dominant species are assigned wetland indicator status ratings (Reed 1988). Any plant rated facultative minus or wetter (FAC-, FAC, FAC+, FACW-, FACW, FACW+ or OBL) is considered hydrophytic. Hydrophytic vegetation is determined to be present if greater than 50% of the dominant species are hydrophytic (Environmental Laboratory 1987).

Survivorship of planted trees will be determined through quantitative sampling. On consecutive planted rows, the first 100 ft in each 1000 ft section of row is sampled (10.6 ft X 100 ft (0.024 acre) plot). This procedure results in a 10% sample (n = 40). Within each sampled section (plot) live trees are tallied by species. A minimum of 217 live bare-root seedlings or 54 3-gallon containerized tree saplings per acre must be present after five years. Importance Values of planted species are calculated as an average of relative frequency and relative density. The tree planting area is mapped using Trimble GPS (global positioning system) and overlaid on digital ortho quad imagery using ArcView 3.2.

Dominant herbaceous species within the wetland compensation site will be determined annually by visual estimation in an attempt to ensure that none of the three most dominant species are nonnative or weedy*, and that at least 90% of the plant species present are native and non-weedy* through the fifth year of monitoring. A species list will be prepared annually and a Floristic Quality Index computed for the site (Taft et al. 1997). In order to determine whether at least 90% of the plant species present are native and non-weedy*, each plant community is carefully searched late in the growing season and a complete list of the species observed is constructed. Nativity and perennial and annual status for each species observed is determined by consulting an appropriate flora (Gleason and Cronquist 1991). Professional judgment is used to determine whether a plant, including a native species, is a weed. Native species, such as sandbar willow (*Salix interior*), are considered to be weedy. Percent native non-weedy perennial and annual species is determined by dividing the number of native non-weedy perennial and annual species by the total number of species observed and multiplying by 100.

*For our purposes here, certain native, early successional species (C=1) that commonly occur in healthy wetlands and do not tend to overwhelm plant communities are not considered weedy: *Acer saccharinum*, *Bidens frondosa*, *Polygonum pensylvanicum*, *Ranunculus abortivus*, etc.

Soils will be monitored by the INHS according to the Midwest Regional Supplement to the 1987 U.S. Army Corps of Engineers Wetland Delineation Manual (U.S. Army Corps of Engineers 2008, Environmental Laboratory 1987). Because features that indicate hydric soils (*e.g.*, low chroma mottling, and gleying) develop relatively slowly, monitoring and reporting of these features may be missing from all but the final monitoring reports. In the final monitoring report, a soil description and hydric soil determination will be provided for each of the planned wetlands.

D. Adaptive management

The IDOT will be responsible for adaptive management at the Sugar Camp Creek wetland and stream mitigation bank. The IDOT recognizes that there are several potential challenges that pose risks to the success of the mitigation bank. The IDOT will monitor site conditions and provide reports on an annual basis to the Corps. Based on the findings of the annual reports, the IDOT, in consultation with the IRT, will apply appropriate adaptive management strategies such as outlined in this section.

Among the anticipated challenges that pose a risk to bank success are floods, drought, spillway or berm degradation, invasive species, tree mortality, stream incision and stream bank erosion.

Pre-project monitoring has shown that the majority of the site floods frequently, although flood durations are not long enough to satisfy jurisdictional wetland hydrology criteria over large portions of the site. Thus, the IDOT plans to block drainage ditches and construct perimeter berms and fixed elevation spillways to prolong the period and area of inundation at the site. However, it is likely that planned wetland restoration areas will be wetter or drier than planned in a given year. Therefore, the IDOT will asses whether annual and seasonal climate patterns (e.g. precipitation and flooding) were within the normal long-term range.

If climate patterns are within the normal range and jurisdictional wetland hydrology area estimates are less than the targeted wetland restoration acreage, the IDOT will review the site development plan (see Figure 8) and consider adaptive management strategies to increase the period of saturation and/or inundation such as adjusting the threshold elevations of the spillways. If minor adjustments to the spillway elevations do not help in meeting hydrologic performance standards,

potential remedial actions would be additional excavation or adjustment of berm elevations. If adaptive management of water levels does not aid in meeting the performance standard, then the principle remedial actions that would be proposed are shallow excavation to create additional or deeper depressions on the floodplain and adjustment of berm elevations.

If planted tree survival does not meet the performance standard, then remedial measures such as replanting, or installing tree berms and replanting on them, or planting more mature stock may be considered. Weed mats and mowing to reduce competition may also be considered to improve survivorship where it appears the site supports establishment of forested wetlands.

It is also likely that planned forested wetland areas may be more suitable to emergent vegetation after hydrology is restored. If planted forested wetlands remain inundated for prolonged periods after site development, there is a possibility that flooding will cause planted trees to die. If hydrologic conditions are wetter than anticipated and prevent development of a planned forested wetland/scrub-shrub wetland area, the IDOT will propose either replanting with emergent vegetation or allowing for natural regeneration by flood tolerant species based on vegetation monitoring provided by the INHS.

The IDOT expects native species composition to progress so that at least 90% of the herbaceous plants present will be non-weedy, native, perennial and annual species, and that none of the three most dominant plant species in any stratum will be non-native or weedy species by the end of the 5-year monitoring period for each phase. To achieve these final performance standards the need for vegetation maintenance will be determined from annual monitoring reports provided by the INHS. Starting at the end of year 2, after the completion of construction of each restoration phase, both planted and non-planted fields containing weedy, invasive, or non-native species will be sprayed with a systemic herbicide either in the early fall or in both spring and early fall. Examples of species that will be targeted for control are reed canary grass (*Phalaris arundinacea*), common reed (*Pragmities australis*), Japanese honeysuckle (*Lonicera japonica*) and mulitfora rose (*Rosa multiflora*). Control of these species may also be accomplished though prescribed burns.

There is the possibility that some plantings will be overcome by natural growth and survivorship of planted trees will be low. If the floristic quality of volunteer community meets the performance standard (Table 8) and the vegetation is dominated by hydrophytic plants, then the IDOT will request that the IRT grant restoration of that area through natural regeneration. If floristic quality does not meet the performance standard, the IDOT will implement additional vegetation management to improve floristic quality.

Natural deposition and erosion (including incision and bank erosion) are expected to occur in Sugar Camp Creek. However, it is possible that the rates of channel incision and/or bank failure may be detrimental to the proposed riparian or wetland areas. If monitoring of channel conditions shows that the rate of channel incision and/or bank erosion is detrimental to the riparian buffer or wetland bank, the IDOT will propose remedial measures to stabilize the stream channel (e.g. installation of grade control structures, reshaping and re-vegetating banks).

For any resource area (wetland, upland, or riparian) failing to meet the performance standards outlined in this banking instrument, remedial actions may also involve modification of performance standards and attendant vegetative sampling, hydrologic monitoring, and geomorphic monitoring schemes. In such a case, performance standards would be modified to evaluate aquatic resource functions (e.g. water quality improvement) that are not directly evaluated as proposed in the original banking instrument. Any modification of monitoring or performance standards would be executed in consultation with the IRT.

Remedial actions and responsibilities

Should the Corps in consultation with the IRT determine that remedial action is necessary because the bank site or credit area is failing to achieve the performance standards specified in Section IV. B., the IDOT shall develop and implement remedial action plans in coordination with the IRT. Corps and IRT determinations will be based on results provided in monitoring reports—see IV. C.

In the event IDOT fails to implement necessary remedial actions at the bank site within 90 calendar days or other time period determined by the IRT, the IRT Chair will notify IDOT that debiting from the bank is suspended.

E. Schedule of credit availability

Wetland mitigation credits generated from wetland and upland buffer restoration/creation and stream mitigation credits generated from riparian buffer restoration will be available for debiting as the mitigation bank is developed. Upon submittal of all appropriate documentation by IDOT and subsequent approval by the USACE District, in consultation with the IRT, it is agreed that credits will become available for use by IDOT in accordance with the following schedule:

1. Initially, 15 percent of total anticipated credits for each resource type (wetland and stream) shall be available for debiting after the IRT's approval of the Banking Instrument, and protection of the bank land under a Declaration of Covenants and Restrictions to be recorded with the Franklin County Recorder of Deeds Office.
2. An additional 15 percent of total anticipated credits for each resource type shall be available for debiting immediately after submittal and approval of the as-built report for each phase of mitigation bank construction.
3. Up to an additional 30 percent of total anticipated credits for each resource type shall be available for debiting following demonstration of meeting performance standards for two consecutive years. The number of credits released will be based on the proportion of proposed wetlands meeting the vegetation and hydrology success criteria.
4. The remaining 40 percent of total anticipated credits for each resource type shall be made available by the IRT Chair for withdrawal when five successive years of performance standards have been attained. If a portion of the Bank does not meet the hydrologic, vegetative, or soil success criteria, the equivalent credit for the area that does not meet the criteria will not be available for debiting until the criteria are achieved.

The IDOT must submit documentation to the Corps demonstrating that the appropriate milestones for a release of credits have been achieved and requesting the release. The Corps will provide copies of this documentation to the IRT members for review. IRT members must provide any comments to the district engineer within 15 days of receiving this documentation. However, if the district engineer determines that a site visit is necessary, IRT members must provide any comments to the IRT chair within 30 days of receipt of this documentation. After full consideration of any comments received, the IRT chair will determine whether the milestones have been achieved and the credits can be released.

V. Financial assurances and long-term bank management

The IDOT will program state funds for the establishment, monitoring, and maintenance of the bank site. State funds will also be programmed to perform remediation on planned wetlands that do not

appear on track to attaining one or more of the established performance standards. The IDOT will not post performance bonds, hold escrow accounts or dedicate legislatively enacted funds to cover contingency measures.

The bank site was acquired in 2005 by District Nine of the IDOT for approximately $300,000. Site planning was performed by the ISGS and the IDOT. Site engineering will be provided by engineers with the IDOT in District Nine, in Carbondale, Illinois. Legal services will be provided by lawyers with the IDOT Office of Chief Counsel in Springfield, Illinois.

The bank site will be constructed in two phases. Within three years after the bank site instrument is signed, the IDOT District Nine Programming Engineer will program a total of approximately $1.1 million to construct the mitigation bank ($530,000 for Phase 1 and $570,000 for Phase 2). This estimate includes cost of mobilization. Each phase of development will require up to two years to complete.

Site monitoring will be provided by the IDOT Bureau of Design and Environment through their Intergovernmental Agreement for Illinois Transportation Biological and Wetland Survey Program Between the State of Illinois, Department of Transportation and the Board of Trustees of the University of Illinois. The agreement was first executed in 9/12/1980 and then updated in 10/25/2006. The agreement is effective until 6/31/2011. Each fiscal year for twenty-eight fiscal years, the IDOT has programmed funds to implement this agreement. Under the agreement, either the INHS or ISGS or both conduct field surveys for threatened and endangered species, wetlands and compensatory mitigation projects and prepare reports that support departmental compliance with the Endangered Species Act, Clean Water Act, Illinois Endangered Species Act, Interagency Wetland Policy Act of 1989 and the National Environmental Policy Act. The central office of Planning and Programming programs funds each fiscal year for the Statewide Biological Survey and Assessment Program Between the State of Illinois, Department of Transportation and the Board of Trustees of the University of Illinois. The FY09 Program provides $3.56 million for this program.

One year following completion of Phase 2, monitoring for attainment of performance standards will begin. If monitoring reports by the INHS and ISGS indicate the need for remediation, the IDOT District Nine Programming Engineer will program funds for remedial measures. Remedial measures will be implemented between 9 and 18 months after identification of non-attainment. Up to $25,000 of district discretionary funds could be used to implement corrective measures which would shorten the time period between identification of non-attainment and implementation of remedial action.

The Sugar Camp Creek wetland mitigation bank site has been designed for low-maintenance. As long as the bank site is owned by the IDOT, it will be maintained for its designated use. After the mitigation bank is established and the final credit allocation is released, the IDOT will transfer the site to the IDNR for long-term stewardship. Such transfer shall not require a commitment from IDOT to provide funds to IDNR to support the management activities. These provisions for the transfer and long-term management of compensatory wetlands and wetland bank sites are contained in the IDOT's Wetlands Action Plan—co-signed in 1998 by the Director of the IDNR and the Secretary of the IDOT. The IDNR is not able to program in perpetuity funds for the maintenance and management of targeted IDNR lands including wetland bank sites transferred from the IDOT. Each year the state legislature appropriates funds for the management IDNR lands and from that, funds are programmed for site management. The distribution of funds is based on need.

VI. Signatories

In accordance with The Final Rule for 33 CFR 332 and 40 CFR 230 Compensatory Mitigation for Losses of Aquatic Resources (Federal Register / V. 73 No. 70 pages 19594-19642, 04-10-2008) this document has been prepared to describe the provisions for establishment, use, and operation of the Sugar Camp Creek mitigation bank site in Franklin County, IL by the IDOT. The undersigned agencies hereby agree that this banking instrument shall provide the basis for proceeding with establishment and operation of the Sugar Camp Creek site in accordance with its terms as approved or as subsequently amended with the concurrence of all signatory agencies.

5-7-09

Gary Hannig — Date

Acting Secretary
Illinois Department of Transportation

VI. Signatories

In accordance with The Final Rule for 33 CFR 332 and 40 CFR 230 Compensatory Mitigation for Losses of Aquatic Resources (Federal Register / V. 73 No. 70 pages 19594-19642, 04-10-2008) this document has been prepared to describe the provisions for establishment, use, and operation of the Sugar Camp Creek mitigation bank site in Franklin County, IL by the IDOT. The undersigned agencies hereby agree that this banking instrument shall provide the basis for proceeding with establishment and operation of the Sugar Camp Creek site in accordance with its terms as approved or as subsequently amended with the concurrence of all signatory agencies.

5-12-09

Marc Miller Date

Director
Illinois Department of Natural Resources

VI. Signatories

In accordance with The Final Rule for 33 CFR 332 and 40 CFR 230 Compensatory Mitigation for Losses of Aquatic Resources (Federal Register / V. 73 No. 70 pages 19594-19642, 04-10-2008) this document has been prepared to describe the provisions for establishment, use, and operation of the Sugar Camp Creek mitigation bank site in Franklin County, IL by the IDOT. The undersigned agencies hereby agree that this banking instrument shall provide the basis for proceeding with establishment and operation of the Sugar Camp Creek site in accordance with its terms as approved or as subsequently amended with the concurrence of all signatory agencies.

Matt T. Morgan 5-20-09

FOR Joyce Collins Date

Marion Ecological Services Sub-Office
U.S. Fish and Wildlife Service

VI. Signatories

In accordance with The Final Rule for 33 CFR 332 and 40 CFR 230 Compensatory Mitigation for Losses of Aquatic Resources (Federal Register / V. 73 No. 70 pages 19594-19642, 04-10-2008) this document has been prepared to describe the provisions for establishment, use, and operation of the Sugar Camp Creek mitigation bank site in Franklin County, IL by the IDOT. The undersigned agencies hereby agree that this banking instrument shall provide the basis for proceeding with establishment and operation of the Sugar Camp Creek site in accordance with its terms as approved or as subsequently amended with the concurrence of all signatory agencies.

5/5/09

Kevin Pierard Date

Chief, Watersheds and Wetlands Branch
U.S. Environmental Protection Agency, Region V

VI. Signatories

In accordance with The Final Rule for 33 CFR 332 and 40 CFR 230 Compensatory Mitigation for Losses of Aquatic Resources (Federal Register / V. 73 No. 70 pages 19594-19642, 04-10-2008) this document has been prepared to describe the provisions for establishment, use, and operation of the Sugar Camp Creek mitigation bank site in Franklin County, IL by the IDOT. The undersigned agencies hereby agree that this banking instrument shall provide the basis for proceeding with establishment and operation of the Sugar Camp Creek site in accordance with its terms as approved or as subsequently amended with the concurrence of all signatory agencies.

Thomas E. O'Hara, Jr. 6-17-09

Thomas E. O'Hara, Jr.
Colonel, U.S. Army
District Commander

Date

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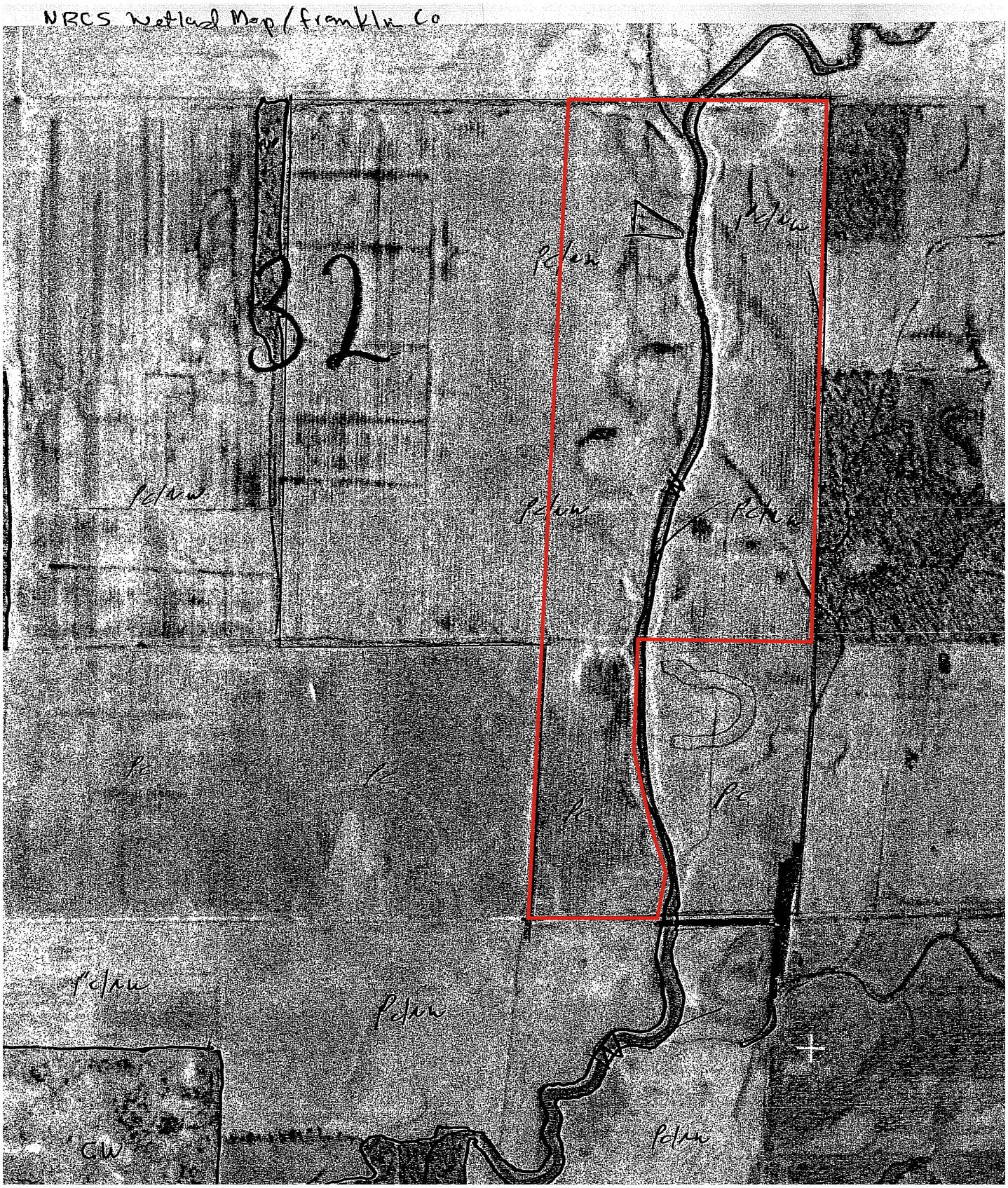
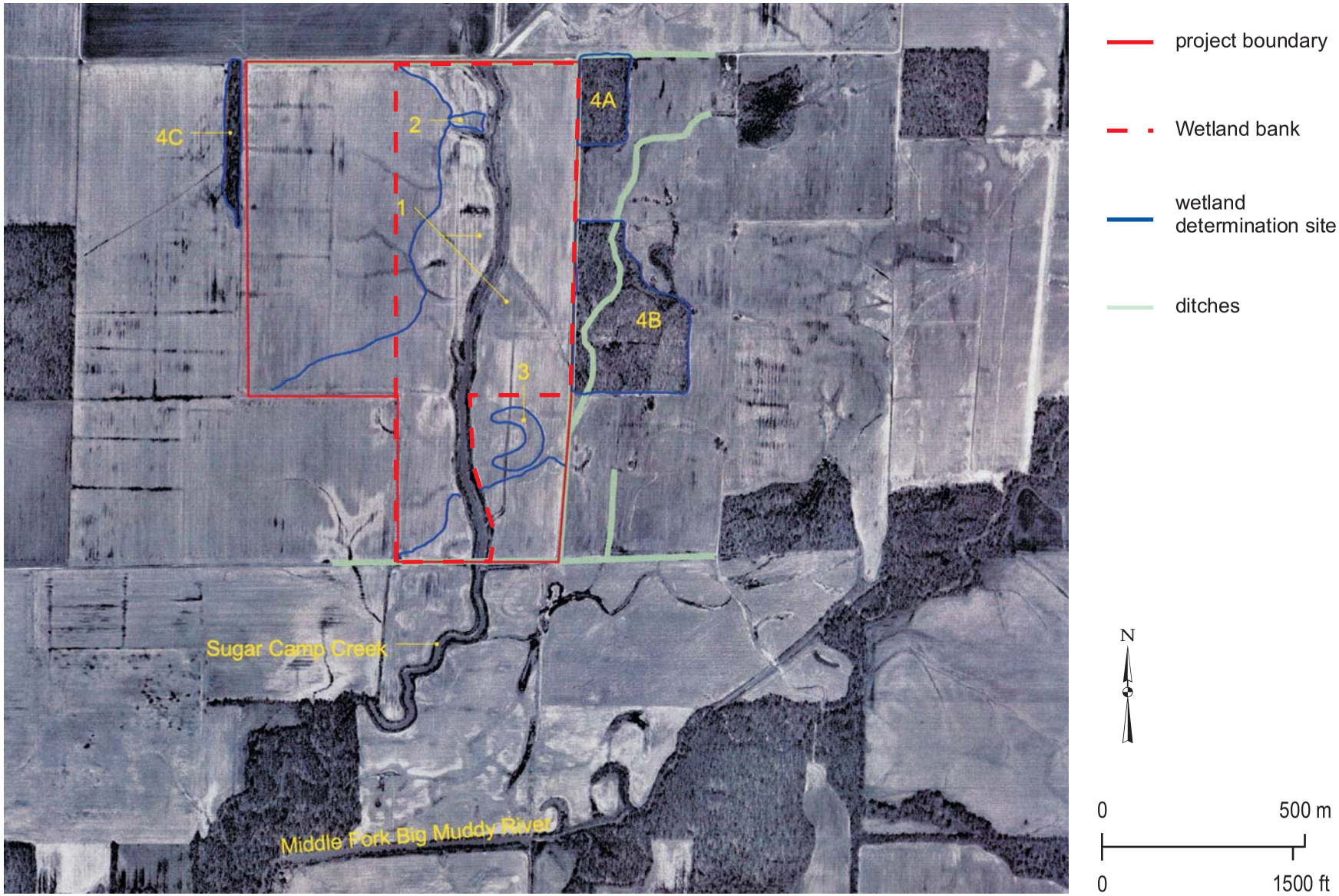
Appendix A: Franklin County NRCS wetland determinations at the proposed Sugar Camp Creek Wetland Mitigation Bank site. The approximate site boundary is outlined in red. Determinations are signified by (W) - wetland and (PC/NW) - prior converted/non-wetland.



Appendix B: Wetland determinations at the Sugar Camp Creek parcel. The limits of the proposed wetland mitigation bank are indicated by the red dashed line. This figure was adapted from the Illinois Natural History Survey Mitigation Site Assessment report (Plocher and Weisbrook 2004).



Appendix C: Archaeological Report

Illinois Department of Transportation
2300 South Dirksen Parkway / Springfield, Illinois / 62764

Concur
Anne Haaker
SHPO
1/10/06

January 4, 2006

Franklin County
IL 14
Sugar Camp Creek
Wetland Mitigation Site
Project: D-99-013-05

IDOT Seq # 12354
ITARP #05004

FEDERAL 106 PROJECT

Ms. Anne Haaker
Deputy State Historic Preservation Officer
Illinois Historic Preservation Agency
Springfield, Illinois 62701

Dear Ms. Haaker:

Enclosed are two copies of an Archaeological Report and Phase I documentation completed by University of Illinois personnel concerning historical and archaeological properties and sites potentially to be impacted by the proposed project referenced above. Archaeological survey in the 120 acre project area resulted in the location of one site, 11-FK-217. This historic period surface scatter was found to contain 20th century materials and is not eligible for the National Register.

In accordance with the established procedure for coordination of Illinois Department of Transportation projects, we request the concurrence of the State Historic Preservation Officer in our determination that no cultural properties which are subject to protection under Section 106 of the National Historic Preservation Act of 1966, as amended, will be impact by this project.

Very truly yours,

John A. Walthall, PhD
Cultural Resources Unit

Appendix D: Stream mitigation bank credit assessment

STREAM MITIGATION BANK
CREDIT ASSESSMENT WORKSHEET

MITIGATION SITE NAME:	Sugar Camp Creek Mitigation Bank		**ORM #:**		**DATE:**	2-Feb-09	**STATE, COUNTY:**	Illinois, Franklin		**SECTION-TOWNSHIP-RANGE:**	Sec. 32, T.5, R.4		
Stream Type			Ephemeral 0.1		Intermittent 0.6		Perennial < 15' 0.8		15'-30' Perennial 1		30'-50' Perennial 1.2		Perennial > 50' 1.4
Priority Area			Tertiary 0.1		Secondary 0.4		Primary 0.8						
Net Benefit (Riparian) for each side of stream		Activity	Creation or Restoration of Buffer and Exotic Removal (51-100% Planting)				Enhancement of Buffer and Exotic Removal (10-50% Planting)				Preservation of Buffer (<10% Planting)		
		Width	300	275	250	225	200	175	150	125	100	75	50	25
Additional Improvements			Restoring or Creating Wetlands				Trash/Debris Removal		Removal of Impairing Structures			Livestock Exclusion / Crossings	
System Protection Credit			Condition: Minimum Buffer Width Restored or Potected on Both Streambanks To calculate: (Net Benefit Stream Side A + Net Benefit Stream Side B) / 2)										
Net Benefit (Stream)			None 0		Moderate 1.0		Good 2.0		Excellent 3.5				
Monitoring / Contingency for each side of stream			**Mitigation Component**				**Success (Required on Action)**		**Failure**			**Action**	
			1. Photo Reference / Sample Site Longitudinal photos, Lateral photos.				No substantial aggradation, degradation or bank erosion.		Substantial aggradation degradation or bank erosion			When substantial aggradation, degradation or bank erosion occurs remedial actions will be planned, approved, and implemented	
	Level I	includes Component 1 0.075	**2. Plant Survival** Survival plots, Stake counts, Tree counts.				≥ 80% Survivial within the planted plots. These plots should mimic reference reach		< 80% Survival within the planted plots.			Area with less than 80% coverage of target species will be re-seeded and/or	
	Level II	includes 2 of Components 1,2, & 3 0.3	**3. Channel Stability** Diimensions, Longitudinal profiles, Pebble count.				Stable stream with pattern, profile and dimension of similar reference reach. Minimal evidence of instability (down-		Substantial evidence of instability.			When Substantial evidence of instability occurs, remedial actions will be planned, approved, and implemented.	
	Level III	includes Components 1,2 & 3, may include 4 0.5	**4. Biological Indicators** Invertebrate populations, Fish populations.				Population measurements remain the same or improve, and target species composition indicates a positive trend.		Population measurements and target species composition indicate a negative trend.			Reasons for failure will be evaluated and remedial action plans developed, approved, and implemented.	
Control / Site Protection			Corps approved site protection without 3rd party grantee 0.075				Corps approved site protection with 3rd party grantee 0.3		Title transfer to a conservancy 0.3				

Appendix D: Stream mitigation bank credit assessment

For each Category select a Criteria from the drowp down list for each tan box for a Dominant Impact Type. A red box indicates that no selection has been made.

		Dominant Impact Type 1				Dominant Impact Type 2				Dominant Impact Type 4			
Site Name		**Sugar Camp Creek Wetland Mitigation Bank**											
		Criteria			**Factor**	**Criteria**			**Factor**	**Criteria**			**Factor**
Stream Type		15'-30' Perennial			1.000				?				?
Priority Area		Secondary			0.400				?				?
Net Benefit (Riparian Buffer)		**Activity**	**Width**	**Factor**		**Activity**	**Width**	**Factor**		**Activity**	**Width**	**Factor**	
	Stream Side A	Creation or	50	0.80				?				?	
	Stream Side B	Creation or Restoration	50	0.80				?				?	
Additional Improvements	Stream Side A				0.800				?				?
	Stream Side B				0.800				?				?
System Protection Credit Met (Buffer on both sides)		Yes			0.80	No			0.00	No			0.00
Net Benefit (In-Stream)		None			0.000				?				?
Monitoring / Contingency	Stream Side A	Level III			0.500				?				?
	Stream Side B	Level III			0.500				?				?
Control / Site Protection	Stream Side A	Title transfer			0.300				?				?
	Stream Side B	Title transfer			0.300				?				?
Sum of Factors (M) =					5.400				?				?
Stream Length in Reach (do not count each bank separately) (LF) =					4200								
Credits (C) = M x LF					22680.000				?				?

Total Mitigation Bank Credits Generated = **22680.000**

Explanatory Notes: Stream credits may be adusted pending approval of the State of Illinois Stream Assessment Method.

Appendix E: Work Specifications Supplement

Part A. Pre-construction hydrology monitoring. See document section IV. C. p. 25, Figure 11, and Appendix .

Part. B. Drainage tile and culvert search. See document section II. C. Site Hydrology

Part C. Control weedy and invasive vegetation.

Weed control, non-selective and non-residual. This work shall consist of the application of a non-selective and non-residual herbicide (Rodeo or equal) to kill all existing vegetation at designated areas within the wetland bank site. This item will be used prior to seeding at the direction of the Engineer wherever stands of weeds are present. It will also be used as a spot spray application if weeds persist in subsequent seasons.

Materials: The non-selective and non-residual herbicide (Rodeo or equal) shall have the following formulation:

A. Active Ingredient	
*Glyphosate, N- (phosphonomethyl) glycine, in the form of its isopropylamine salt	53.8%
B. Inert Ingredients (including surfactant)	46.2%
TOTAL	100.00%

*Contains 5.4 pounds per gallon glyphosate, isopropylamine salt (4 pounds per gallon glyphosate acid).

The Contractor shall submit a certificate, including the following, prior to starting work:

1) The chemical names of the compound and the percentage by volume of the ingredients which must match the above specified formulation.

2) A statement that the material is in a solution which will form a satisfactory emulsion for use when diluted with water for normal spraying conditions.

3) A statement that the Rodeo or equal, when mixed with water, will be completely soluble and dispersible and remain in suspension with continuous agitation.

4) A statement describing the products proposed for use when the manufacturer of Rodeo or equal requires that surfactants, drift control agents, or other additives be used with the product. These tank mix additives shall be used as specified by the manufacture. Required additives will not be paid for separately.

All material shall be brought to the spray area in the original, unopened containers supplied by the manufacturer.

Scheduling: Spraying will not be allowed when temperatures exceed 90º F or under 60º F, when wind velocities exceed fifteen (15) miles per hour, when foliage is wet or rain is eminent, when visibility is poor or during legal holiday periods.

Application Rate: The Rodeo or equal non-selective and non-residual herbicide shall be applied at the rate of one 5 pints per acre.

Five pints of Rodeo or equal formulation shall be diluted with a minimum of 50 gallons of water and applied as a mixture. Water for dilution of the mixture will not be paid for separately.

Part D. Excavate wetland creation areas and levees.

Excavation activities related to wetland creation and levee removal will proceed according to IDOT Standard Specifications for Road and Bridge Construction, Section 201 Clearing, Tree Removal and Protection Care and Repair of Existing Plant Material, and Section 202—Earth and Rock Excavation

Clearing vegetation. See IDOT Standard Specifications Section 201—Clearing, Tree Removal, and Protection, Care and Repair of Existing Plant Material.

Prior to starting excavation operations in any area, all clearing, tree removal, and protection of existing plant material in that area shall be performed according to Section 201. This work shall consist of the satisfactory removal and disposal of all existing trees, shrubs, brush, etc. from the proposed earth excavation and embankment areas, construction limits, as shown in the plans and as directed by the Engineer in accordance with applicable portions of Section 201 of the Standard Specifications. Approximately 90% of the site was farmed in 2006 and only narrow strips of woody vegetation occur along the stream margins and site boundaries. It shall be the Contractor's responsibility to visit the site prior to bidding to determine the exact work involved with this item of work.

Earth Excavation and Removal. See also IDOT Standard Specifications Section 202— Earth and Rock Excavation.

This work shall consist of the excavation of earth in planned wetland creation areas, the excavation of earth in existing berms and the excavation of earth in existing levees as shown in the plans, and the transportation of suitable excavated material to embankment locations throughout the limits of the contract; or the excavation, transportation, and disposal of excavated material. This work does not include excavation for structures or channel excavation.

Basins shall be excavated according to the lines, grades, and cross sections shown on the plans.

There shall be no topsoil stockpiling and backfilling. However, suitable excavated materials shall not be wasted without permission of the Engineer. The Contractor shall dispose of all surplus, unstable, and unsuitable materials and organic waste in such a manner that public or private property will not be damaged or endangered.

Appendix E: Work Specifications Supplement

Part E. Block and fill ditches.

This work shall consist of utilizing excavated material to fill drainage ditches and to construct berms, levees and field access roads as shown in the plans and in accordance with applicable portions of IDOT Standard Specifications Section 205—Embankment, and / or as directed by the Engineer.

Ditch segments that intersect existing wetland areas will not be filled. These areas will be identified prior to ditch deactivation. Ditch deactivation will include blocking each ditch near its outlet and filling the ditch to match the surrounding grade using materials similar in texture to those in unaltered areas surrounding the ditch. Fill material shall be compacted to reduce the likelihood of erosion.

The procedure that will be used to block and fill ditches is as follows:

1) Aggregate ditch checks will be constructed at 50-foot intervals along the lowermost 500 feet of each ditch.

2) For each ditch to be blocked and filled, one ditch check will be placed where the ditch intersects the existing levee. The check should be installed in a trench that is dug 2 feet below the bottom of the ditch, and 5 feet into the bank on each side of the ditch. The trench should be 5 feet wide at the bottom. The trench should be filled with compacted local earth materials to an elevation that is 6 inches above the highest land surface on either side of the ditch.

3) After completion of ditch checks, clean fill equivalent to the surrounding parent material will be placed into the ditches and compacted. In order to reduce the likelihood of drainage re-activation, ditches will need to be filled without preserving or creating swale topography. To accomplish this, additional material may be needed to ensure that the ditch can be brought to grade with surrounding areas. If so, additional fill material should be of equivalent grain size and composition as that of the material in the immediate vicinity of the ditch being filled.

4) After the ditch is backfilled to the surrounding grade it will immediately be covered with 2 inches of local top soil and seeded with nurse crop grasses.

Part F. Culvert removal.

Two culverts pass through the levees along Sugar camp creek. Each culvert will be removed using the following guidelines:

1) Excavation should begin away from the stream (at the landward end of the pipe) and the culvert will be removed after it is exposed along its full length to minimize disturbance of the stream bank.

2) After removal, the remaining trench will be backfilled with materials equivalent to those in unaltered areas surrounding the tile trench. Backfill materials should be compacted as they are placed to prevent the piping and sapping through the stream bank.

After the trench is backfilled it will immediately be covered with at least 2 inches of local top soil and seeded with nurse crop grasses. An erosion control fabric or geotextile will be installed and stapled to protect the seeding while vegetation becomes established.

Part G. Levee reconstruction.

The following guidelines will be used to reconstruct the existing levees:

1) The design elevation for the levee top elevation will range from 408 feet for the northernmost 1100 feet along the creek (both sides) and grading gradually down to 407 feet at the south end of the site. Where added material is needed to build the levee to the design elevation, the constructed elevation of the levee top will exceed the design elevation by 0.5 feet to allow for settling of the placed material.

2) The maximum elevation of the levee top (stream side) will be established at least 30 feet from the top of the existing stream bank. Where the existing levee exceeds the maximum design elevation within 30 feet of the bank line, slopes on the stream side of the levee left in tact and the remainder of the levee will be graded to the target elevation.

3) Slopes on the landward side of the levee will grade into the adjacent wetland restoration or creation areas at no more than 2% slope within 100 to 120 or until the 406.5 elevation is reached.

4) After the levee is constructed, it will immediately be covered with top soil and seeded with nurse crop grasses and subsequently planted with trees.

See also IDOT Standard Specifications Section 205—Embankment. Articles 205.03, 205.04, 205.05 are summarized below:

205.03 Preparation of Existing Ground Surface. Before any embankment is placed, all clearing and tree removal over the entire area shall be performed according to Section 201, and the top 150 mm (6 in.) of the existing ground surface shall be disked and then compacted to the satisfaction of the Engineer. Snow and ice shall be removed from the area to be covered by the embankment. Embankment shall not be placed on frozen earth. When construction is resumed after any winter shutdown period, the top 200 mm (8 in.) of all partially completed embankments shall be reprocessed and compacted to the minimum specified density prior to placing more fill material on the embankment. When embankments are to be constructed on hillsides or slopes, or if existing embankments are to be widened or included in new embankments, the existing slopes shall be plowed deeply. If additional precautions for binding the fill materials together are justified, steps shall be cut into the existing slopes before the construction of the embankment is started.

205.04 Placing Material. Embankments shall be constructed of materials that will compact and develop a stability satisfactory to the Engineer. No sod, frozen material or any material which, by decay or otherwise, might cause settlement, shall be placed or allowed to remain in embankments. Embankments shall be constructed to the height and width deemed necessary to provide for shrinkage during compaction. Upon completion, the embankments shall conform to the lines, grades and cross

sections shown on the plans. When embankments are constructed of materials specified in Article 202.03, such materials shall be well distributed, and sufficient earth, or other fine material shall be incorporated with them when they are deposited to fill the interstices and provide solid embankment. No rock, stones or broken concrete shall be permitted within the subgrade for such construction. So far as practicable, each layer of material shall extend the entire length and width of the embankment. The material shall be leveled by means of bulldozers, blade graders or other equipment approved by the Engineer. Each layer shall be not more than 200 mm (8 in.) thick when in loose condition, uniform in cross section, and thoroughly compacted before the next layer is started.

205.05 Compaction. Each layer of the embankment material shall be disked sufficiently to break down oversized clods, secure a uniform moisture content, and ensure uniform density and compaction. The embankment shall be sprinkled with water when it is necessary to increase the moisture content of the soil to permit the embankment to be constructed to the appropriate densities. Compacting equipment and compacting operations shall be coordinated with the rate of placing embankment so that the required density is obtained. Special care shall be exercised in compacting embankments adjacent to structures and in sharp depressions. Where such areas are inaccessible to the compacting equipment being used, the material shall be placed in 200 mm (8 in.) horizontal layers and uniformly compacted with suitable mechanical equipment.

Part H. Berm Construction.

The following guidelines will be used to construct berms:

1) Berms will be built according to the design plans given in Appendix D. Berms will be level-crested with a 10-foot top width. The top elevation of the berms will range from 408 feet and will be no lower than 407 feet.

2) The maximum target elevation on the berm crests will be established at 15 feet from the existing perimeter ditches. No grading or construction will take place where the existing land surface exceeds the maximum design elevation of the berm, rather the constructed berm will be tied in to the higher existing landscape using IDOT standard specifications.

3) The inside slope from the top of the berm will grade into the existing landscape or the local design grade of the wetland creation areas at no more than 10% (1:10 slope). The outside slope will grade toward the perimeter ditches at no more than 33% (1:3 slope).

4) After the berm is constructed, it will immediately be covered with top soil and seeded with nurse crop grasses.

Like levee construction, berm construction will proceed according to the specifications indicated in Part G above and those otherwise indicated in IDOT Standard Specifications Section 205—Embankment.

Appendix E: Work Specifications Supplement

Part I. Spillway Installation.

Spillways will be built according to guidelines and plans in the USDA-NRCS Engineering Field Manual, Chapter 6. (U.S. Department of Agriculture 1984). Excavation, preparation of the substrate and erosion control measures will be employed in accordance with Section 200 of the IDOT Standard Specifications Manual. See Appendix D for design drawings of spillways.

Part J. Ditch capture and re-routing. See also IDOT Standard Specifications Section 203—Channel Excavation.

***Swale excavation*.** This work shall consist of the removal and satisfactory disposal of all materials encountered in the construction of swales. Swales shall be excavated according to the lines, grades, and cross sections shown on the plans. The guidelines for swale excavation are as follows:

1) Flow will be routed from the site perimeter to planned wetland restoration and creation areas by excavating broad, shallow, low-gradient swales (less than 2% slope).

2) The bed of each swale will be tied into the existing or design grade of the wetland restoration or creation areas. Each swale will have at bottom width of at least 50 feet and the swale bed will be no more than 0.5 feet lower than the surrounding grade. The downstream slope of each swale will not exceed 1% and the side slopes of the will not exceed 5%.

3) Where blocking of small segments of connecting ditches is called for in the design, the ditch segment will be filled to the surrounding grade along the uppermost 10 feet with clean fill. The fill will be placed and compacted according to item 3 in Part E above.

4) Construction will be executed in a manner that will not decrease the current rate of drainage from adjacent farm fields.

5) After the final grade for the swale is attained, it will immediately be covered with 2 inches of local top soil and seeded with nurse crop grasses and covered with straw or other seed mulch.

Culvert installation. This work shall consist of the installation of a culvert according to IDOT Standard Specifications Section 542, and satisfactory placement and compaction of cover material according to Articles 205.04, 205.05 summarized in part G above. Guidelines for culvert installation are given below.

1) A linear trench will be excavated to accommodate the culvert. The bottom of the trench will be sloped and graded from 408.5 feet where it meets the existing ditch bed to 408 feet where it enters the planned wetland area at the inside flank of the berm.

2) The installed culvert will be corrugated steel, 18-inches in diameter with steel flares and aprons, and of adequate length to pass completely through the berm.

3) The culvert will be covered according to IDOT Standard Specifications, Section 542 and Articles 205.04, 205.05.

4) After the final grade for top cover is attained, it will immediately be covered with 2 inches of local top soil and seeded with nurse crop grasses and covered with straw or other seed mulch.

Part K. Seeding, tree and shrub planting.

Seeding - Class 2 (Special). All work, materials and equipment shall conform to Section 250 and 1081 of the Standard Specifications.

Tree and shrub planting – containerized. All work, materials and equipment shall conform to Section 253 and 1081 of the Standard Specifications except as modified herein. Articles 253.09, 253.10 (e), 253.11, 253.12, 253.13 do not apply. The following specification shall be added:

Fertilizer: The fertilizer for the backfill mix shall be controlled slow release fertilizer tablets. The tablets shall be 16 gram briquettes containing 4.9% water soluble urea nitrogen and water insoluble nitrogen as expressed in the following formulation:

14% nitrogen, 3% available phosphoric acid, and 3% water-soluble potash (14-3-3 analysis) plus trace elements

When placing the prepared backfill, the fertilizer nutrient tablet shall be uniformly spread in the planting hole around the root ball and within the top 1/3 of the backfill mix.

The rate of application and placement shall be governed by the manufacturer's recommendation or the following table, if none is given, for all trees:

a. 3 tablets in bottom of hole

b. 2 tablets per foot of height to a maximum of 30 tablets

The cost of the fertilizer tablets will not be paid for separately, but shall be considered as included in the contract unit price(s) per each for the trees, intermediates, and shrubs of the various kinds and sizes specified in this contract.

Tree and shrub planting – bare root seedlings. All work, materials and equipment shall conform to Section 253 and 1081 of the Standard Specifications except as modified herein. Articles 253.09, 253.10 (e), 253.11, 253.12, 253.13 do not apply.

Tree trunk predator protection. Tree trunk predator protection will only be used if 3-gallon containerized trees and shrubs are chosen to plant at the site. This work shall consist of providing the necessary personnel, material and equipment to install predator protection to all trees and shrubs from the ground line to a height of 4 feet.

Material: The contractor shall use a 19-gauge hardware cloth with a one-half inch square mesh design. Steel staples, also known as pig rings, shall be used to fasten hardware

cloth together. Six foot wooden stakes shall be used to hold cloth upright and 6 inch long staples, such as those used to secure erosion control blanket, shall be used to secure cloth to the ground.

Method: The predator protection shall be 14 inches in diameter with a 4 inch overlap. The hardware cloth shall be secured to itself with a minimum of four pig rings. Each mesh tube shall be supported with two 6 foot wooden stakes and secured to the ground with four 6 inch long staples.

For two years following the tree planting (during the tree care cycles), the Contractor shall remove and replace any damaged predator protection as determined by the Engineer. Any predator protection damaged due to Contractor operations shall be replaced immediately at the Contractor's expense.

Maintenance mowing. This work shall consist of mowing the vegetation between rows of planted trees and shrubs. The equipment used shall be capable of shredding all vegetation two (2) inches in diameter or less. Mowing shall be accomplished in a north-south or east-west orientation only and a two- to three-foot strip of vegetation (including planted trees and shrubs) shall remain between mowed rows. Vegetation shall be mowed to a height of between 6 and 18 inches. Mowing shall be completed twice a year, between July 1 and September 30, for two years following the period of establishment.

TOOLS

A Simplified Soil-Zone Monitoring Well

by James J. Miner and Scott D. Simon

A new device is proving useful in work with wetlands in Illinois.

Wetlands are fundamentally a hydrologic feature (Winter, 1992), and variations in hydrologic conditions are a major factor controlling the distribution of wetland vegetation (Gosselink and Turner, 1978; Niering, 1987a; Niering, 1987b; Weller, 1987). Measuring various aspects of site hydrogeology is an increasingly common practice in wetland restoration and management projects. However, because past hydrogeologic studies often did not focus on wetlands, as several authors have noted (see for example Gosselink and Turner, 1978; LaBaugh, 1986; Doss, 1995), the standard techniques used in hydrogeology are not well known to wetland managers. Also, in hydrogeologic studies, each site commonly requires an individualized approach (Nielsen, 1991), so that the design of a monitoring well and methods for its installation are generally determined at each well site by a hydrogeologist. Natural-areas workers without training in hydrogeology are generally not aware of the pitfalls that can adversely affect water-level measurements if adjustments in design are not made.

Because many of the hydrogeologic conditions that complicate well design occur at depth, wells designed to measure water levels in the soil zone avoid many hydrogeologic complications, and can be installed using standard designs. This in turn makes it possible for natural-areas workers with little training in hydrogeology to measure water levels in the root zone, which is often the only hydrogeologic data required to make restoration and management decisions, without needing to alter the construction of each well. Another advantage of a standard design is that identically constructed wells allow direct comparison of water-level changes at different sites.

While carrying out a number of wetland studies in Illinois over the last several years (Miner *et al.*, 1994; Miner *et al.*, 1996; Miner *et al.*, 1997; Simon *et al.*, in press), we developed a monitoring well for the specific purpose of measuring the elevation of the water table in the soil zone. We designed the wells to be as shallow as possible while still containing the standard features that ensure the integrity of a well (see for example ASTM, 1990; Nielsen, 1991). In designing them we took advantage of several distinctive features of soil-zone hydrology. The most important of these is that, in the soil-zone, there is less chance of encountering the complex hydrogeologic conditions, such as confined aquifers, that often occur at depth. Also the soil zone typically includes many interconnected macropores, such as root channels and soil structures, which permit the free flow of water through the soil. Wells that intercept these macropores will accurately reflect the level to which soil saturation can occur. These facts lessen the need to tailor wells to the specific geologic conditions of the site, so that a standard design can be used. To test our well in the field, we compared water levels in a well at one site to the saturation measured in a set of nested tensiometers installed nearby, and found that the data showed similar levels and trends.

Data collected from these wells can be used in planning and monitoring the restoration or management of natural areas.

For example, as part of an ongoing study of the relationships between the hydrology and the distribution of vegetation communities in wet prairies, sedge meadows, and deep and shallow marshes (Simon *et al.*, in press), we installed soil-zone monitoring well in each type of wetland along a transect through nature preserves, and collected data on the vegetation along an adjacent, parallel transect. Figure 1 shows the different depths to the water table measured through time in each wetland type at one preserve. These data can be used to characterize the hydrologic regimes required to restore or create wetlands of each type.

While other attempts have been made to describe well-installation methods for wetlands (see for example Sprecher, 1993), there is still a lack of awareness among natural-areas workers of proper installation techniques. The installation method proposed here primarily differs from that described in Sprecher (1993) by advocating a standard design for all wells of this type, by modifying for frost heave experienced in the northern climates and for areas with larger water-level fluctuations, and by using different methods to seal the well. However, this design may need to be adapted for use in geologic or climatic areas other than the glaciated Midwestern United States.

Well Design and Installation

This section describes the methods we use to construct and install soil-zone monitoring wells. These methods are only appropriate for measuring the water table. For studies that require more extensive hydrogeologic data, such as deeper water levels, water levels in confined aquifers, or vertical ground-water flow, different types of monitoring wells are needed, and must be designed specifically for the hydrogeology of each site.

Materials used in the construction and installation of our monitoring wells can be purchased from local well-drilling supply companies or directly from manufacturers. We construct wells from 2.54-cm (1-in.) diameter, threaded, Schedule 40 polyvinyl chloride (PVC) well casing and screen (see Figure 2 for well terminology and construction details). With threaded PVC, the pieces join by screwing together instead of using glued, slip-together couplers that are larger in diameter than the PVC casing and can impede backfilling of the well annulus during installation.

Well screens are lengths of PVC casing that are perforated (slotted) to allow water to flow into the well. Screens made by a manufacturer are uniform, so that each well has the same number and width of openings. Figure 3, a close-up view of a manufactured well screen, shows the uniformity of the slots. When perforations are made by cutting or drilling holes in a piece of casing, the well screen is likely to have less open area than a manufactured screen, causing the well to respond more slowly and less efficiently. Also, each home-made screen will have a different open area, and therefore will respond to a water-level change at different rates. In addition, large or irregular holes made with a drill or hacksaw allow sediment to enter and accumulate in the well through time. In fact, home-made screens are a common cause of well malfunctioning (Nielsen, 1991), so that a manufactured screen is worth the extra cost.

Although American Society for Testing and Materials (ASTM) standards suggest choosing the width of the slots in relation to the grain size of the sediments on site, this is impractical for most natural-areas workers. Therefore, we recommend buying screens with slots 0.25-mm (0.010-in.) wide, which will work in a wide variety of sediments. In cases where finer materials do enter the well through the slots, sediment can be pumped out as needed, as discussed later. However, we have not encountered any conditions that cause sig-

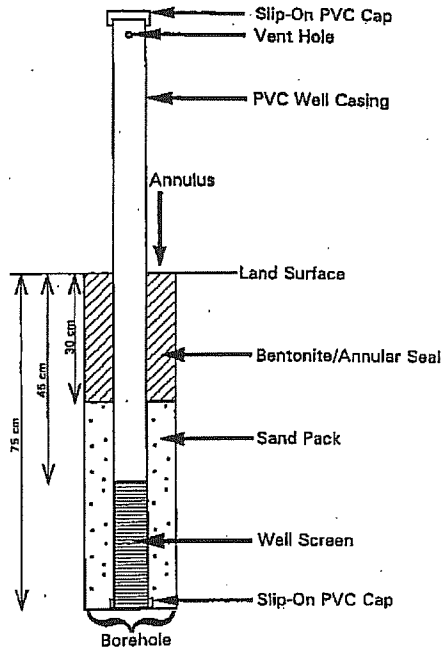


Figure 2. Diagram of soil-zone monitoring well shows features of design discussed in text.

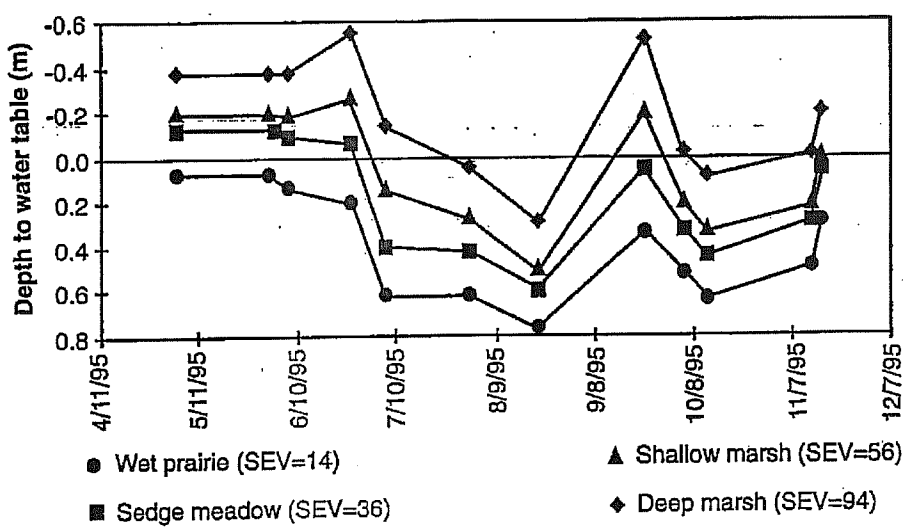


Figure 1. Depths to water table measured in four wetland types at Wadsworth Prairie Nature Preserve near Wadsworth, Illinois (Simon *et al.*, in press). Negative values indicate water levels above land surface.

nificant sedimentation in the wells, even in peat or clay-rich sediments.

To make a well, cut a 30-cm (1-ft) long piece off each end of a 75-cm (2.5-ft) long, manufactured, 2.5-cm (1-in) diameter well screen, so that each piece has threads on one end and not on the other. Each of the two pieces is used to make a well, and the remaining 15-cm (0.5-ft) long piece of screen with no threads can be used for other projects. Screw the threaded end of one piece of the screen onto a 1.5-m (5-ft) long piece of threaded, unperforated PVC casing. To prevent sediment from entering the well from the bottom, glue a slip-on cap on the cut end of the screen using PVC cement. Drill a small hole in the bottom cap so that water does not become trapped in the well during dry periods, producing false readings. After installation, place a removable slip-on cap on the top of the well between measurements to keep rain and debris out of the well.

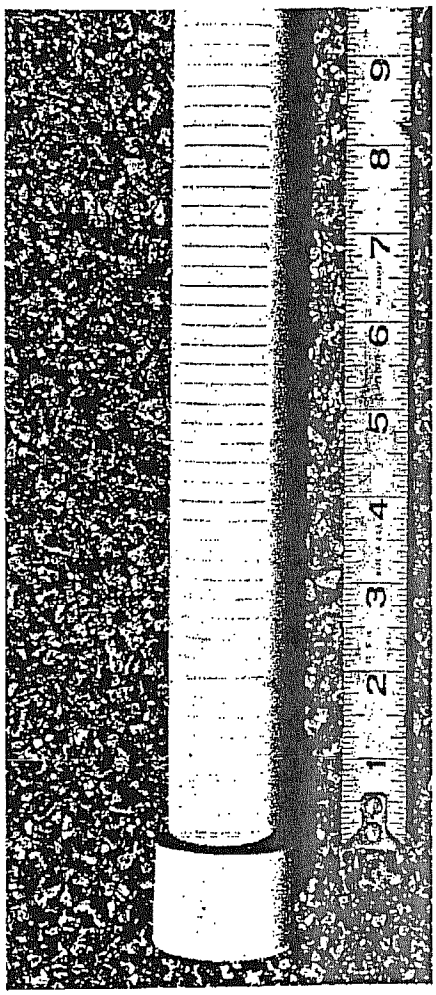


Figure 3. Close-up of a manufactured well screen shows uniform width of water-admitting slots, an advantage over hand-made well screens, which tend to be less regular and to have less open space and register changes in water level more slowly.

Install the well in a 75-cm (2.5-ft.) deep, 7.5-10-cm (3-4-in.) diameter borehole made with a hand auger or post-hole digger (Figure 4). Although wells can be driven directly into the ground, installing the well in an open borehole has a number of advantages. One is that it provides an opportunity to examine the sediments removed from the borehole, which can be helpful in interpreting the behavior of water levels in the well. For example, the time expected for water levels to change in clay is much greater than in sand; also, the range of the water table can sometimes be estimated from soil features. Another advantage is that the well screen can clog with sediment if the well is driven directly into the ground. Finally, sediments provide clues to potential problem situations such as perched water tables and confined aquifers, which will be discussed below.

We chose a borehole depth of 75 cm on the basis of observations of water levels common in Illinois wetlands during most of the year. Basically, this is the minimum amount of space required to include each well component as discussed below. Although deeper wells may occasionally be needed to intercept the water table during the driest months, we do not recommend them because they increase the chance of cross-connecting two geologic beds with greatly differing porosity or hydraulic conductivity. This may cause ground water to flow through the well from a more saturated part of the soil zone to a less saturated part, thus affecting water levels. If measurements are needed in the driest periods of the year, it will be necessary to install additional, deeper wells designed for the specific geologic conditions of the site.

Center the well in the borehole, then fill the annulus around the well screen with quartz sand 0.5 -1.0 mm (0.020-0.040 in.) in diameter to 30 cm below the land surface. This buries the uppermost slot in the screen beneath 15 cm of sand. The sand prevents the borehole wall from collapsing, filters out soil particles that might eventually clog the screen or fill the well, and effectively increases the screened interval to within 30 cm of land surface. Also, the extra sand above the top slot helps prevent the annular seal, which is described next, from clogging the screen. Larger-or smaller-diameter sand may also be used, but finer sand may fall through the slots, and larger sand may allow more sediment into the well.

Next, place medium-sized (1 cm or 0.375 in.) bentonite gravel, which swells into a sticky clay on contact with water, above the sand pack up to land surface to seal the annulus. Once swollen, this prevents surface water from entering the well directly and altering water levels. If the wells are installed during a dry season, add water to the bentonite to facilitate swelling and sealing of the annulus. The seal tends to dehydrate and crack at the land surface during dry periods, but the cracks do not extend through the seal and they rehydrate and heal rapidly when precipitation begins again. If the recommended size of bentonite is not available, other types also work, with the exception of powdered bentonite. In regions where the water table drops below the annular seal for several months at a time, or where bentonite doesn't swell efficiently (for example, in areas where ground water is high in dissolved salts), investigate an alternative to pure bentonite such as grout (see for example Sprecher, 1993).

Vent the well near the top of the casing by drilling a small hole with a drill, or making a small cut with a hacksaw. Without a vent, air may become trapped in the well and prevent water from entering or leaving.

Well Development

Traditionally, monitoring wells are developed after installation. This normally involves surging ground water back and forth through the sand pack using a variety of methods, then pumping the wells out to remove any trapped sediment. Because surging often increases turbidity in wells installed in fine-grained sediments such as the silts and clays (Nielsen, 1991) that are often found in wetlands, we do not recommend surging for soil-zone wells. How-

ever, wells should always be pumped. Pumping removes sediment, helping the well to respond quickly to changes in water levels. Also, pumping provides a way to check whether the well is functioning properly. If after pumping the water level in the well returns to near its previous level, then the well is functioning properly. The time required for water levels to recover depends on the type of sediments encountered. Wells in sandy sediments may take minutes to refill, but wells in clay-rich sediments may take days to refill, yet be functioning properly. Again, a geologic description of the sediments can help in predicting and interpreting the behavior of a well. Hand-operated pumps can be found in hardware stores. Peristaltic pumps found in field-supply catalogs are expensive, but they can easily pump the sediment-laden water without damage. Inexpensive PVC bailers, which can be also found in field-supply catalogs, can also be used to bail water out of a well and can work as well as pumping.

Figure 4. "Although wells can be driven directly into the ground, installing the well in an open borehole has a number of advantages." Here researcher Martha Cardona uses a hand auger to bore a hole for a well in a wet prairie. *Photo courtesy of James Miner*

Water-level Measurement and Surveying

Water levels in wells can be measured in a number of ways. Expensive, but easy-to-operate electronic water-level indicators that are lowered into the well make sound or light up when they contact water. Or, if you are working on a small budget, simply rub a block of chalk on a steel surveyor's tape and lower it into the well; the chalk will be removed below the water surface. (Klaus Richter of the King County Department of Natural Resources in Seattle, Washington [personal communication] suggests using a transparency marker rather than chalk to place a water-soluble stripe on a retractable, metal measuring tape.) Do not submerge the tape any more than is required to contact the water, because the tape will displace water and cause well levels to rise slightly. Whether using chalk or marker, wipe the tape off after each use; Richter suggests using a thin sponge used by swimmers. All of these items can be ordered from a field-supply catalog or be found locally, possibly at a surveying-supply store.

This method measures water levels in the well below the top of the casing. In order to convert that measurement to a depth below land surface, measure the length of the well casing that protrudes above land surface (also called the stick-up). Subtract the stick-up from the depth-to-water measurement to obtain the depth below land surface. Remember that water levels in the wells are occasionally higher than land surface (a negative depth), sometimes showing that ground water is flowing upward to the land surface. The stick-up of the well changes often due to frost heaving, vandalism, erosion or sedimentation around the well and other factors, so measure the stick-up at the same place during every well reading.

For more-complex hydrogeologic purposes, such as finding ground-water flow directions, the elevation of the water in the well must be known. To determine this, wait two or three weeks after installation to allow the well to settle into place,then use a surveyor's level to measure the elevation of the top of the well. Repeat this measurement annually following the spring thaw or as needed. Between surveys, recalculate the elevation of the top of the well when a measurement of the stick-up suggests that a change has occurred. If heaving has occurred, push the well down to the original 75 cm depth during the annual survey to prevent the screen from rising enough to contact the annular seal, which can clog the slots. Any wells that are pushed down should be surveyed or remeasured afterward. Never pull up on a well that appears to have sunk into the ground. Using a paint marker, draw a line on the casing at land surface to indicate when heaving has occurred, and to help reset the well to its original depth. Paint markers are available at hardware or hobby stores, and are the only type of permanent marking that lasts outdoors.

Record Keeping

Keep detailed measurements of each well during installation to allow reconsideration of data in the future should a problem arise. Make measurements of the exact total length of the well, the length and location of the screened interval in the well, the length of the sand pack and bentonite seal in the annulus, and the stick-up. Mark an identification number on the casing with a paint marker.

Potential Problems

These well-installation techniques do not work well in some geologic situations. Installing wells in sand and gravel below the water table is difficult because the boring may collapse rapidly. In these cases, make a boring to 75 cm and push the well to

depth through the softer, collapsed sediment. Gentle tapping with a rubber mallet is sometimes required to vibrate the screen to depth if necessary, but care should be taken to prevent deformation of the screen and closure of the slots. Add sand only if the top of the collapsed sediments is below 30 cm in depth. Additional pumping may be required in this type of installation to remove sediment from the well. When possible, install wells during the dry season to avoid this situation.

Interpreting water levels can sometimes be difficult. Water can enter the well from any saturated bed below the annular seal that is penetrated by the well, so that it is not possible to know where the water is coming from in sharply layered sediments. Also, because these wells are intended to measure the position of the water table, penetration of a geologic bed that is under water pressure (a confined unit) can result in misleading data. If a unit is confined, the water in a well will rise above the top surface of the geologic unit. This level is not the water table, and may not show the level to which sediments higher in the soil zone are saturated if the sediments above have greatly different hydrogeologic properties. Also, perched water tables are of concern, especially if the well penetrates completely through the unit that is impeding downward flow, thus allowing drainage down through the borehole. However, it has been our experience that, within the soil zone, few sediments efficiently perch ground water because soil structure, fractures, and root channels act as conduits for ground-water flow. In Illinois, water tables perched on glacial till commonly rest on the undisturbed till below the soil zone, which impedes infiltration, so that this type of well will not drain a perched water table in this situation. In other climates with different soil structures (for example, caliche in arid climates), this design may not be desirable. Carefully describing the geologic deposits encountered when making a borehole helps indicate when these situations may occur.

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