BROWN'S LAKE
INSPECTION OF COMPLETED WORKS
2017

I. PROJECT

Brown's Lake Habitat Rehabilitation and Enhancement Project (HREP)

II. AUTHORITY

Upper Mississippi River Restoration (UMRR) Program

III. LOCATION

Pool 13, Upper Mississippi River, Miles 544-546, Jackson County, Iowa

IV. PREVIOUS REPORTS

Reports listed below are posted at this website:
http://www.mvr.usace.army.mil/Missions/Environmental-Protection-and-Restoration/Upper-Mississippi-River-Restoration/Habitat-Restoration/Rock-Island-District/Browns-Lake/

U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River System, Environmental Management Program, Definite Project Report (R-2) with Integrated Environmental Assessment, Brown's Lake Rehabilitation and Enhancement, November 1987.

U.S. Army Corps of Engineers, Rock Island District, Operation and Maintenance Manual, Brown's Lake Habitat Rehabilitation and Enhancement Program, January 1991.

U.S. Army Corps of Engineers, Rock Island District, Pump Operation and Maintenance Manual, Brown's Lake Habitat Rehabilitation and Enhancement Program, 1993.

U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River System, Environmental Management Program, Performance Evaluation Report, Brown's Lake Habitat Rehabilitation and Enhancement, 1996.

U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River System, Environmental Management Program, Performance Evaluation Report, Brown's Lake Habitat Rehabilitation and Enhancement, 1997.

U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River System, Environmental Management Program, Performance Evaluation Report, Brown's Lake Habitat Rehabilitation and Enhancement, 2003.

U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River System, Environmental Management Program, Performance Evaluation Report, Brown's Lake Habitat Rehabilitation and Enhancement, 2015.

V. PROJECT GOAL & OBJECTIVES:

The project goals and objectives were outlined in the original Definite Project Report and are summarized in Table 1 below.

Table 1: Project Goals and Objectives

Project Goals and Objectives		
Goals	**Objectives**	**Project Features**
Enhance Wetland, Terrestrial, and Aquatic Habitat	Retard loss of fish and wildlife aquatic habitat by reducing sedimentation Improve water quality by decreasing suspended sediment concentrations and increasing winter dissolved oxygen concentrations Increase fish habitat by dredging Increase fish diversity by providing varied water depths Increase habitat available for wintering fish by providing deeper water areas Increase bottomland hardwood diversity by increasing selected terrestrial elevations and reducing frequency of flooding	Deflection Levee Water Control Structures Inlet Channel Improvement Side Channel Excavation Lake Dredging Terrestrial Dredging Material Disposal

VI. MONITORING PLAN EVALUATION CRITERIA:

Table 2 was copied from the following report: U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River Restoration, Environmental Management Program, Performance Evaluation Report, Brown's Lake Habitat Rehabilitation and Enhancement, 2015.

No changes or discussion of these tables was made during this site assessment.

Table 2: Performance Evaluation and Monitoring Schedule

Goal	Objectives	Enhancement Measures	Units	Year 0 w/out Project (1990)	Year 0 w/ Project(as-built)	Year 11 w/ Project(2001	Year 25 w/ Project (2015)	Year 50 Target w/ Project	Monitoring Schedule
Enhance Aquatic Habitat	Retard loss of aquatic habitat by reducing sedimentation	Deflection levee	Annual reduction in sedimentation (Acre-feet)	0	21.6	11.4	7.1[a]	20	Hydrographic soundings of transects
	Increase fish habitat and diversity	Dredging	Acre-feet of additional lake volume	0	230	140	Not Defined	8	Hydrographic soundings of transects
	Increase overwintering fish habitat	Dredging	Number of deep water holes (>6-8')	0	5	5	Not Measured	5	Hydrographic soundings of holes
	Improve water quality	Water Control Structure/ Inlet Channel Improvement	Dissolved Oxygen (mg/L)	<5	>5	>5	Avg range 9.62 to 10.6 mg/L	>5	Water quality testing
			Total Suspended Solids (mg/L)	300	Not Measured	<50	Avg range 16.3 to 20.7 mg/L	50	Water quality testing
Enhance Wetland Habitat	Increase bottomland hardwoods diversity	Plantings	Acres of mast trees	0	Not Measured	Not Measured	Not measured	35	Use forest inventory methods in 2019 to calculate canopy species composition and proportion of canopy species that are mast trees. Use aerial imagery in 2020 to calculate acreage of all trees. Adjust acreage of all trees using composition values generated from 2019 forest inventory data to generate a value for acreage of mast trees.[c] Repeat in 2029/2030 and 2039/2040.
			Density of mast trees	Not Measured	Not Measured	Not Measured	150 oaks/acre[b]	NA	Repeat in 2030 and 2040

a: Calculated for the 1995 to 2014 time period, b: Based on 2008 survey, c: Vegetation transects removed from monitoring schedule in 1997 PER

VII. SIGNIFICANT EVENTS SINCE LAST INSPECTION

Recent significant high water events are compiled in Table 3 below. All high water elevations exceeding flood stage at Brown's Lake since project completion are shown below. Elevations exceeding the deflection berm are highlighted.

Table 3: Recent High Water Events at the Site

High Water Elevations Since Project Completion http://water.weather.gov/ahps2/hydrograph.php?wfo=dvn&gage=blvi4 WS slope from 50-year flood profile (2004 Mississippi River FFS)	
Date	Elevation at Brown's Lake, ft. MSL 1912
4/22/2001	599.4
7/1/1993	598.3
4/20/2011	597.4
4/17/1997	597.0
6/14/2008	595.5
7/3/2014	595.4
4/28/2008	595.1

VIII. PROJECT SPONSOR UPDATES

The US Fish and Wildlife Service (USFWS) Operation and maintenance costs are tabulated and described in the table below.

Table 4: Sponsor O&M Costs

Fiscal Year	Cost	Description
FY14	$435	Inspections, mowing and gate operations
FY15	$505	Inspections, mowing and gate operations
FY16	$505	Inspections, mowing and gate operations

IX. DATE OF FIELD VISIT: July 26, 2017, Warm, overcast, mid 70's °F

X. ATTENDEES

Table 5 outlines the list of personnel who visited the site in 2017.

Table 5: 2017 Site Visit Attendees

Name	Office	Title	Number
Kara Mitvalsky	USACE – Rock Island	Environmental Engineer	(309) 794-5623
Steve Gustafson	USACE – Rock Island	Environmental Protection Specialist	(309) 794-5202
Madalyn Sowar	USACE – Rock Island	Civil Engineer	(309) 794-6962
Kaleigh Scott	USACE – Rock Island	Civil Engineer	(309) 794-5318
Tara Gambon	USACE – Rock Island	Engineering Intern	NA

Breann Popkin	USACE – Rock Island	Biologist	(309) 794-5817
Ben Vandermyde	USACE – Rock Island	Forester	(309) 794-4522
Dave Bierman	Iowa DNR	Team Leader	(563) 872-5495
Kirk Hanson	Iowa DNR	Wildlife Biologist	(563) 872-5700
Mike Griffin	Iowa DNR	Wildlife Biologist	(563) 872-5700
Forrest Fromm	Iowa DNR	Specialist	NA
Scott Gritters	Iowa DNR	Fisheries Biologist	(309) 880-8781
Sara Schmuecker	USFWS	Fish & Wildlife Biologist	(309) 757-5800
Russell Engelke	USFWS	Savanna District Assistant Manager	(815) 273-2732
Ed Britton	USFWS	Savanna District Manager	(815) 273-2732
Sharonne Baylor	USFWS	Environmental Engineer	(507) 494-6207
Brenna Smith	Iowa STEM	Extern Teacher	NA

XI. OBSERVATIONS

Forest:
The wetland forest within and around the main lake of the project area was inundated during the site visit; there was a limited acreage of forest that remained dry. Silver maple was dominant in canopy cover and overall looked very healthy. Isolated areas viewable from the path of the site visit route taken by vehicle and boat were showing significant signs of stress on the trees in the canopy. In general, the understory conditions observed during the site visit were predominantly void with no natural regeneration present. Heavy canopy shading of the forest floor appeared to be directly correlated to the areas that the understory was non-existent and void of sustainable saplings.

Dredge Placement Cells:
The west cell remains void of any hard mast trees. Willow and cottonwood trees have continued to develop with good form and vigor. The green ash within the west cell still appear to be healthy and show no signs of emerald ash borer damage.

The east cell remains densely populated with hard mast trees. The hard mast trees seen during the visit included: pin oak, northern red oak, bur oak, swamp white oak, northern pecan, and black walnut. The best surviving hard mast trees averaged 8” in diameter at breast height and 30’ tall. The density of the trees planted for the study from the university still continues to cause problematic growing conditions for the hard mast trees. Due to high survival, trees are overcrowded and half of these trees are in significant decline. Thinning of the competition around the best developing hard mast trees should occur within 1 or 2 growing seasons to reduce further stunting and stress to prevent higher a probability of mortality. Soft mast trees seen during the visit in the east cell included: black willow, boxelder, cottonwood, American elm, green ash, and silver maple. Soft mast trees range from 10’ to 50’ tall and are primarily of vigorous health. Less than 15% of the soft mast trees a showing signs of stress and overcrowding.

Dredge Cuts:
The channels and deep holes were still noticeable using the depth finder on boats. The depth finder on the boat was used to determine approximate depths of the dredge cuts shown in Figure 1. The depth below the top of water surface is unknown, and depths should be used only for a general understanding of dredge depth conditions. Additionally, less vegetation was noted in the deeper elevations of the channels. Bathymetry conducted in March 2017 of the dredge cuts, inlet channel and access channel was shared with the sponsors. Figure 2 provides a map of a portion of the surveyed area. Areas of sedimentation, residual overwintering habitat, and the presence of deep holes were discussed with the group, and then confirmed with boat depth finders.

In general, water clarity appeared much better (clearer) in the upstream ends of the project. The water between the river and the water controls structure was very muddy in appearance. The channel has been cleaned out several times since construction to ensure that water can be transported between the river and the water control structure. The structure is often kept closed during river flooding conditions to ensure that additional sediment is kept out of the backwater areas.

Smith's Creek continues to introduce sediment into Brown's Lake. However, the channels and deep hole closest to Smith's Creek were still observable during the site visit.

The further downstream of the project, in particularly near the outlet, the water clarity was degraded and appeared much muddier. At the downstream end of Lainsville Slough, significantly muddy water was observed mixing with the clear water leaving the dredge cuts. The IA DNR believes that the trees and berms provide a buffer, filtering out more heavily sediment water from entering the lake. This is something they have observed at Brown's Lake and at other locations in the River.

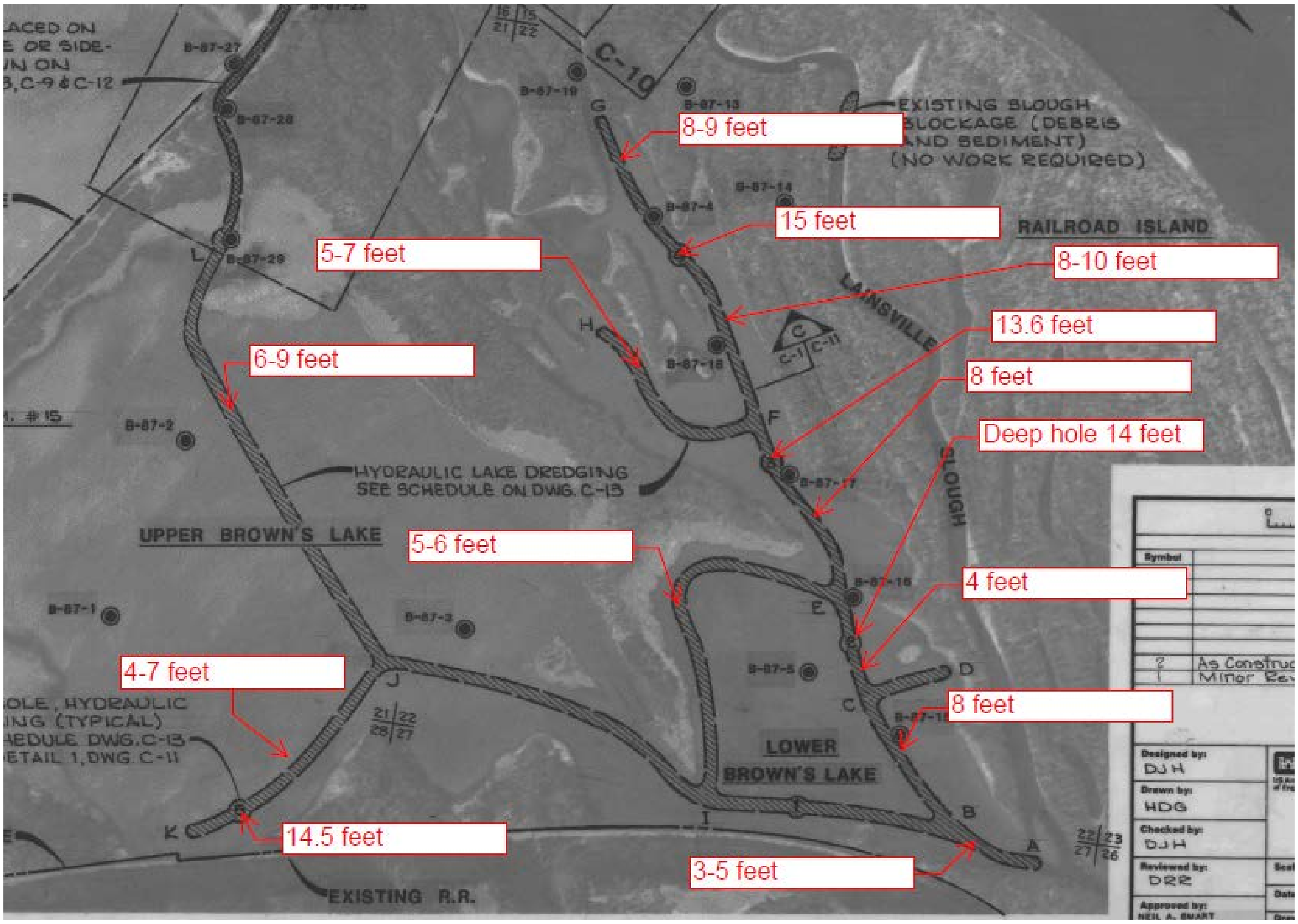


Figure 1: Boat Depth Finder Results (Brown's Lake elevation during site visit 589.54)

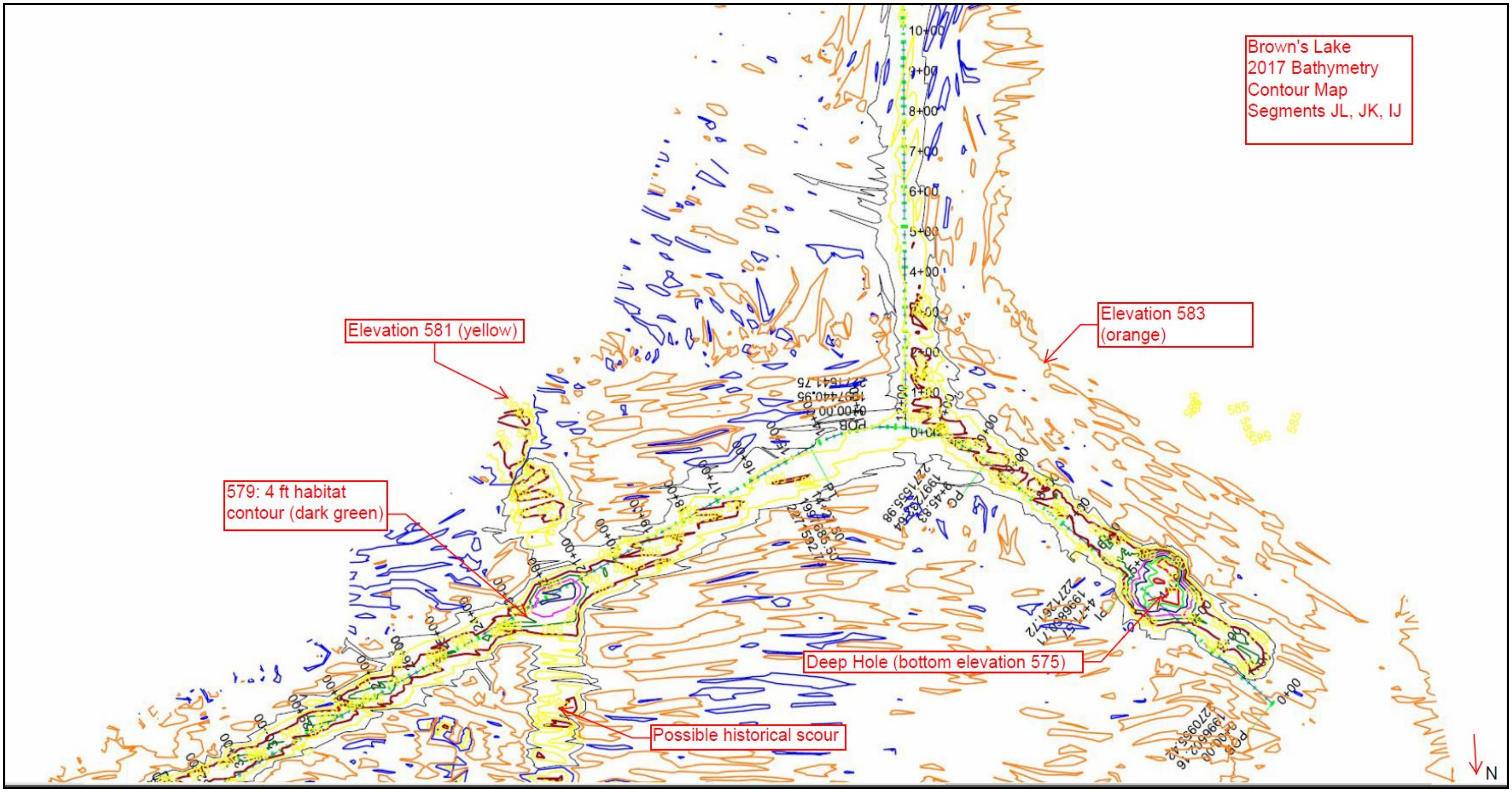


Figure 2: Preliminary Survey Data Segments JL, JL and IJ (2017)

The 90 degree bend connection to the river has observed heavy sedimentation. The inlet has been dredged at least three times since project completion, including one emergency dredging to clear a sediment plug and prevent winter fish kill.

In between the water control structure and where the access channel turns south away from the Green Island Levee, the channel was constructed nearly adjacent to the existing levee. Some minor erosion was observed at the levee toe.

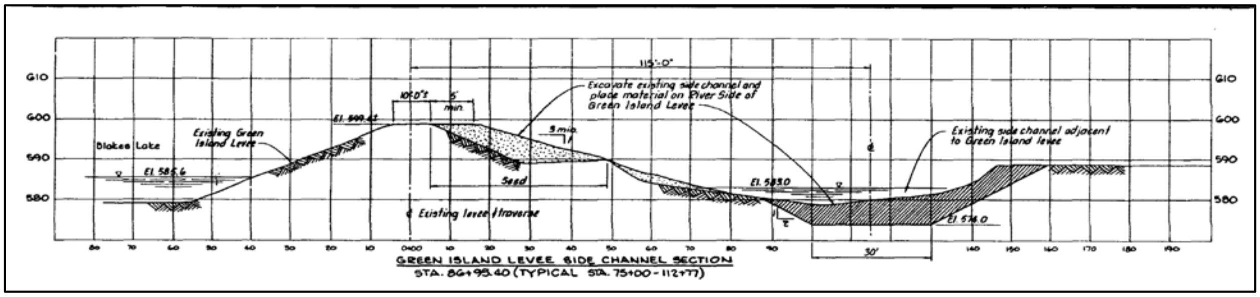


Figure 3: Channel Design Section Adjacent to Green Island Levee (Sheet C-12, O&M Manual)

For the initial portion south of the Green Island levee, the channel was mechanically excavated and sidecast. The sidecast material was used to repair the Green Island levee following a levee breach in 2008. Since the sidecast material was not serving as a project feature, there are no impacts to the HREP from this removal of material.

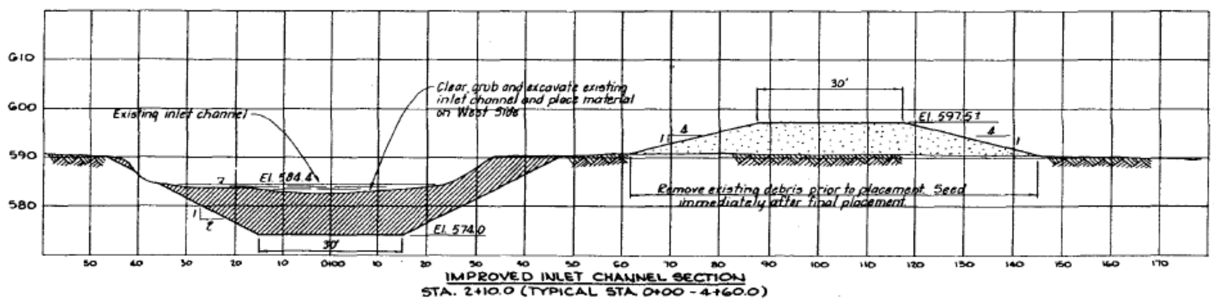


Figure 4: Inlet Channel Side Cast Design Drawing (C-12)

The Channel Lake Dredging and deep holes were hydraulically excavated, with dredged material placed into the Confined Disposal Facility. The design for the remaining channel lake dredging appeared to show a vertical cut. Due to limited as-builts available, it is uncertain if the Contractor constructed vertical cuts, or were just paid to the vertical pay line and that additional excavation may have occurred. Some slide slopes were constructed near the bottom of the deep holes, although surveyed as-builts of these conditions are also not available.

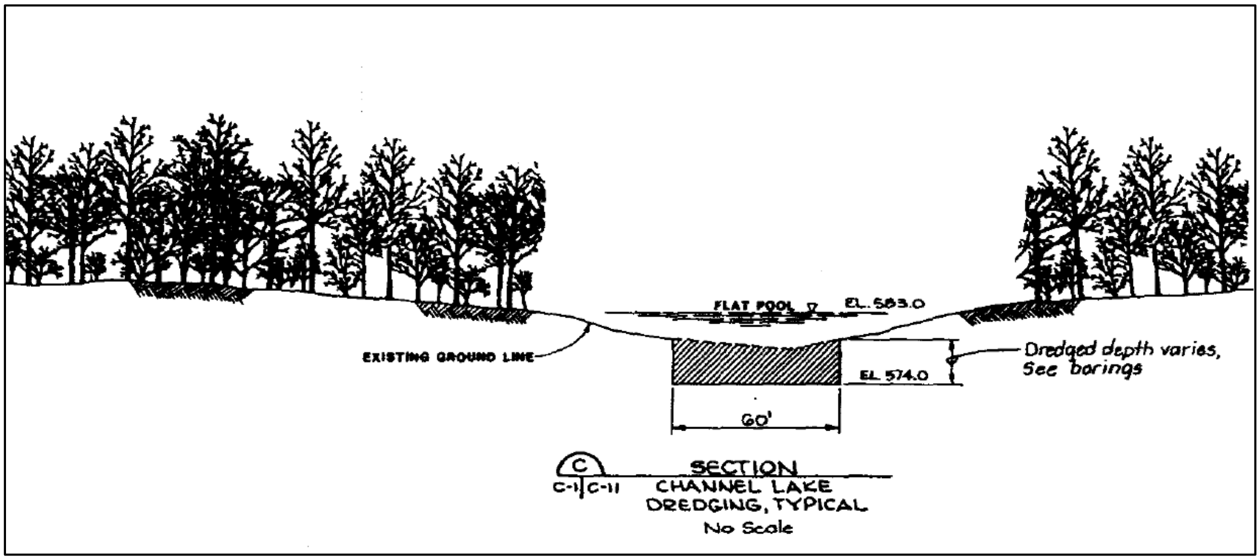


Figure 5: Channel Design for Lake Dredging (Sheet C-11 O&M Manual)

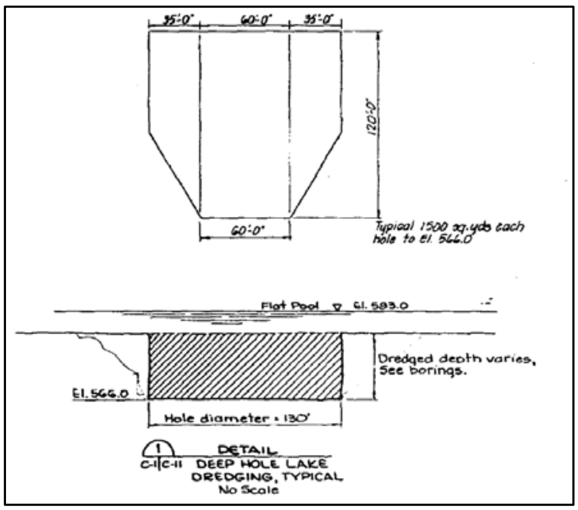


Figure 6: Channel Design for Deep Holes (Sheet C-11 O&M Manual)

Water Control Structure:

The water control structure consisted of four gates approximately 5 ft. x 5 ft. and is significantly oversized. One gate is typically opened about 0.5 – 1 ft. all winter to allow oxygenated water into the Lake. The gate is closed prior to the first high water event in the spring. Closing the structure reduced the amount of sediment introduced into the backwater lakes during flooding or high water conditions on the river. The gate opened in the winter is alternated yearly to prevent debris buildup. Maintenance of the gates includes winterizing and greasing of gears. Stop logs are available for maintenance but have not been used according to USFWS. The sponsor is satisfied with the operation of the water control structure.

At the inlet of the water control structure, the water appears to have a high sediment load. At the outlet of the water control structure, the water appears clear with algae. Denitrification benefits are suspected at Brown's Lake.

Deflection Levee:

As-built elevation for the top of the deflection levee is 597.6 ft. MSL 1912 at the lower end and 600 ft. MSL 1912 at the higher end. The sponsor noted overtopping of the deflection berm in July 1993 which inundated saplings in the northern terrestrial site. The berm overtopped in April 2001 as well. High water elevations exceeding flood stage are highlighted in Table 3. The sponsor continues to maintain this site by mowing. Reed canary grass as well as several wetland species were noted along the levee.

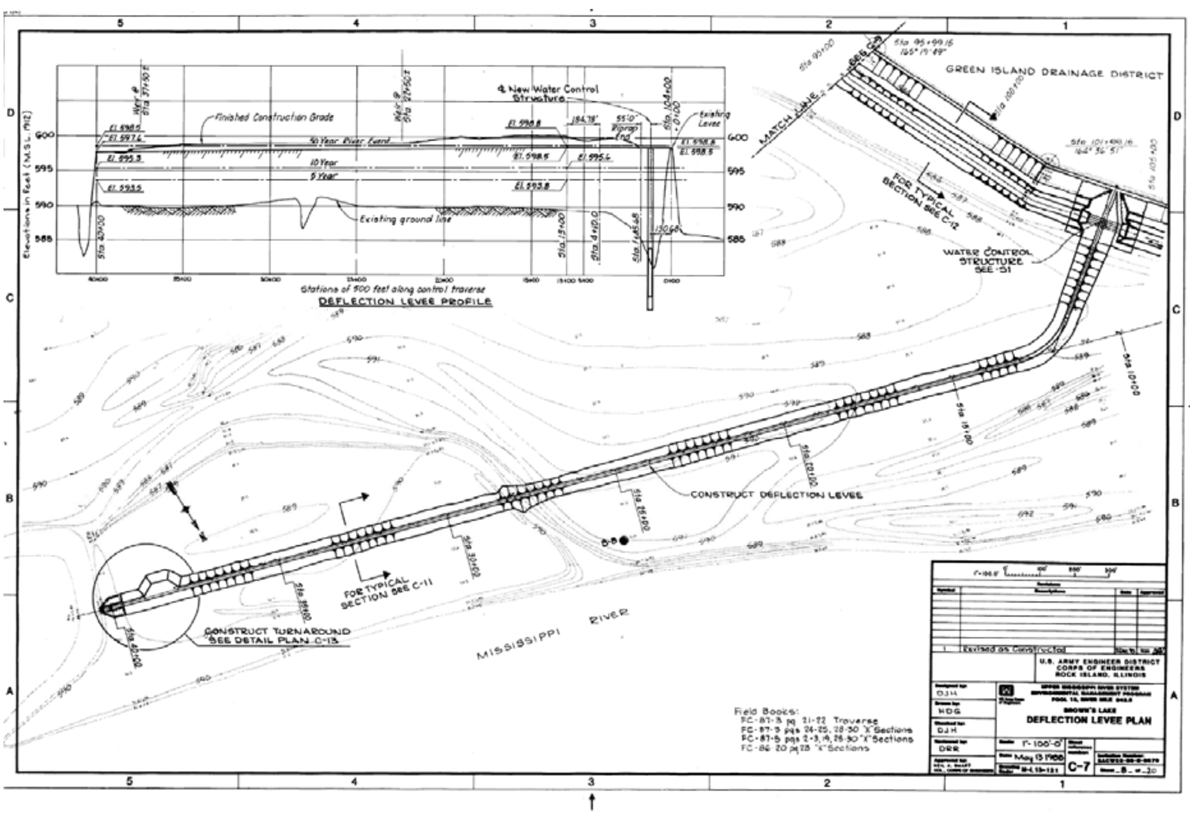


Figure 7: Deflection Levee (Sheet C-7 in O&M Manual)

Vegetation:

Vegetation along the spur dike and levee had recently been mowed to allow access to the project area. Plants noted growing along the levees included reed canary grass *(Phlaris arundinacea)*, buttonbush (*Cephalanthus occidentalis)*, swamp milkweed *(Asclepias incarnate)*, sensitive fern *(Onoclea sensibilis)*, swamp rose mallow *(Hibiscus moscheutos)* and smooth hedge nettle (*Stachys tenuifolia)*.

XII. REPORTS AND STUDIES

Evaluating the Effectiveness of a Mandatory Catch and Release Regulation on a Riverine Largemouth Bass Population:
Brown's Lake was used as a study area to evaluate the effectiveness of a mandatory catch-and-release regulation initiated there. The abundance and size structure of largemouth bass within the study area was found to have improved during the three years immediately following the implementation of this regulation. However, the regulation did not prove to have any long lasting effects. These results could be caused by natural variances in largemouth bass stocks, ineffectiveness at a small spatial scale, or voluntary catch-and-release practices pre-regulation. Refer to Attachment C for more details.

Hydrology and Hydraulics Observations and Data:
This document includes observations from the site visit specifically in reference to the hydrology and hydraulics at the site. Areas of vulnerability to wave wash erosion are noted along the dredge cuts. Locations of heavy sediment laden flow are also noted near the outlet of Brown's Lake in Lainsville Slough and Brown's Lake inlet channel. Further details can be found in the report in Attachment D regarding the spur dike, dredge cuts, inlet channel, water control structure, deflection levee, and outlet.

XIII. SUMMARY

Overall the Brown's Lake HREP appears to be generally meeting its goals and objectives through continued operation and maintenance by the US Fish and Wildlife Service, with assistance from the Iowa Department of Natural Resources.

XIV. RECOMMENDATIONS

- Monitor depths at inlet channel to ensure that water can access the water control structure.
- Monitor erosion along the Green Island Levee.
- Monitor sediment load from Smith Creek and Lainsville Slough.

XV. LESSONS LEARNED

- Projects should be designed to eliminate or minimize sedimentation at the inlet channel. Smaller water control structures may achieve desired results. The inlet structure consists of four (60" x 61") gates. Typically only one gate is opened to 10 inches. This allows for sufficient DO to enter the backwater complex, while keeping velocities relatively low.

  Since this project was constructed rock notches have been used in the Refuge for flow control rather than structures with movable gates.

- The varied nature of the materials present in dredged material placement sites needs to be taken into consideration when mast tree planting is proposed.

- Timing of mast tree plantings after dredged material is placed should also be taken into account. Tree plantings done later (approximately 4 years following dredged material placement) did much better than those done directly following placement.
- Consider all sedimentation sources, outside of the main stem river. At Brown's Lake, sediment sources include Smith's Creek and Lainsville Slough.

Attachment A
Site Visit Photos

Site Inspection Team

Inlet Channel

Inlet Channel going south
from Green Island Levee

Inlet Channel
downstream of WCS

Inlet Channel
upstream of WCS

Green Island Levee

Inlet Channel going south from Green Island levee

Toe erosion on Green Island levee

Water Control Structure

CDF Cells

South CDF cell with stunted growth

Berm between CDF cells

North CDF cell with willows

Brown’s Lake

Brown’s Lake

Lainsville Slough mixing with
Brown’s Lake

Sediment from Smith Creek

Brown's Lake

Deeper water not filled with vegetation

Wildlife

Heron

Egret

Bald Eagle

Snake

Frog

Wildlife

Migratory Waterfowl

Vegetation

Fern

Vegetation on levee

Attachment B
Site Plan and Monitoring Plan Plates

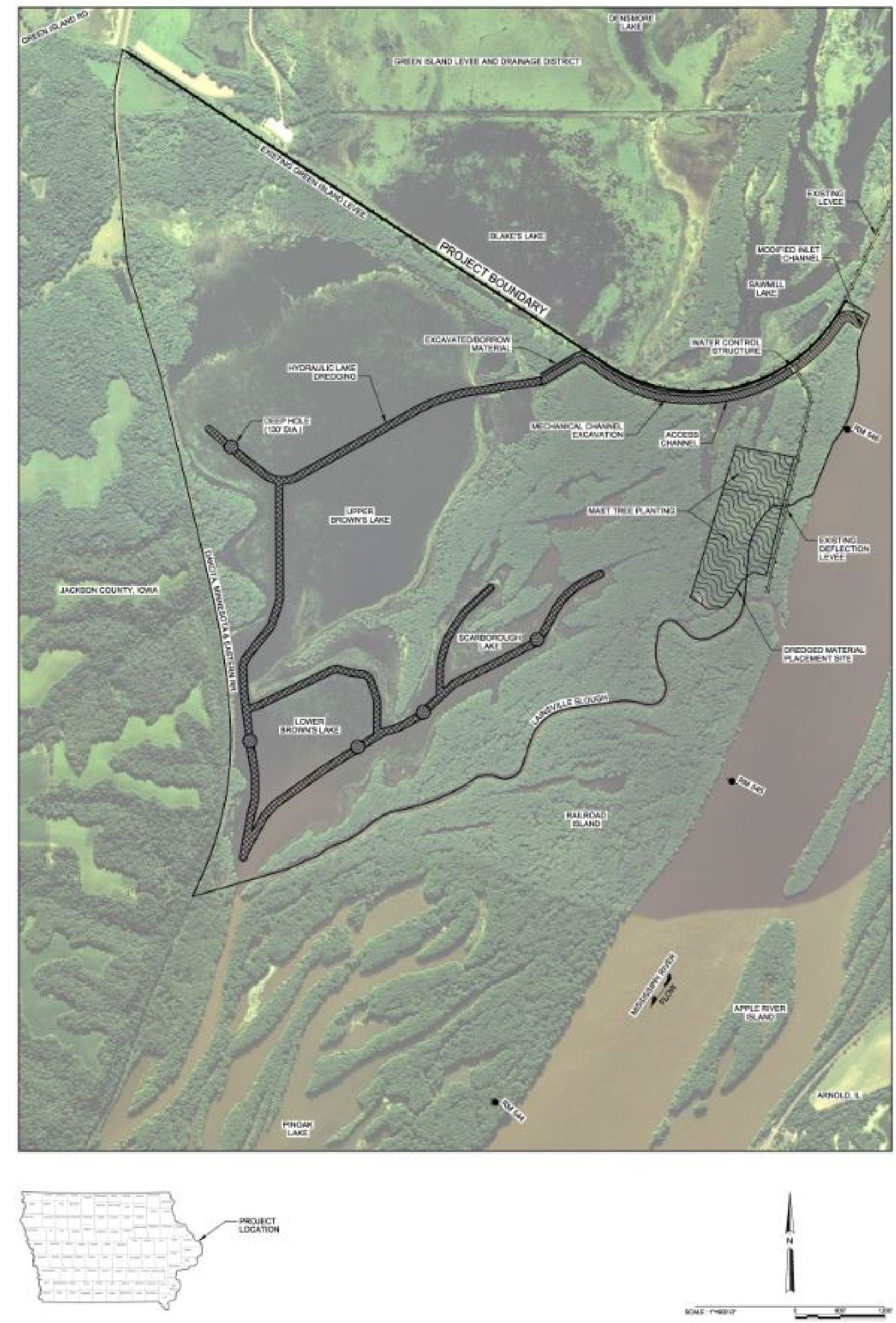
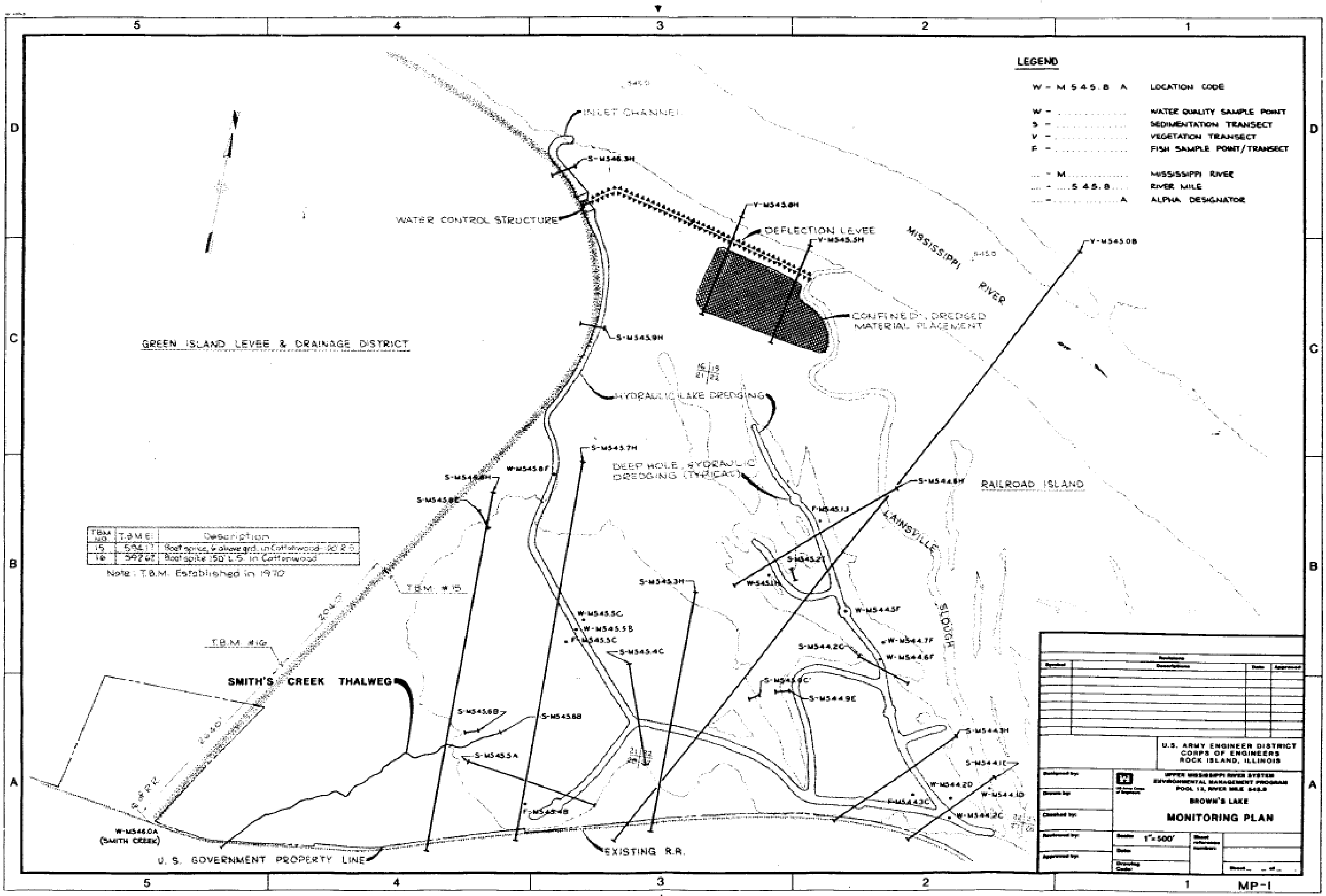
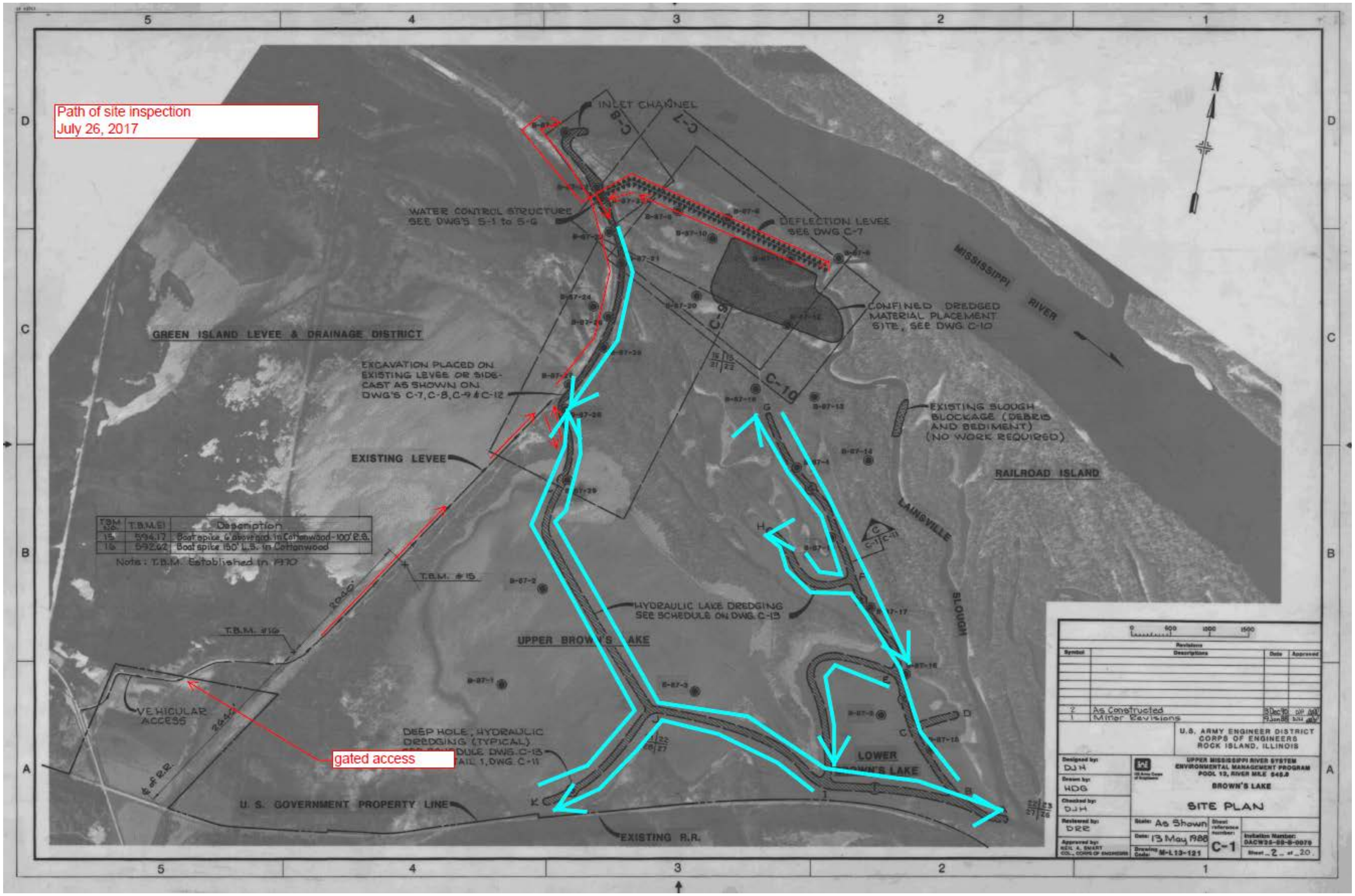


EXHIBIT 1

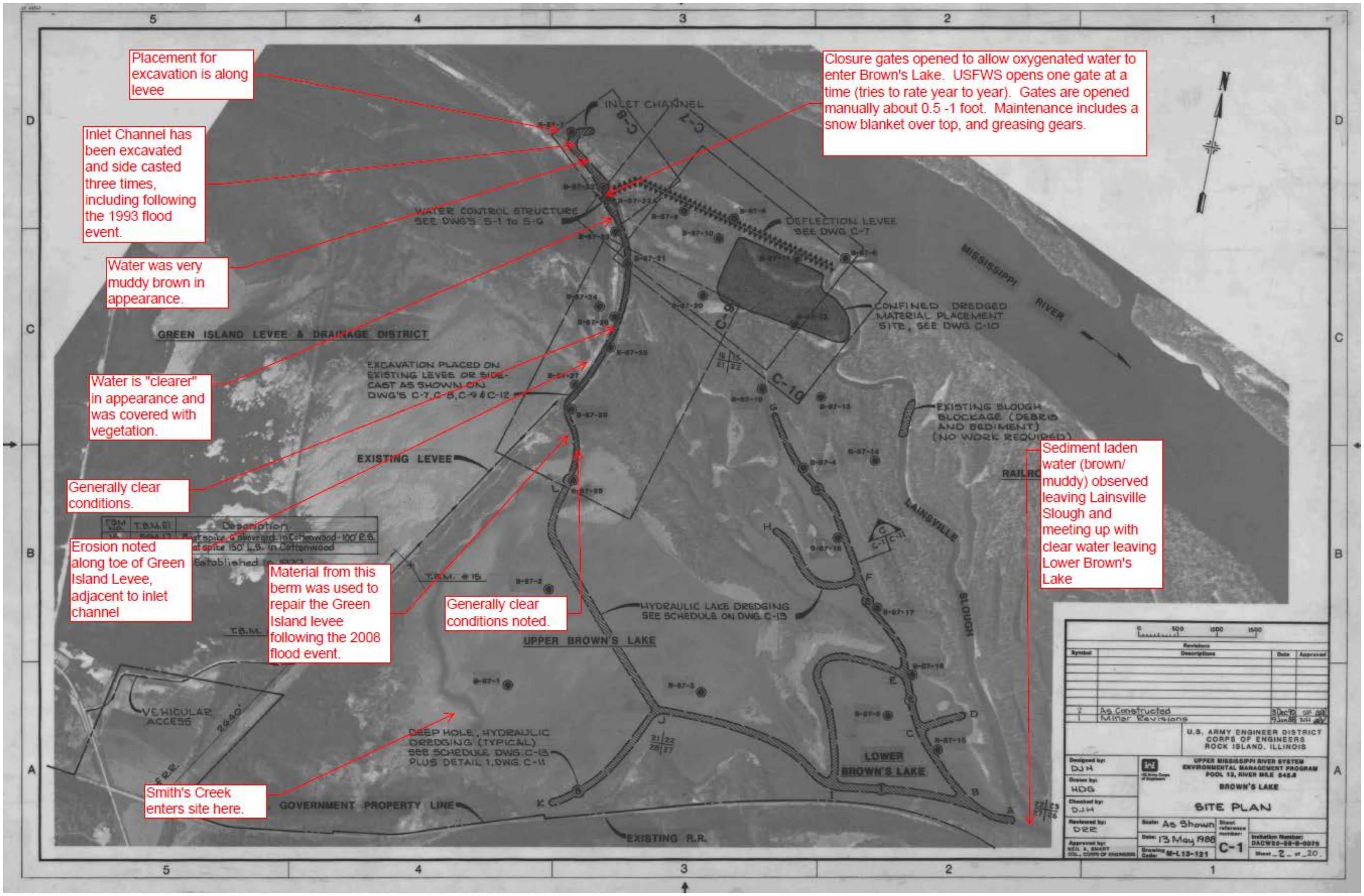
BROWN'S LAKE SITE PLAN

US Army Corps of Engineers

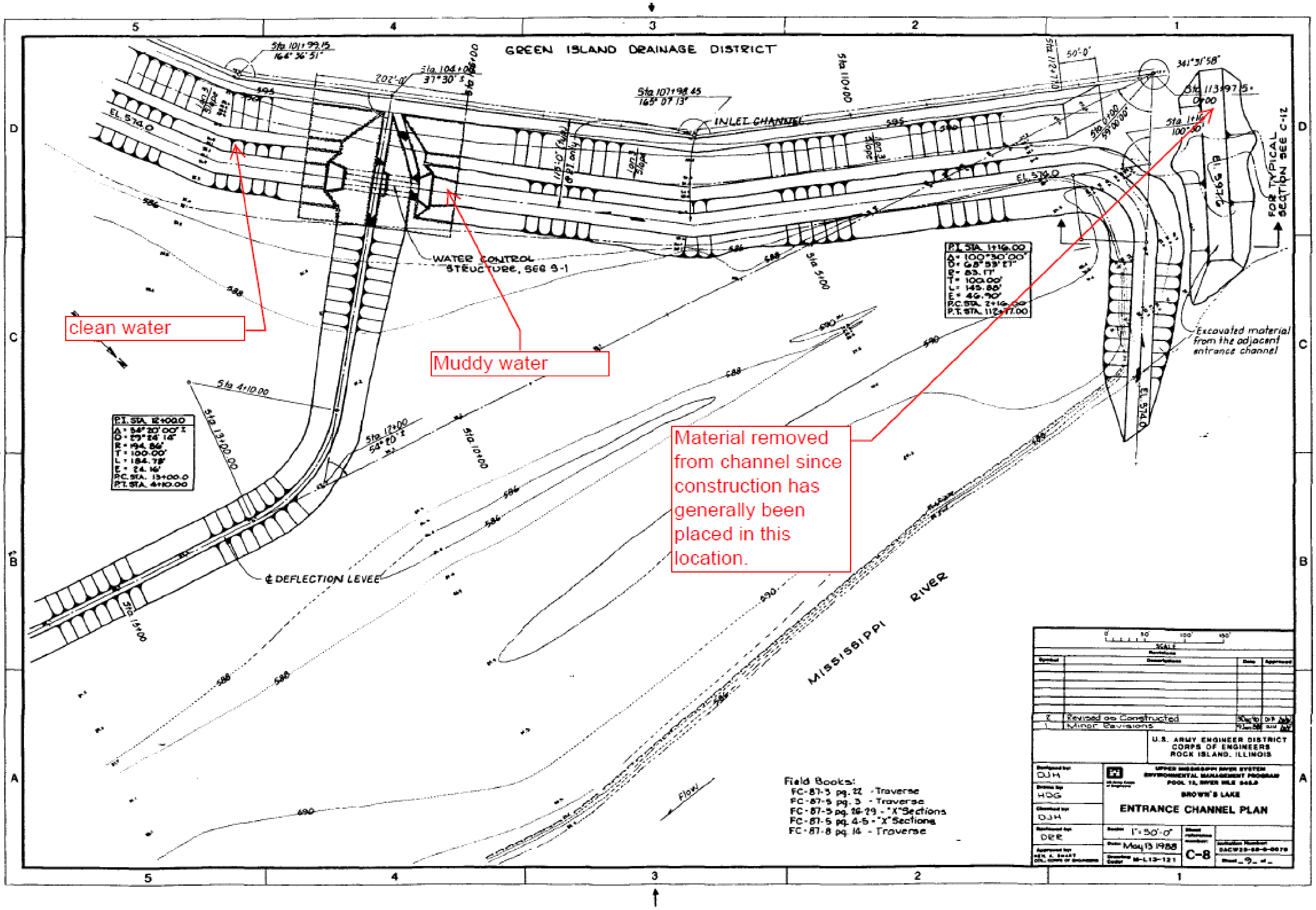

LEGEND
W - M 5 4 5 . 8 A LOCATION CODE
W - WATER QUALITY SAMPLE POINT
S - SEDIMENTATION TRANSECT
V - VEGETATION TRANSECT
F - FISH SAMPLE POINT/TRANSECT
... - M ... MISSISSIPPI RIVER
... - ... 5 4 5 . 8 ... RIVER MILE
... - ... A ALPHA DESIGNATOR
INLET CHANNEL
WATER CONTROL STRUCTURE
DEFLECTION LEVEE
MISSISSIPPI RIVER
CONFINED DREDGED MATERIAL PLACEMENT
GREEN ISLAND LEVEE & DRAINAGE DISTRICT
HYDRAULIC LAKE DREDGING
DEEP HOLE, HYDRAULIC DREDGING (TYPICAL)
RAILROAD ISLAND
LAINSVILLE SLOUGH
T.B.M. #15
T.B.M. #16
SMITH'S CREEK THALWEG
W-M546.0A (SMITH CREEK)
U. S. GOVERNMENT PROPERTY LINE
EXISTING R.R.
Note: T.B.M. Established in 1970
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
BROWN'S LAKE
MONITORING PLAN
1"=500'
MP-1

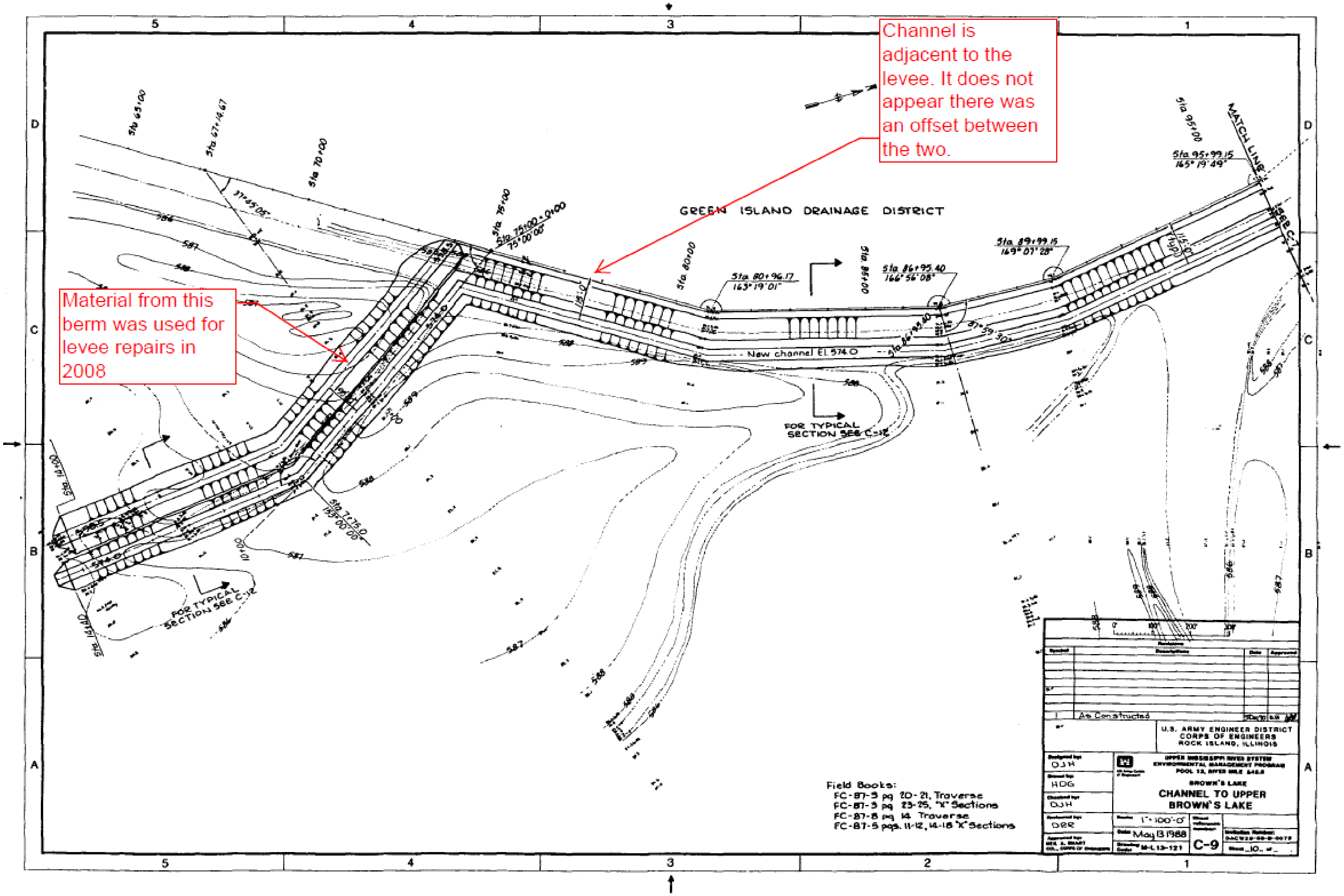


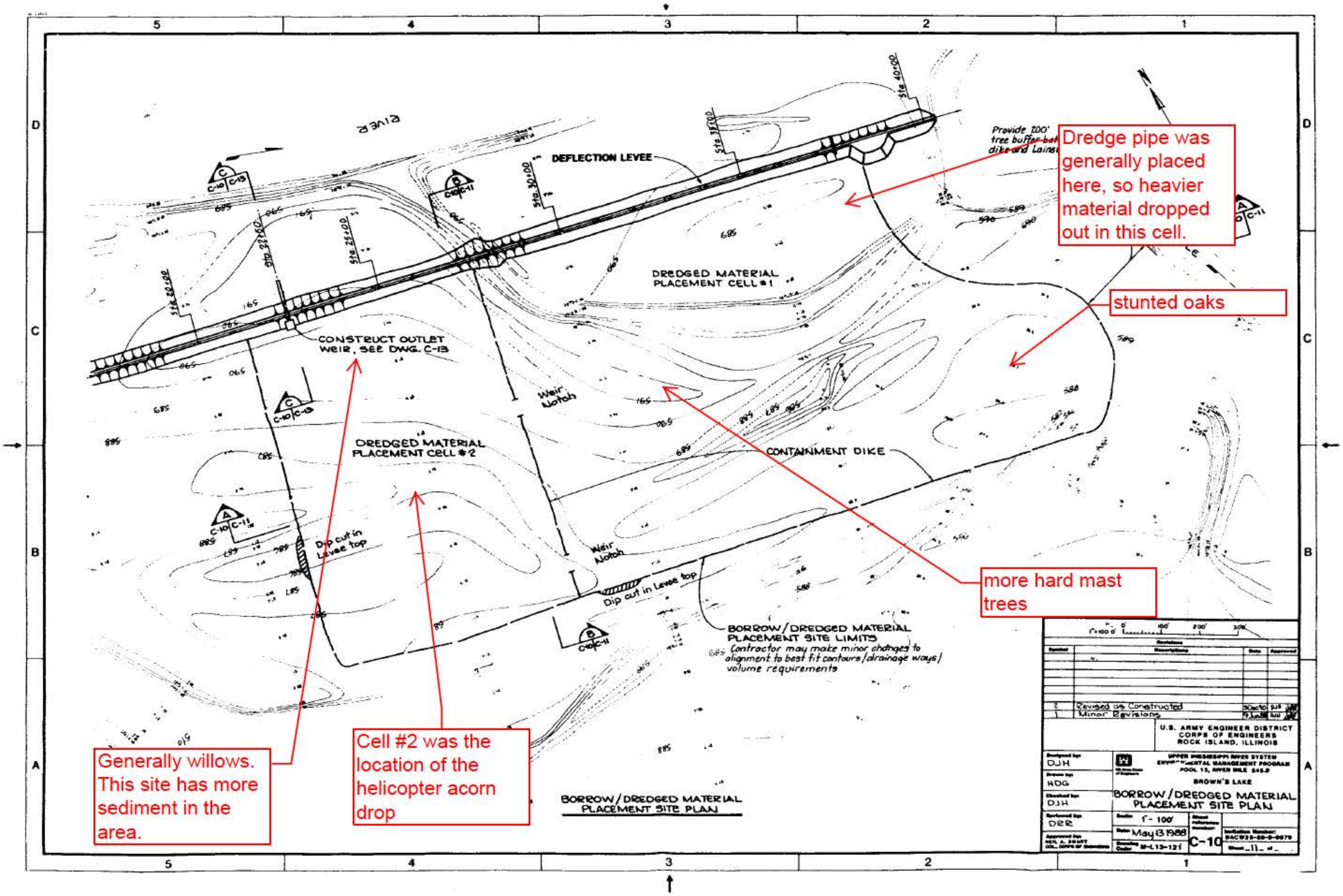
Path of site inspection
July 26, 2017
INLET CHANNEL
WATER CONTROL STRUCTURE SEE DWG'S S-1 to S-6
DEFLECTION LEVEE SEE DWG C-7
MISSISSIPPI RIVER
CONFINED DREDGED MATERIAL PLACEMENT SITE, SEE DWG C-10
GREEN ISLAND LEVEE & DRAINAGE DISTRICT
EXCAVATION PLACED ON EXISTING LEVEE OR SIDE-CAST AS SHOWN ON DWG'S C-7, C-8, C-9 & C-12
EXISTING SLOUGH BLOCKAGE (DEBRIS AND SEDIMENT) (NO WORK REQUIRED)
EXISTING LEVEE
RAILROAD ISLAND
LAINSVILLE SLOUGH
Note: T.B.M. Established in 1970
T.B.M. #15
T.B.M. #16
HYDRAULIC LAKE DREDGING SEE SCHEDULE ON DWG. C-13
UPPER BROWN'S LAKE
VEHICULAR ACCESS
DEEP HOLE, HYDRAULIC DREDGING (TYPICAL)
gated access
LOWER BROWN'S LAKE
U. S. GOVERNMENT PROPERTY LINE
EXISTING R.R.
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 545.8
BROWN'S LAKE
SITE PLAN
As Constructed
Minor Revisions
Scale: As Shown
Date: 13 May 1988
C-1



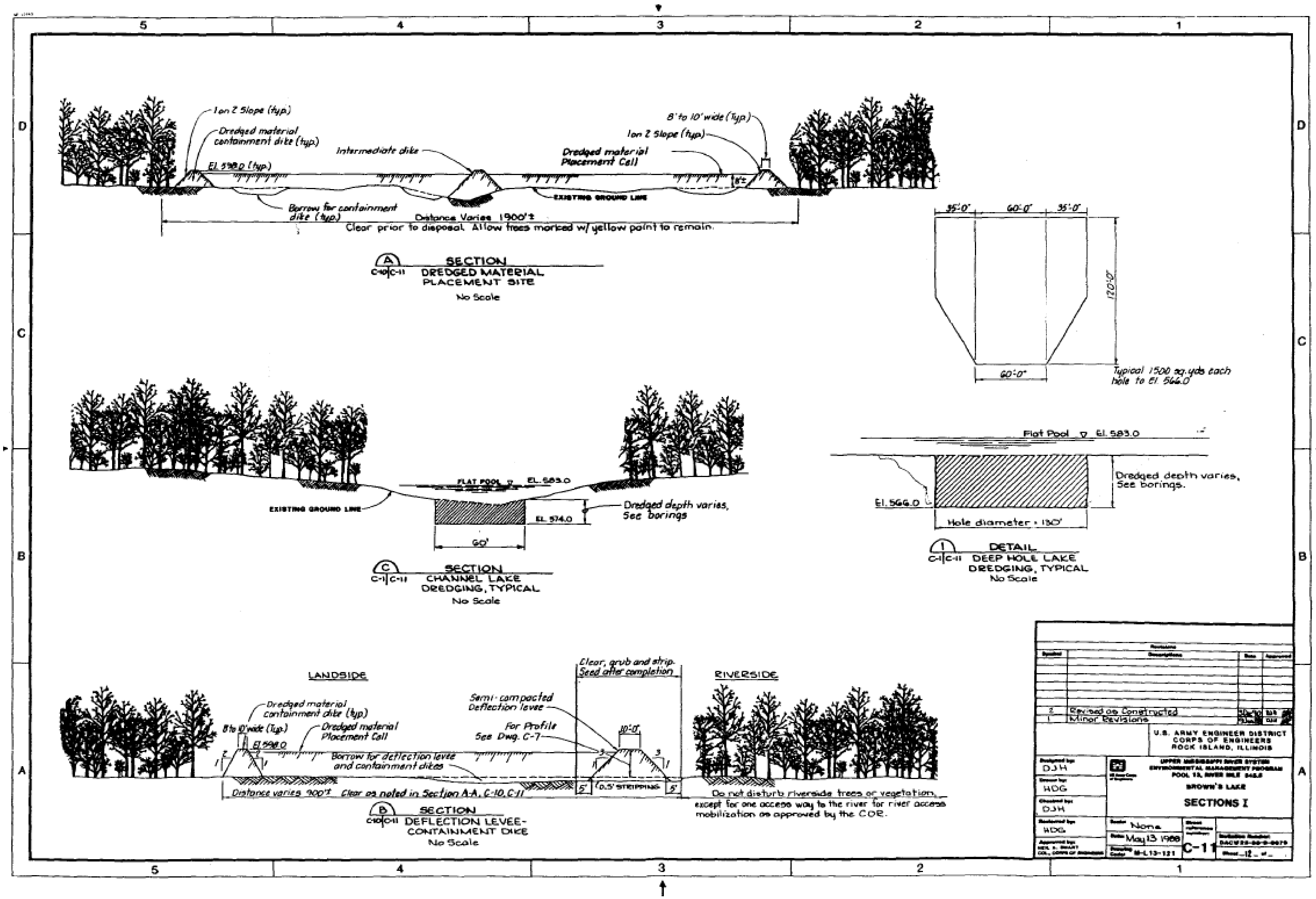
Placement for excavation is along levee
Inlet Channel has been excavated and side casted three times, including following the 1993 flood event.
Water was very muddy brown in appearance.
Water is "clearer" in appearance and was covered with vegetation.
Generally clear conditions.
Erosion noted along toe of Green Island Levee, adjacent to inlet channel
Material from this berm was used to repair the Green Island levee following the 2008 flood event.
Generally clear conditions noted.
Smith's Creek enters site here.
Closure gates opened to allow oxygenated water to enter Brown's Lake. USFWS opens one gate at a time (tries to rate year to year). Gates are opened manually about 0.5 -1 foot. Maintenance includes a snow blanket over top, and greasing gears.
Sediment laden water (brown/ muddy) observed leaving Lainsville Slough and meeting up with clear water leaving Lower Brown's Lake
INLET CHANNEL
WATER CONTROL STRUCTURE SEE DWG'S S-1 to S-6
DEFLECTION LEVEE SEE DWG C-7
MISSISSIPPI RIVER
CONFINED DREDGED MATERIAL PLACEMENT SITE, SEE DWG C-10
GREEN ISLAND LEVEE & DRAINAGE DISTRICT
EXCAVATION PLACED ON EXISTING LEVEE OR SIDE-CAST AS SHOWN ON DWG'S C-7, C-8, C-9 & C-12
EXISTING SLOUGH BLOCKAGE (DEBRIS AND SEDIMENT) (NO WORK REQUIRED)
EXISTING LEVEE
LAINSVILLE SLOUGH
HYDRAULIC LAKE DREDGING SEE SCHEDULE ON DWG C-13
UPPER BROWN'S LAKE
VEHICULAR ACCESS
DEEP HOLE, HYDRAULIC DREDGING (TYPICAL) SEE SCHEDULE DWG C-13 PLUS DETAIL 1, DWG C-11
LOWER BROWN'S LAKE
GOVERNMENT PROPERTY LINE
EXISTING R.R.
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 545.8
BROWN'S LAKE
SITE PLAN
As Constructed
Minor Revisions
Scale: As Shown
Date: 13 May 1986
C-1

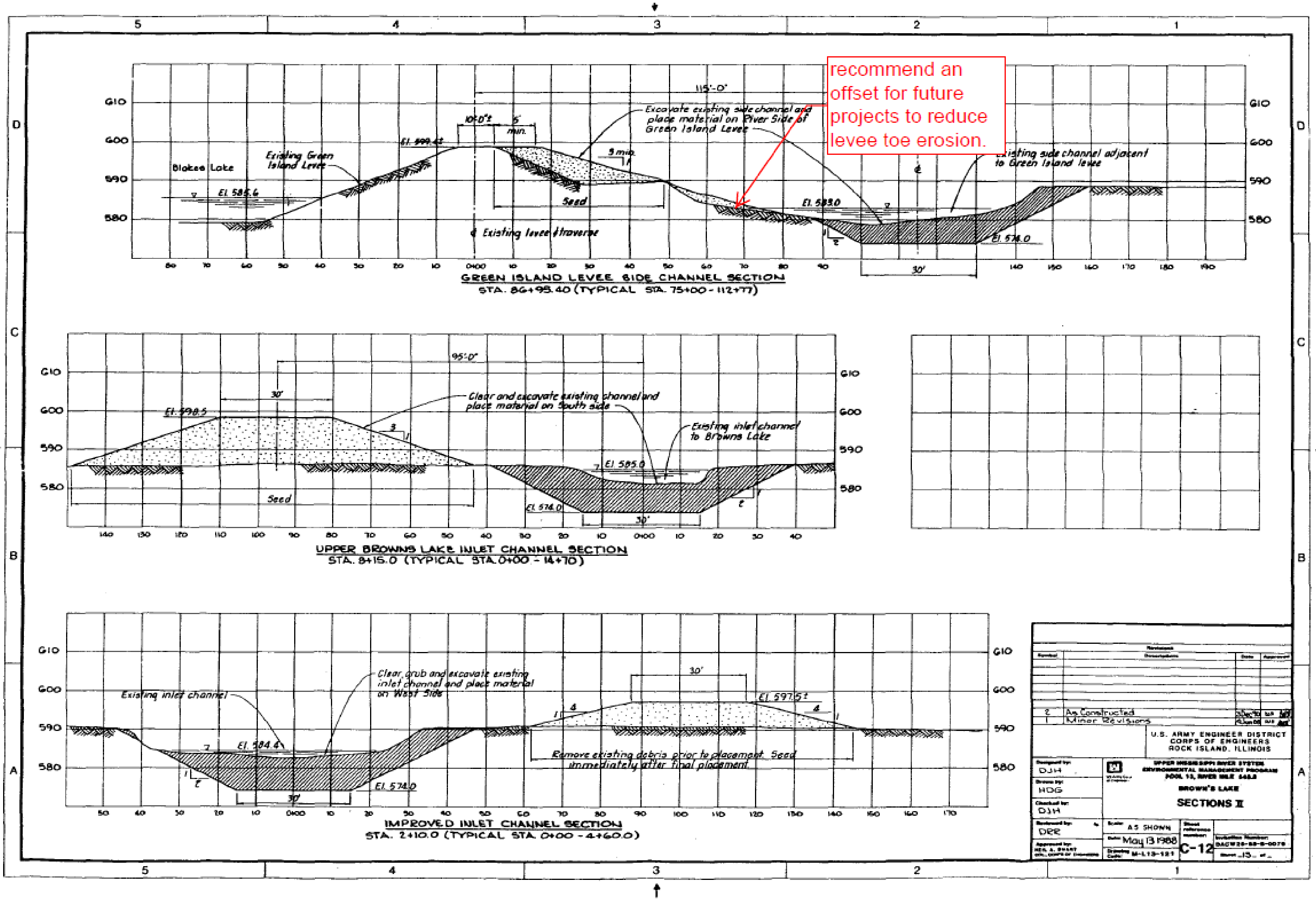

GREEN ISLAND DRAINAGE DISTRICT
INLET CHANNEL
WATER CONTROL STRUCTURE, SEE 9-1
clean water
Muddy water
Material removed from channel since construction has generally been placed in this location.
℄ DEFLECTION LEVEE
MISSISSIPPI RIVER
Flow
Excavated material from the adjacent entrance channel
FOR TYPICAL SECTION SEE C-12
Field Books:
FC-87-3 pg. 22 - Traverse
FC-87-5 pg. 3 - Traverse
FC-87-5 pg. 26-29 - "X" Sections
FC-87-5 pg. 4-5 - "X" Sections
FC-87-8 pg. 14 - Traverse
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
BROWN'S LAKE
ENTRANCE CHANNEL PLAN
C-8


Channel is adjacent to the levee. It does not appear there was an offset between the two.
Material from this berm was used for levee repairs in 2008
GREEN ISLAND DRAINAGE DISTRICT
Sta 65+00
Sta 67+14.67
Sta 70+00
Sta 75+00
Sta 75+00 = 0+00
75°00'00"
Sta 80+00
Sta 80+96.17
165°19'01"
Sta 85+00
Sta 86+95.40
166°56'08"
Sta 89+99.15
169°07'28"
Sta 95+00
Sta 95+99.15
165°19'49"
MATCH LINE
New channel El 574.0
FOR TYPICAL SECTION SEE C-12
Sta 7+75.0
Field Books:
FC-87-5 pg 20-21, Traverse
FC-87-5 pg 23-25, "X" Sections
FC-87-8 pg 14 Traverse
FC-87-5 pgs. 11-12, 14-18 "X" Sections
As Constructed
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
BROWN'S LAKE
CHANNEL TO UPPER BROWN'S LAKE
OJH
HDG
OJH
ORR
1" = 100'-0"
May 13 1988
C-9
Sheet 10 of

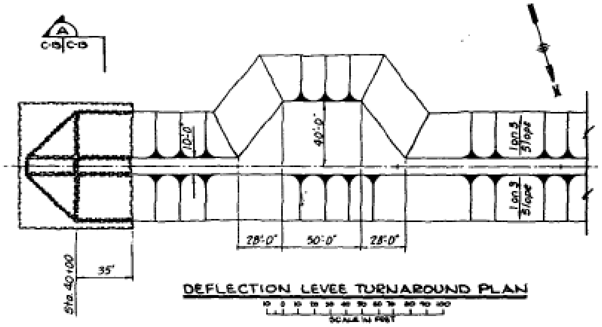


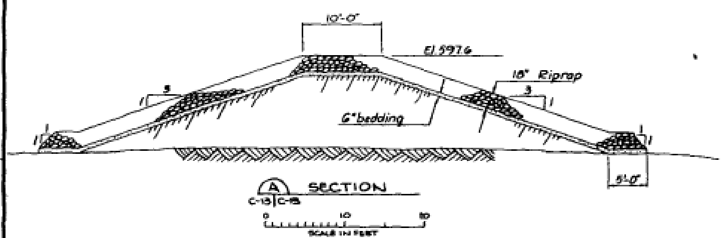
DEFLECTION LEVEE
DREDGED MATERIAL PLACEMENT CELL #1
DREDGED MATERIAL PLACEMENT CELL #2
CONSTRUCT OUTLET WEIR, SEE DWG. C-13
Weir Notch
CONTAINMENT DIKE
Dip cut in Levee top
BORROW/DREDGED MATERIAL PLACEMENT SITE LIMITS
Contractor may make minor changes to alignment to best fit contours/drainage ways/volume requirements
Provide 200' tree buffer between dike and Lainsville
BORROW/DREDGED MATERIAL PLACEMENT SITE PLAN
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
BROWN'S LAKE
Revised as Constructed
Minor Revisions
DJH
HDG
DRR
1" - 100'
May 13 1988
C-10
Dredge pipe was generally placed here, so heavier material dropped out in this cell.
stunted oaks
more hard mast trees
Generally willows. This site has more sediment in the area.
Cell #2 was the location of the helicopter acorn drop

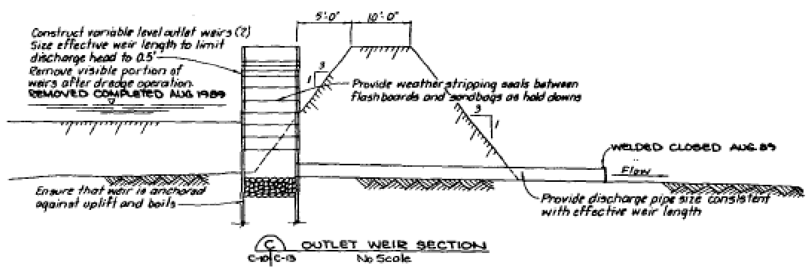

1 on 2 Slope (typ.)
Dredged material containment dike (typ.)
Intermediate dike
El. 598.0 (typ.)
Borrow for containment dike (typ.)
Distance Varies 1900'±
Clear prior to disposal. Allow trees marked w/ yellow paint to remain.
8' to 10' wide (Typ.)
1 on 2 Slope (typ.)
Dredged material Placement Cell
EXISTING GROUND LINE
SECTION
DREDGED MATERIAL PLACEMENT SITE
No Scale
35'-0"
60'-0"
35'-0"
120'-0"
60'-0"
Typical 1500 sq.yds each hole to El. 566.0
FLAT POOL
EL. 583.0
EXISTING GROUND LINE
Dredged depth varies, See borings
EL. 574.0
60'
SECTION
CHANNEL LAKE DREDGING, TYPICAL
No Scale
Flat Pool
El. 583.0
Dredged depth varies, See borings.
El. 566.0
Hole diameter = 130'
DETAIL
DEEP HOLE LAKE DREDGING, TYPICAL
No Scale
LANDSIDE
Dredged material containment dike (typ.)
8 to 10' wide (Typ.)
El. 598.0
Dredged material Placement Cell
Borrow for deflection levee and containment dikes
Semi-compacted Deflection levee
For Profile See Dwg. C-7
Clear, grub and strip. Seed after completion
10'-0"
0.5' STRIPPING
RIVERSIDE
Distance varies 900'± Clear as noted in Section A-A, C-10, C-11
Do not disturb riverside trees or vegetation, except for one access way to the river for river access mobilization as approved by the COR.
SECTION
DEFLECTION LEVEE-CONTAINMENT DIKE
No Scale
2 Revised as Constructed
1 Minor Revisions
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
DJH
HDG
DJH
HDG
BROWN'S LAKE
SECTIONS I
None
May 13 1988
C-11



recommend an offset for future projects to reduce levee toe erosion.
GREEN ISLAND LEVEE SIDE CHANNEL SECTION
STA. 86+95.40 (TYPICAL STA. 75+00 - 112+77)
UPPER BROWNS LAKE INLET CHANNEL SECTION
STA. 8+15.0 (TYPICAL STA. 0+00 - 14+70)
IMPROVED INLET CHANNEL SECTION
STA. 2+10.0 (TYPICAL STA. 0+00 - 4+60.0)
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
BROWN'S LAKE
SECTIONS II
C-12







HYDRAULIC DREDGING SCHEDULE

Channel Dredging	Length	Width	Bottom of dredge Cut, Elevation	Square Yards
A - B	750'	60'	574	5,000
B - C	1100'	60'	574	7,400
C - D	550'	60'	574	3,700
C - E	650'	60'	574	4,400
E - F	1210'	60'	574	8,100
F - G	2250'	60'	574	15,000
F - H	1400'	60'	574	9,400
E - I	2700'	60'	574	18,000
B - I	1500'	60'	574	10,000
I - J	2450'	60'	574	16,400
J - K	1710'	60'	574	11,400
J - L	3250'	60'	574	21,700
	19,520			130,500

Deep Holes	Diameter			Square Yards
①	130'		566	1500
②	130'		566	1500
③	130'		566	1500
④	130'		566	1500
⑤	130'		566	1500
				7,500

Symbol	Description	Date	Approved
2	Revised as Constructed		
1	Minor Revisions		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: DJH
Drawn by: HDG
Checked by: DJH
Reviewed by: DRE

BROWN'S LAKE

DETAILS AND DREDGING SCHEDULE

Scale: As shown
Date: May 13 1988
Drawing Code: M-L13-121
C-13
Sheet 14

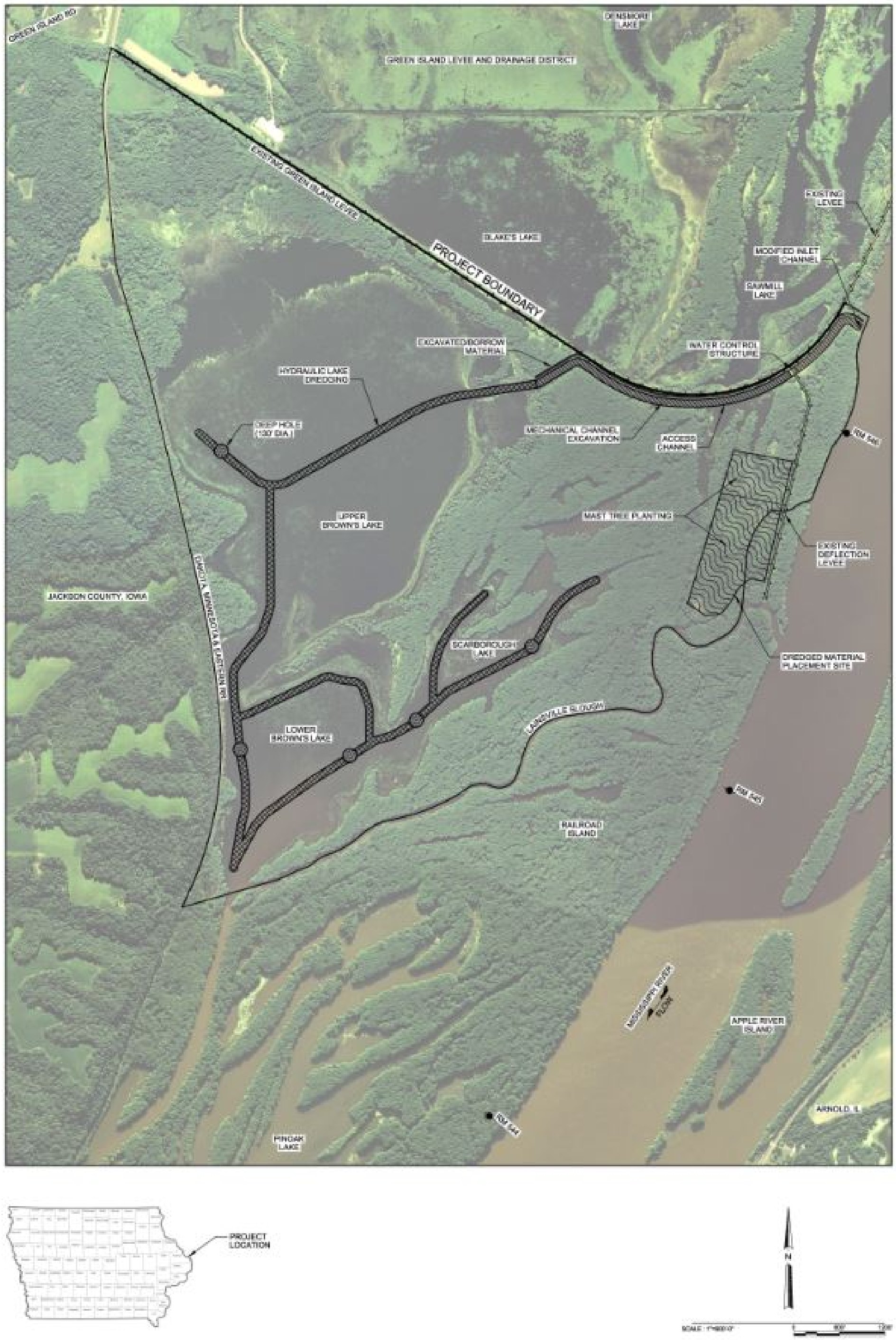
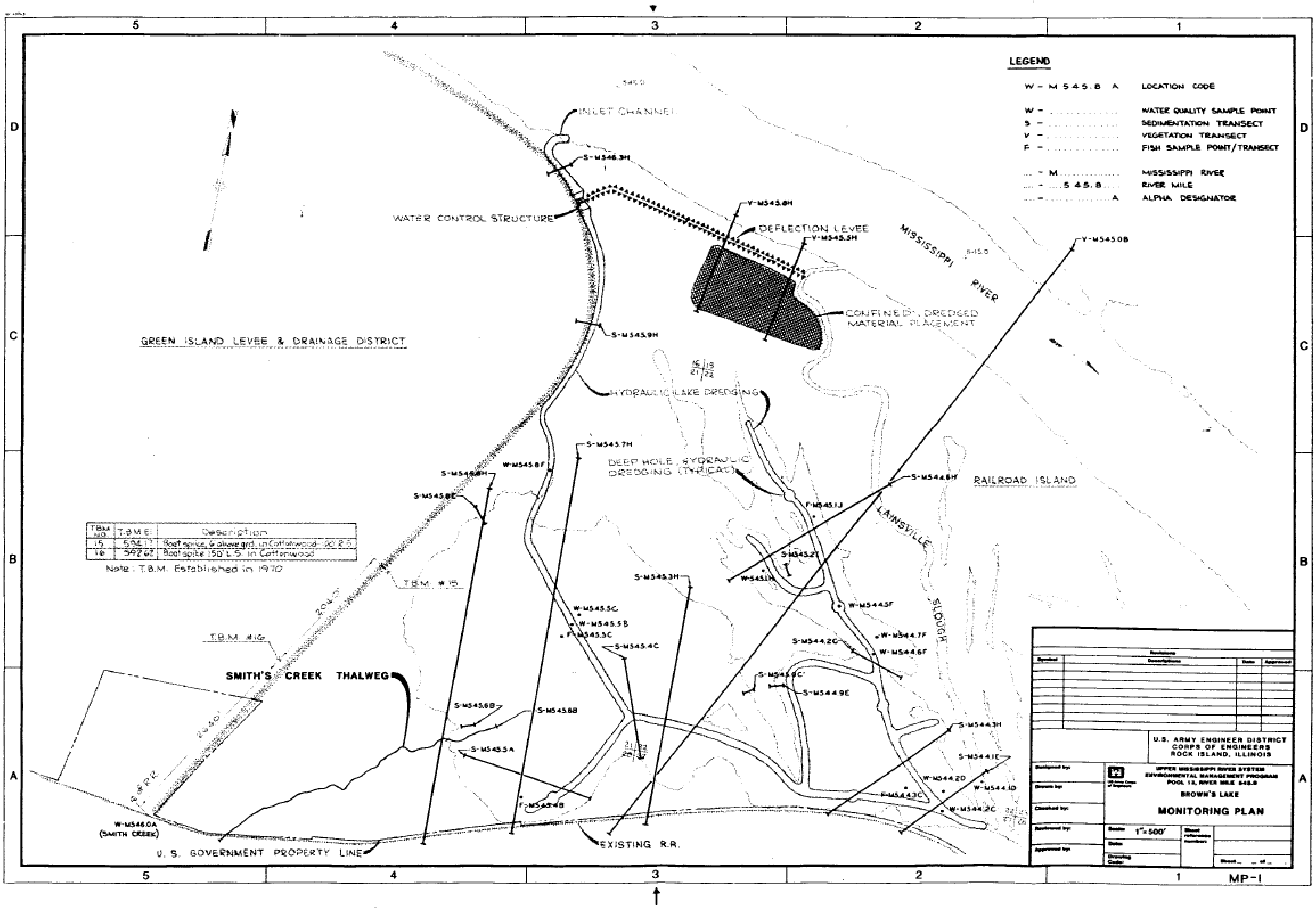


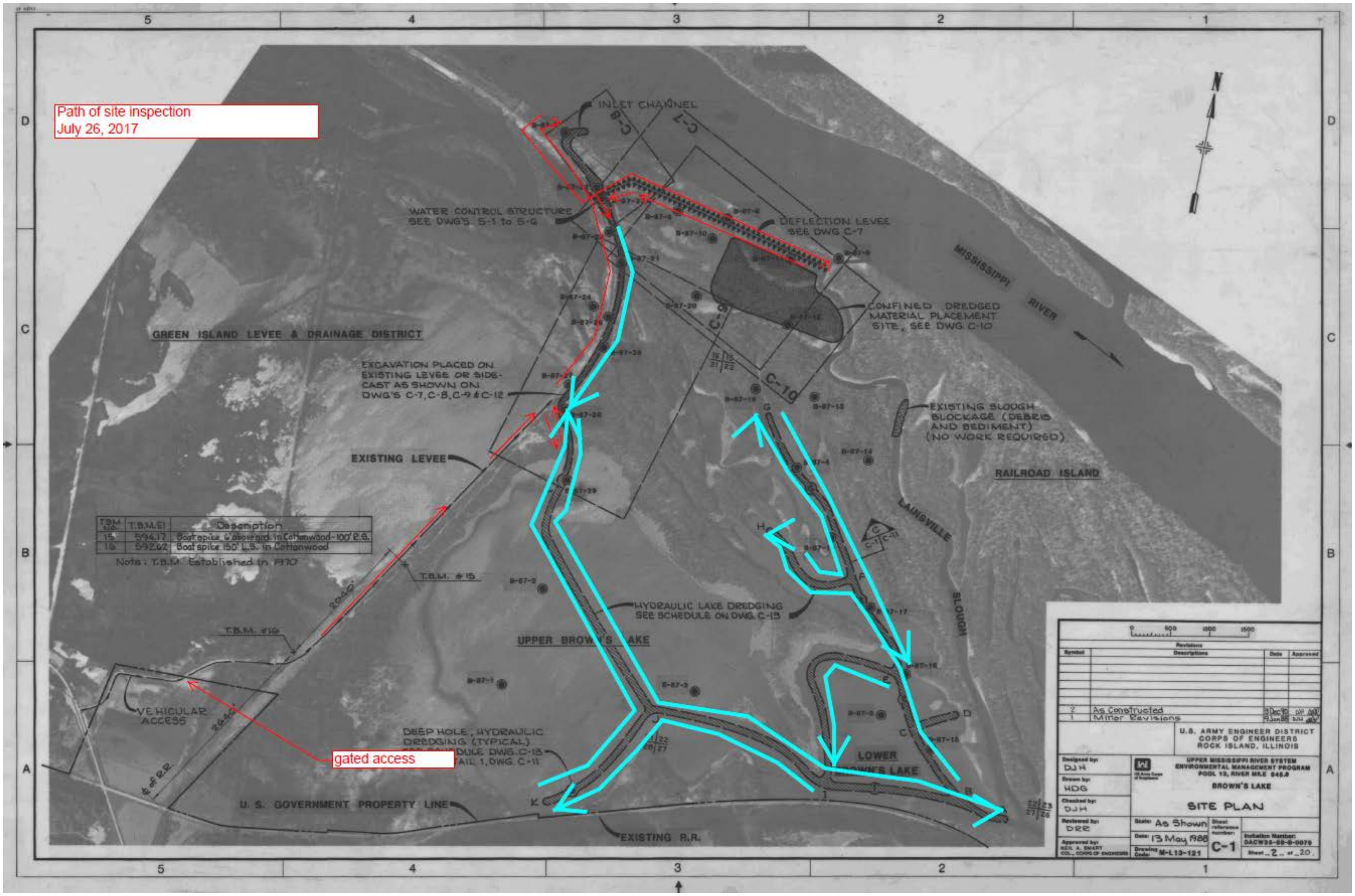
EXHIBIT 1

BROWN'S LAKE SITE PLAN

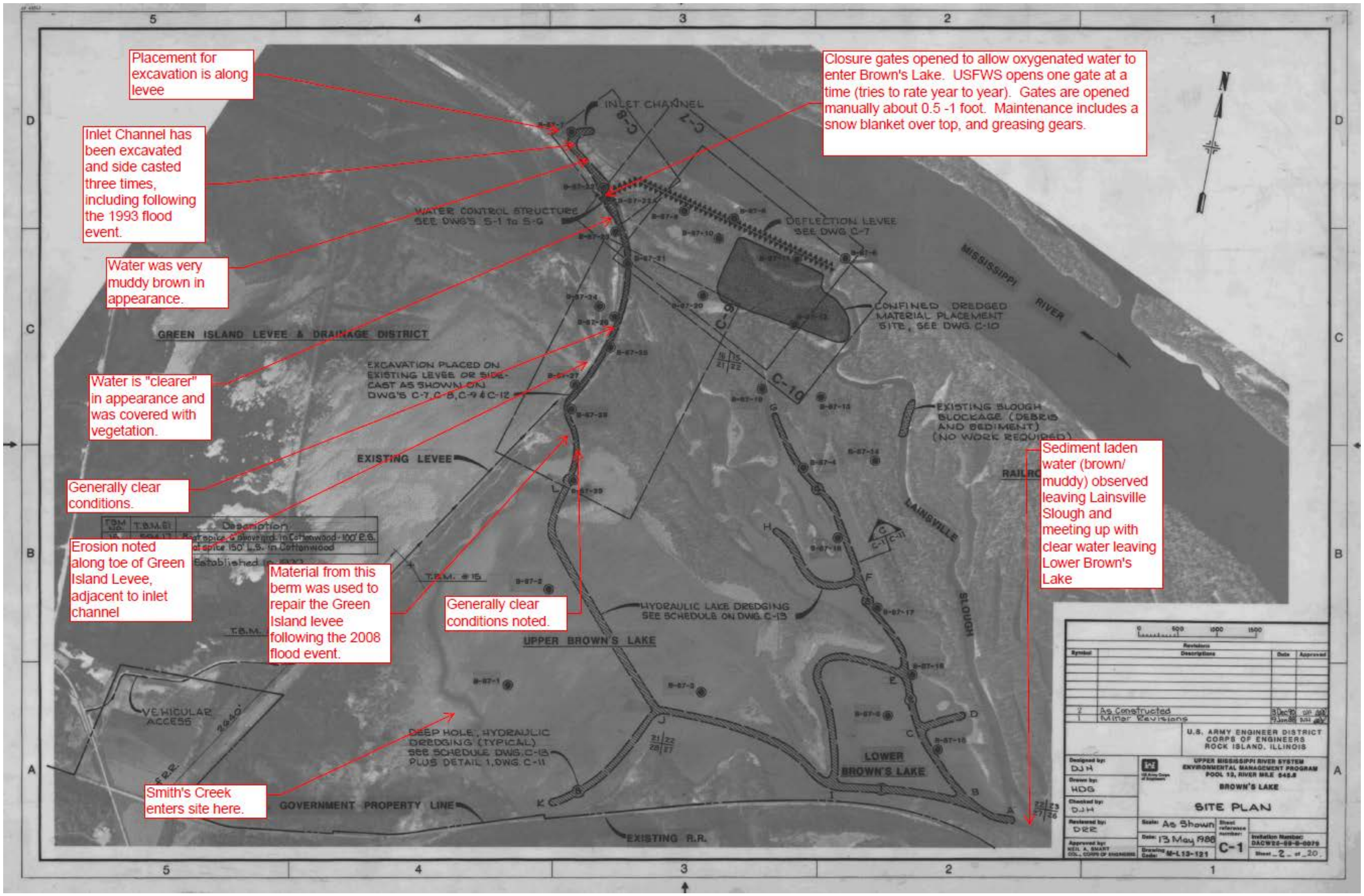
US Army Corps of Engineers



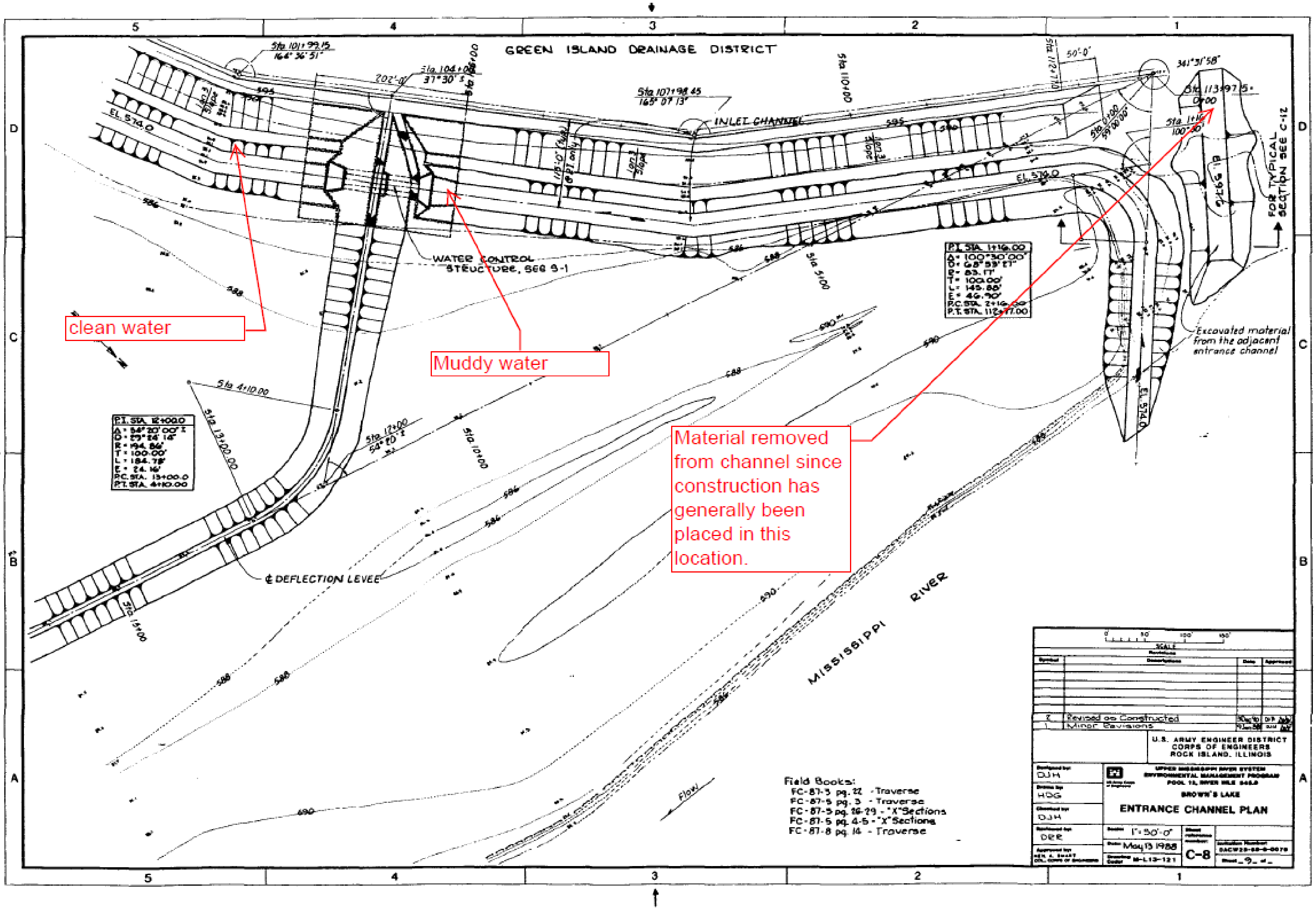
T.B.M. NO.	T.B.M. E.	Description
15	594.17	Roof spike, 6' above grd. in Cottonwood
16	592.62	Roof spike 150' L.S. in Cottonwood

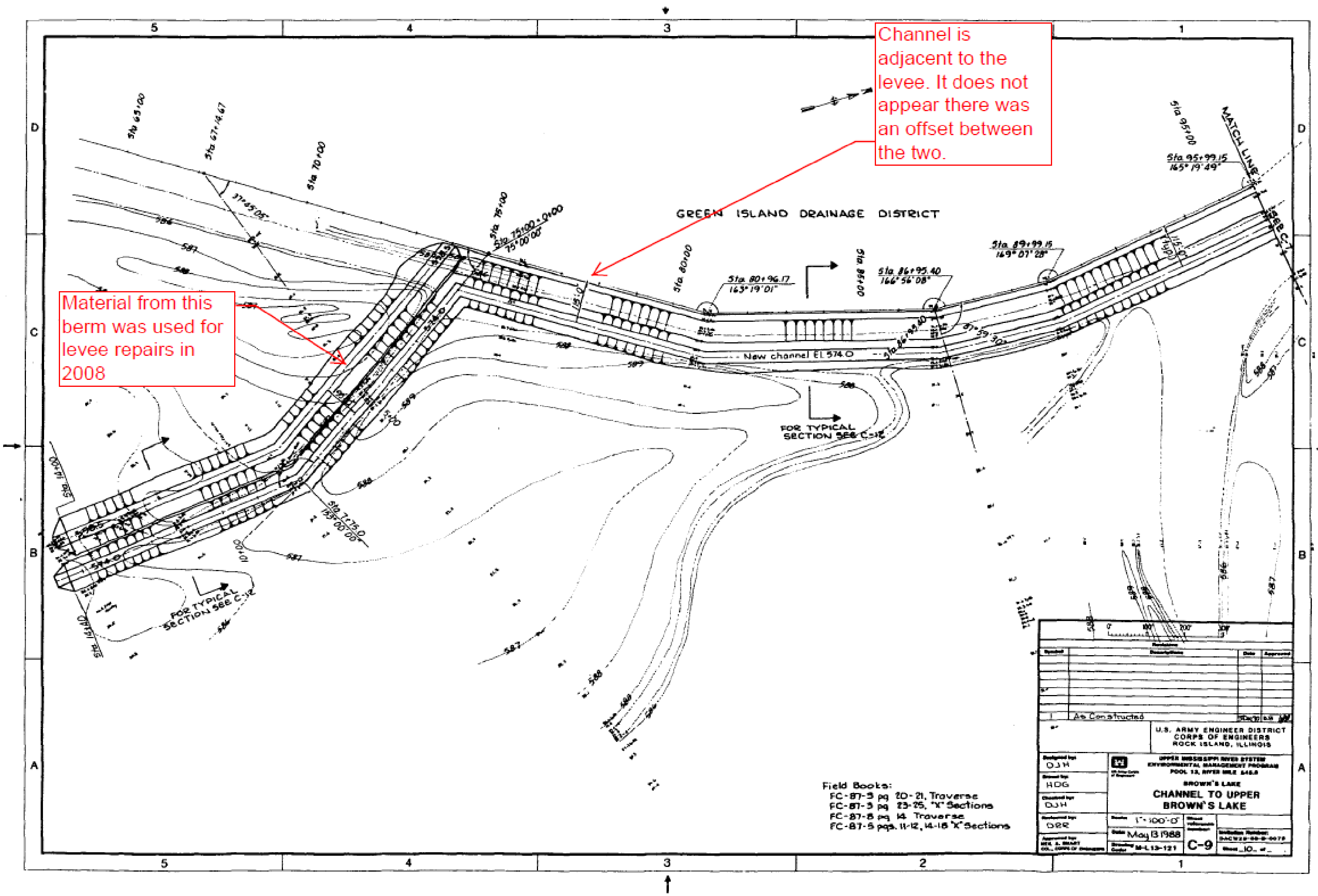


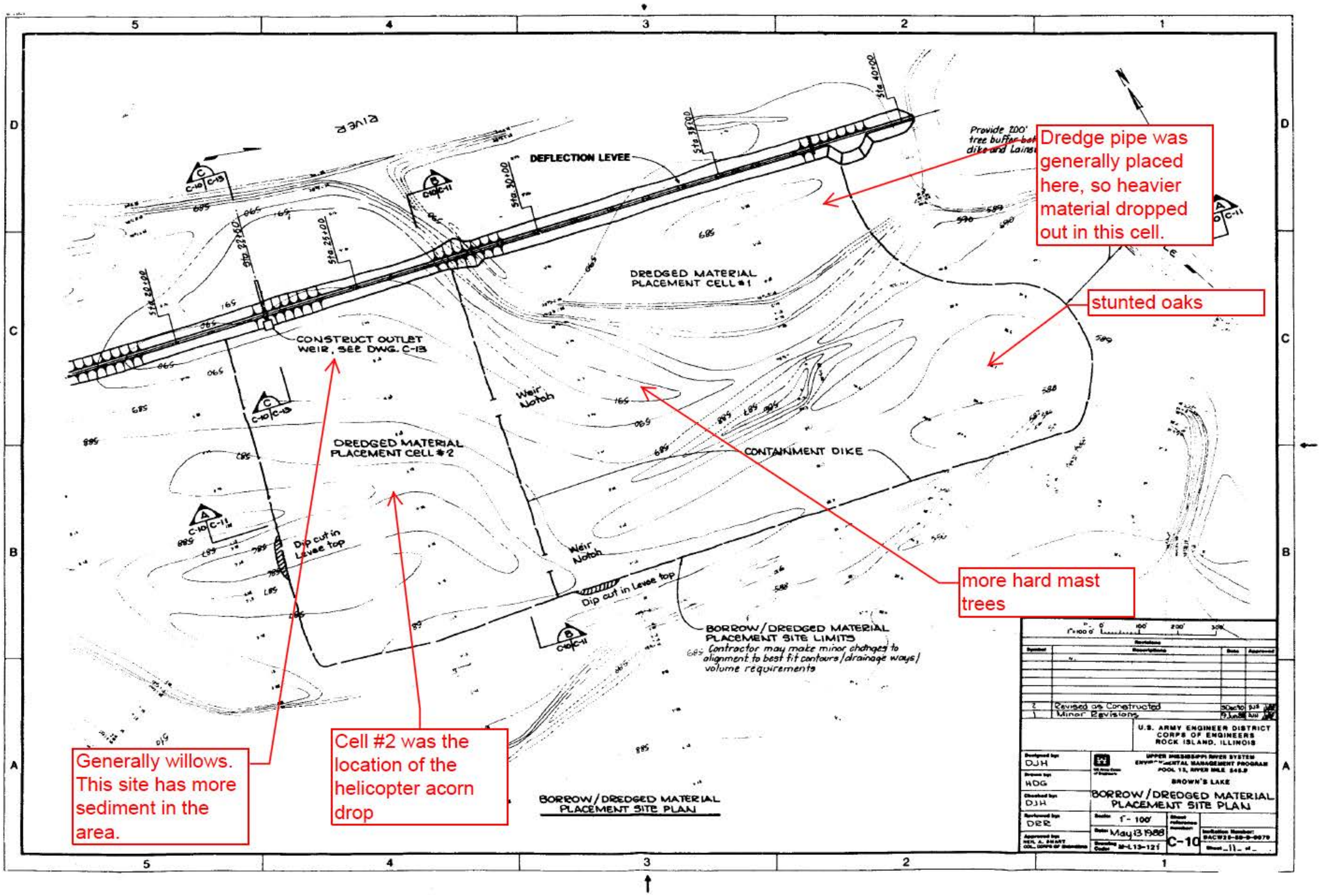
Path of site inspection
July 26, 2017
INLET CHANNEL
WATER CONTROL STRUCTURE SEE DWG'S S-1 to S-6
DEFLECTION LEVEE SEE DWG C-7
MISSISSIPPI RIVER
CONFINED DREDGED MATERIAL PLACEMENT SITE, SEE DWG C-10
GREEN ISLAND LEVEE & DRAINAGE DISTRICT
EXCAVATION PLACED ON EXISTING LEVEE OR SIDE-CAST AS SHOWN ON DWG'S C-7, C-8, C-9 & C-12
EXISTING SLOUGH BLOCKAGE (DEBRIS AND SEDIMENT) (NO WORK REQUIRED)
EXISTING LEVEE
RAILROAD ISLAND
LAINSVILLE SLOUGH
Note: T.B.M. Established in 1970
T.B.M. #15
T.B.M. #16
HYDRAULIC LAKE DREDGING SEE SCHEDULE ON DWG. C-13
UPPER BROWN'S LAKE
VEHICULAR ACCESS
gated access
DEEP HOLE, HYDRAULIC DREDGING (TYPICAL)
LOWER BROWN'S LAKE
U. S. GOVERNMENT PROPERTY LINE
EXISTING R.R.
As Constructed
Minor Revisions
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 545.8
BROWN'S LAKE
SITE PLAN
Scale: As Shown
Date: 13 May 1988
C-1

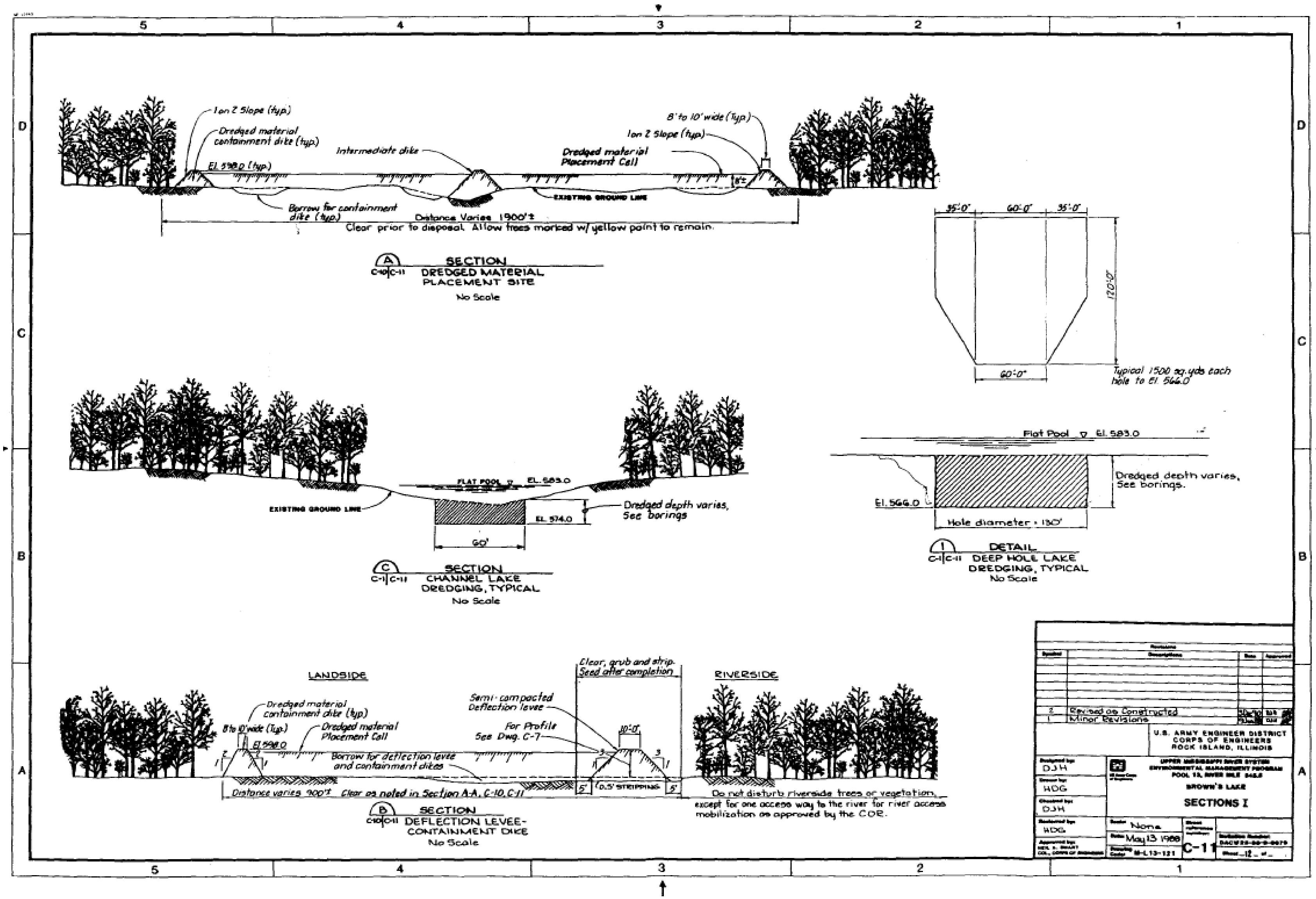


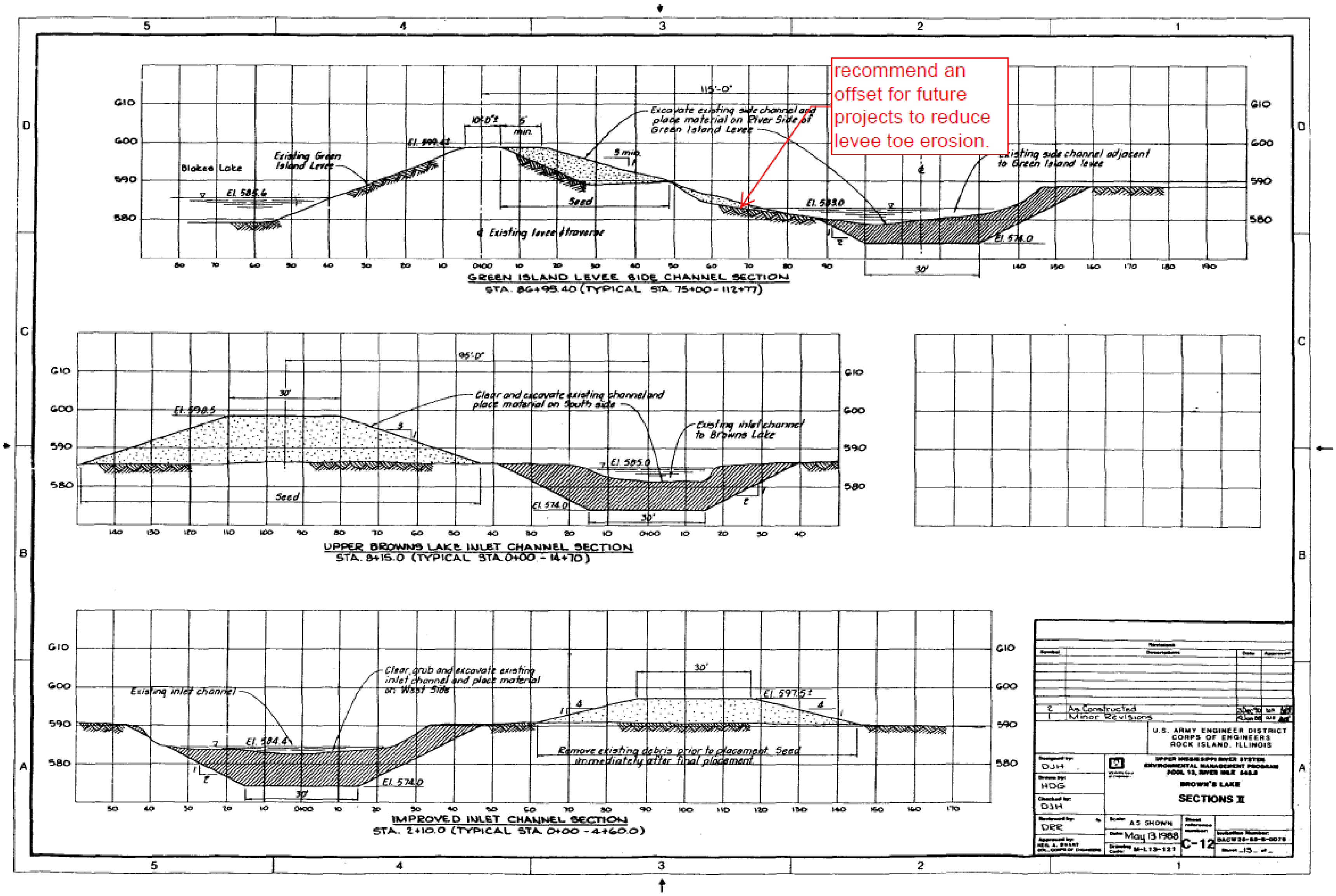
Placement for excavation is along levee
Inlet Channel has been excavated and side casted three times, including following the 1993 flood event.
Water was very muddy brown in appearance.
Water is "clearer" in appearance and was covered with vegetation.
Generally clear conditions.
Erosion noted along toe of Green Island Levee, adjacent to inlet channel
Material from this berm was used to repair the Green Island levee following the 2008 flood event.
Generally clear conditions noted.
Smith's Creek enters site here.
Closure gates opened to allow oxygenated water to enter Brown's Lake. USFWS opens one gate at a time (tries to rate year to year). Gates are opened manually about 0.5 -1 foot. Maintenance includes a snow blanket over top, and greasing gears.
Sediment laden water (brown/ muddy) observed leaving Lainsville Slough and meeting up with clear water leaving Lower Brown's Lake
INLET CHANNEL
WATER CONTROL STRUCTURE SEE DWG'S S-1 to S-6
DEFLECTION LEVEE SEE DWG C-7
MISSISSIPPI RIVER
CONFINED DREDGED MATERIAL PLACEMENT SITE, SEE DWG C-10
GREEN ISLAND LEVEE & DRAINAGE DISTRICT
EXCAVATION PLACED ON EXISTING LEVEE OR SIDE-CAST AS SHOWN ON DWG'S C-7, C-8, C-9 & C-12
EXISTING SLOUGH BLOCKAGE (DEBRIS AND SEDIMENT) (NO WORK REQUIRED)
EXISTING LEVEE
LAINSVILLE SLOUGH
HYDRAULIC LAKE DREDGING SEE SCHEDULE ON DWG C-13
UPPER BROWN'S LAKE
VEHICULAR ACCESS
DEEP HOLE, HYDRAULIC DREDGING (TYPICAL) SEE SCHEDULE DWG C-13 PLUS DETAIL 1, DWG C-11
LOWER BROWN'S LAKE
GOVERNMENT PROPERTY LINE
EXISTING R.R.
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 545.8
BROWN'S LAKE
SITE PLAN
As Constructed
Minor Revisions
Scale: As Shown
Date: 13 May 1986
C-1

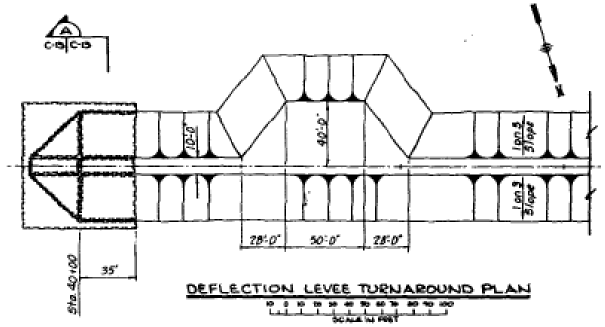

GREEN ISLAND DRAINAGE DISTRICT
INLET CHANNEL
clean water
Muddy water
Material removed from channel since construction has generally been placed in this location.
WATER CONTROL STRUCTURE, SEE S-1
℄ DEFLECTION LEVEE
MISSISSIPPI RIVER
Flow
Excavated material from the adjacent entrance channel
FOR TYPICAL SECTION SEE C-12
EL 574.0
Field Books:
FC-87-3 pg. 22 - Traverse
FC-87-5 pg. 3 - Traverse
FC-87-5 pg. 26-29 - "X"Sections
FC-87-5 pg. 4-5 - "X"Sections
FC-87-8 pg. 14 - Traverse
Revised as Constructed
Minor Revisions
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
BROWN'S LAKE
ENTRANCE CHANNEL PLAN
1"=50'-0"
May 13 1988
C-8


Channel is adjacent to the levee. It does not appear there was an offset between the two.
Material from this berm was used for levee repairs in 2008
GREEN ISLAND DRAINAGE DISTRICT
New channel EL 574.0
FOR TYPICAL SECTION SEE C-12
MATCH LINE
Sta 95+99.15
165° 19' 49"
Sta 89+99.15
169° 07' 28"
Sta 86+95.40
166° 56' 08"
Sta 80+96.17
163° 19' 01"
Sta 75+00 = 0+00
75° 00' 00"
Field Books:
FC-87-5 pg 20-21, Traverse
FC-87-5 pg 23-25, "X" Sections
FC-87-8 pg 14 Traverse
FC-87-5 pgs. 11-12, 14-18 "X" Sections
As Constructed
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
BROWN'S LAKE
CHANNEL TO UPPER BROWN'S LAKE
1" = 100'-0"
May 13 1988
C-9

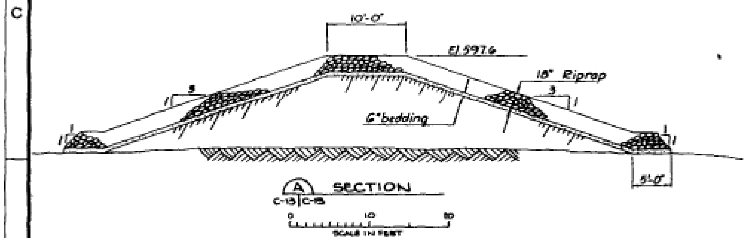

RIVER
DEFLECTION LEVEE
Sta 20+00
Sta 22+50
Sta 25+00
Sta 30+00
Sta 35+00
Sta 40+00
Provide 200' tree buffer bet dike and Laine
Dredge pipe was generally placed here, so heavier material dropped out in this cell.
DREDGED MATERIAL PLACEMENT CELL #1
stunted oaks
CONSTRUCT OUTLET WEIR, SEE DWG. C-13
Weir Notch
DREDGED MATERIAL PLACEMENT CELL #2
CONTAINMENT DIKE
more hard mast trees
Dip cut in Levee top
Dip cut in Levee top
BORROW/DREDGED MATERIAL PLACEMENT SITE LIMITS
Contractor may make minor changes to alignment to best fit contours/drainage ways/volume requirements
Generally willows. This site has more sediment in the area.
Cell #2 was the location of the helicopter acorn drop
BORROW/DREDGED MATERIAL PLACEMENT SITE PLAN
Revised as Constructed
Minor Revisions
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 545.9
BROWN'S LAKE
BORROW/DREDGED MATERIAL PLACEMENT SITE PLAN
DJH
HDG
DJH
DRR
1" = 100'
May 13 1988
C-10


1 on 2 Slope (typ.)
Dredged material containment dike (typ.)
Intermediate dike
El. 598.0 (typ.)
8' to 10' wide (Typ.)
1 on 2 Slope (typ.)
Dredged material Placement Cell
EXISTING GROUND LINE
Borrow for containment dike (typ.)
Distance Varies 1900'±
Clear prior to disposal. Allow trees marked w/ yellow paint to remain.
SECTION
DREDGED MATERIAL PLACEMENT SITE
No Scale
35'-0"
60'-0"
35'-0"
120'-0"
60'-0"
Typical 1500 sq. yds each hole to El. 566.0
FLAT POOL
EL. 583.0
EXISTING GROUND LINE
EL. 574.0
Dredged depth varies, See borings
60'
SECTION
CHANNEL LAKE DREDGING, TYPICAL
No Scale
Flat Pool El. 583.0
Dredged depth varies, See borings.
El. 566.0
Hole diameter = 130'
DETAIL
DEEP HOLE LAKE DREDGING, TYPICAL
No Scale
LANDSIDE
RIVERSIDE
Clear, grub and strip. Seed after completion
Dredged material containment dike (typ.)
8 to 10' wide (Typ.)
El. 598.0
Dredged material Placement Cell
Semi-compacted Deflection levee
For Profile See Dwg. C-7
10'-0"
Borrow for deflection levee and containment dikes
0.5' STRIPPING
Distance varies 900'± Clear as noted in Section A-A, C-10, C-11
Do not disturb riverside trees or vegetation, except for one access way to the river for river access mobilization as approved by the COR.
SECTION
DEFLECTION LEVEE-CONTAINMENT DIKE
No Scale
Revised as Constructed
Minor Revisions
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
DJH
HDG
DJH
HDG
BROWN'S LAKE
SECTIONS I
None
May 13 1988
C-11

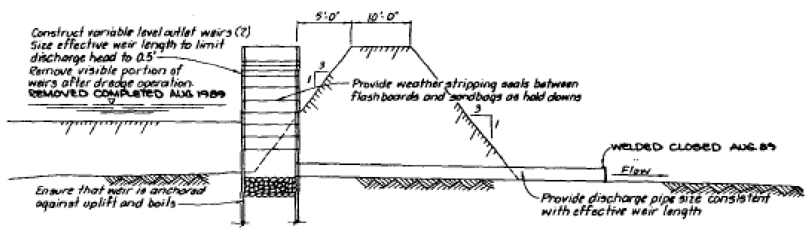

recommend an offset for future projects to reduce levee toe erosion.
GREEN ISLAND LEVEE SIDE CHANNEL SECTION
STA. 86+95.40 (TYPICAL STA. 75+00 - 112+77)
115'-0"
10'-0"±
5' min.
El. 599.45
Excavate existing side channel and place material on River Side of Green Island Levee
Existing Green Island Levee
Blakes Lake
El. 585.6
3 min.
Seed
℄ Existing levee traverse
El. 583.0
Existing side channel adjacent to Green Island levee
El. 574.0
30'
UPPER BROWNS LAKE INLET CHANNEL SECTION
STA. 8+15.0 (TYPICAL STA. 0+00 - 14+70)
95'-0"
30'
El. 598.5
Clear and excavate existing channel and place material on South side
Existing inlet channel to Browns Lake
El. 585.0
El. 574.0
Seed
IMPROVED INLET CHANNEL SECTION
STA. 2+10.0 (TYPICAL STA. 0+00 - 4+60.0)
Existing inlet channel
Clear, grub and excavate existing inlet channel and place material on West Side
El. 584.4
El. 574.0
El. 597.5±
Remove existing debris prior to placement. Seed immediately after final placement.
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
BROWN'S LAKE
SECTIONS II
As Constructed
Minor Revisions
AS SHOWN
May 13 1988
C-12



DEFLECTION LEVEE TURNAROUND PLAN



A SECTION C-13 | C-13



C OUTLET WEIR SECTION C-10 | C-13
No Scale

HYDRAULIC DREDGING SCHEDULE

Channel Dredging	Length	Width	Bottom of dredge Cut, Elevation	Square Yards
A-B	750'	60'	574	5,000
B-C	1100'	60'	574	7,400
C-D	550'	60'	574	3,700
C-E	650'	60'	574	4,400
E-F	1210'	60'	574	8,100
F-G	2250'	60'	574	15,000
F-H	1400'	60'	574	9,400
E-I	2700'	60'	574	18,000
B-I	1500'	60'	574	10,000
I-J	2450'	60'	574	16,400
J-K	1710'	60'	574	11,400
J-L	3250'	80'	574	21,700
	19,520			130,500

Deep Holes	Diameter		Square Yards
①	130'	566	1500
②	130'	566	1500
③	130'	566	1500
④	130'	566	1500
⑤	130'	566	1500
			7,500

Symbol	Description	Date	Approved
2	Revised as Constructed		
1	Minor Revisions		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: DJH
Drawn by: HDG
Checked by: DJH
Reviewed by: DRR

BROWN'S LAKE

DETAILS AND DREDGING SCHEDULE

Scale: As shown
Date: May 13 1988
C-13

Attachment C

Evaluating the Effectiveness of a Mandatory Catch and Release Regulation on a Riverine Largemouth Bass Population

PROJECT: Evaluating the Effectiveness of a Mandatory Catch and Release Regulation on a Riverine Largemouth Bass Population

PROJECT LEADER: Melvin C. Bowler and Kirk A. Hansen

LOCATION: Pool 13, UMR, between Bellevue and Clinton, Iowa

PERIOD OF RESEARCH: 1993-2006

ABSTRACT – *We used two long-term monitoring datasets from 1993 through 2006 to evaluate the effectiveness of a largemouth bass Micropterus salmoides mandatory catch-and-release regulation initiated in Brown's Lake, a 183-ha backwater in Pool 13 of the Upper Mississippi River. The abundance (catch-per-unit-effort; fish/h) and size structure (proportional size distribution, quality-preferred and preferred-memorable) of largemouth bass improved within the three years immediately following the regulation. Post-regulation largemouth bass in Brown's Lake exhibited no definitive indication of size specific, density-dependent reduction in body condition (mean relative weight). However, the regulation did not appear to have any long-lasting effects (> 3 years) on size structure or the abundance of largemouth bass ≥ 229 mm total length in Brown's Lake. The relationship of largemouth bass abundances between the two datasets were significantly and positively correlated for stock-quality, preferred-memorable, and all sized fishes ≥ 200 mm when two years of post-regulation data (2000 and 2001) were removed from the analysis. The lack of long-term positive effects of the regulation could not be attributed to any one factor and may be explained by natural variation in largemouth bass stocks at larger spatial scales, ineffectiveness of the regulation at small spatial scales within a large river system, or pre-regulation, voluntary catch-and-release practices. Had regulations assessment been limited to two or three years post-regulation, different conclusions would have been reached, demonstrating the importance of long-term data sets for analysis of regulation effects on fisheries populations.*

INTRODUCTION

Inland fisheries managers frequently use various forms of catch-and-release (C-R) regulations to manage a broad array of contemporary recreational fisheries in lentic systems throughout the world. Presently, a growing number of fisheries managers are applying inland management approaches to enhance the fisheries in large, warmwater rivers (Dunning et al. 1982; Hayes et al. 1997; Scarnecchia and Stewart 1997; Maceina et al. 1998; Slipke et al. 1998; Cochnauer 2002). Largemouth bass *Micropterus salmoides* are important sport fish inhabiting the Upper Mississippi River (UMR) and are often the target of recreational and tournament anglers. Historically, restrictive regulations for largemouth bass in many North American jurisdictions have been implemented to directly reduce or eliminate fishing mortality, and to thereby increase angler catch rates and improve the size structure in a given fishery (Allen et al. 1998; Noble and Jones 1999; Quinn 2002; Paukert et al. 2007). Success of C-R regulations and management strategies is critically dependent upon high release survival rates by minimizing injury and mortality (Burkett et al. 1986; Bartholomew and Bohnsack 2005). However, the extents of the desired improvements by such regulations can be unclear (Wilde 1997; Askey et al. 2006).

Fisheries researchers have evaluated the effects of C-R regulation changes with before-after experimental designs, but the reported effectiveness of these regulations has been mixed. Clark (1983) correlated angler releases of legal-sized largemouth bass to increased angler catch and reduced total mortality rates of the population. Furthermore, by encouraging the practice of voluntary C-R, Clark (1983) eluded this strategy may be used as a viable fisheries management tool to maintain angling mortality at a level that provides optimum societal benefits. In contrast, Swenson (2002) found no increase in angler catch rates immediately following a closure of the largemouth bass fishery in a northern Wisconsin lake, and Pope and Wilde (2004) found no significant change in the growth (weight) between caught and uncaught largemouth bass populations. Beamesderfer and North (1995) and Perry et al. (1995) suggested that restrictive regulations may increase catch rates in productive largemouth bass populations, but they may also increase competition and reduce growth through density-dependant interactions.

Few long-term studies have assessed the biological effects of C-R regulations in large river ecosystems. This is likely due to budgetary, logistic, and personnel limitations, which in turn, lead to a general lack of enduring datasets and consequently a small body of peer-reviewed literature exists for these types of evaluations, regardless of species. As such, this analysis was conducted to evaluate the long-term effectiveness of a mandatory C-R regulation for largemouth bass implemented on Brown's Lake, a contiguous backwater within Pool 13 of the UMR.

On January 1, 1998, the Iowa DNR implemented a mandatory C-R regulation (no possession) for largemouth bass in Brown's Lake. The regulation was established in response to increasing open water angling effort and the declining trends in the harvestable-sized largemouth bass in Brown's Lake from 1991-1997. The long-term goal of the mandatory C-R regulation was to improve and sustain the number and size of the Brown's Lake largemouth bass population through a reduction in harvest (Boland 2002). Although Schramm et al. (1987) suggested that C-R black bass tournaments caused less mortality than non-tournament fishing, there was an additional concern that increasing competitive fishing pressure and tournament harvest in Brown's Lake could potentially lead to increased mortality and undesirable shifts in largemouth bass population metrics (e.g., Zagar and Orth 1986; Meals and Miranda 1994; Hayes et al. 1995).

We examined pre- and post-regulation abundance and size structure of two comparable largemouth bass datasets that were collected over a 14-year span from 1993-2006. Focused sampling within Brown's Lake served as the primary data source. Data collected by the Long Term Resource Monitoring Program (LTRMP) from randomly-selected backwater sites within Pool 13 served as a secondary dataset and provided a means for comparing pre- and post regulation largemouth bass population metrics. The use of this secondary dataset also allowed us to account for annual variations in recruitment and environmental factors that can hinder regulation assessments (Wilde 1997; Allen and Pine III 2000). In many circumstances, LTRMP fisheries data does not lend itself that well (i.e. statistical power and collecting sufficient numbers stock-sized fish) to make inferences on species specific population dynamics in a single area of interest. However, when the LTRMP fisheries data is pooled across a stratum (in this instance, contiguous backwaters) random spatial variance and bias within an individual backwater is reduced (e.g., differences in specific habitat availability, annual hydrological differences, water quality parameters, etc.). In this context, the LTRMP data was an unbiased indicator of largemouth bass abundance (catch-per-unit-effort) and size structure, and served as a secondary data source to assess the natural variation of the collective backwaters in a navigation pool (Pool 13) of the Mississippi River.

STUDY AREA

Brown’s Lake is a 183-ha UMR backwater of Pool 13, located approximately 16 km south of Bellevue, Iowa (Figure 1). Pool 13 contains many braided backwater channels, backwater lakes, side channels, and a large, open impounded area. Pool 13 is bounded to the north by Lock and Dam 12 at Bellevue, Iowa and to the south by Lock and Dam 13 at Fulton, Illinois. Contiguous backwater habitat comprises 2,810 ha (28%) of the total 9,991 ha of aquatic habitats in Pool 13. By the mid-to-late 1980s, mean water depths in Brown’s Lake had been reduced by sedimentation, resulting in a shallow, densely vegetated lake, prone to periods of anoxia - especially during winter months. Consequently, Brown’s Lake was selected as a Habitat Rehabilitation and Enhancement Project (HREP), under the Upper Mississippi River Restoration Environmental Management Program, administered by the U. S. Army Corps of Engineers. After the completion of this HREP project in 1989 (which included dredging and the installation of a gated water control structure that would allow flow into the lake in times of low oxygen levels), Iowa Department of Natural Resources (DNR) fisheries personnel evaluated the response of the Brown’s Lake fishery to these changes in habitat and water quality (Gent et al. 1995). Restoration improvements contributed to an immediate increase in open water angling effort and sportfish harvest (58% and 117% respectively; Gent et al. 1995). Additionally, Boland (2002) noted that post-rehabilitation creel and electrofishing data collected in 1995 and 1996 suggested that most legal-length largemouth bass (355 mm) were harvested in Brown’s Lake.

METHODS

We assembled largemouth bass abundance and size structure data from two independent sources. The first source of data was from focused sampling within Brown's Lake. Pulsed-DC electrofishing was conducted during daylight at 4-7 fixed sites in Brown’s Lake in the fall from 1993-2006, using equipment similar to that described by Reynolds (1996). Voltage was fixed at 530 V and amperage varied slightly between 6 and 7 A, via a Smith-Root VI-A control box. Pulse frequency was set at 60 Hz and pulse width was 25% (i.e., ~4 ms pulse width). Power ranged from 3,180-3,710 W. Annual samples were conducted in early October over a 3-4 day period to minimize biases of largemouth bass immigrations and emigrations in Brown’s Lake. A pilot and a two person dip netting crew operated the two-ringed anode electrofishing boat, and individual electrofishing runs had variable time durations that were recorded in seconds. All largemouth bass were targeted for dipping and all fish $\geq$ 229 mm in total length (TL) were given left pelvic clips and

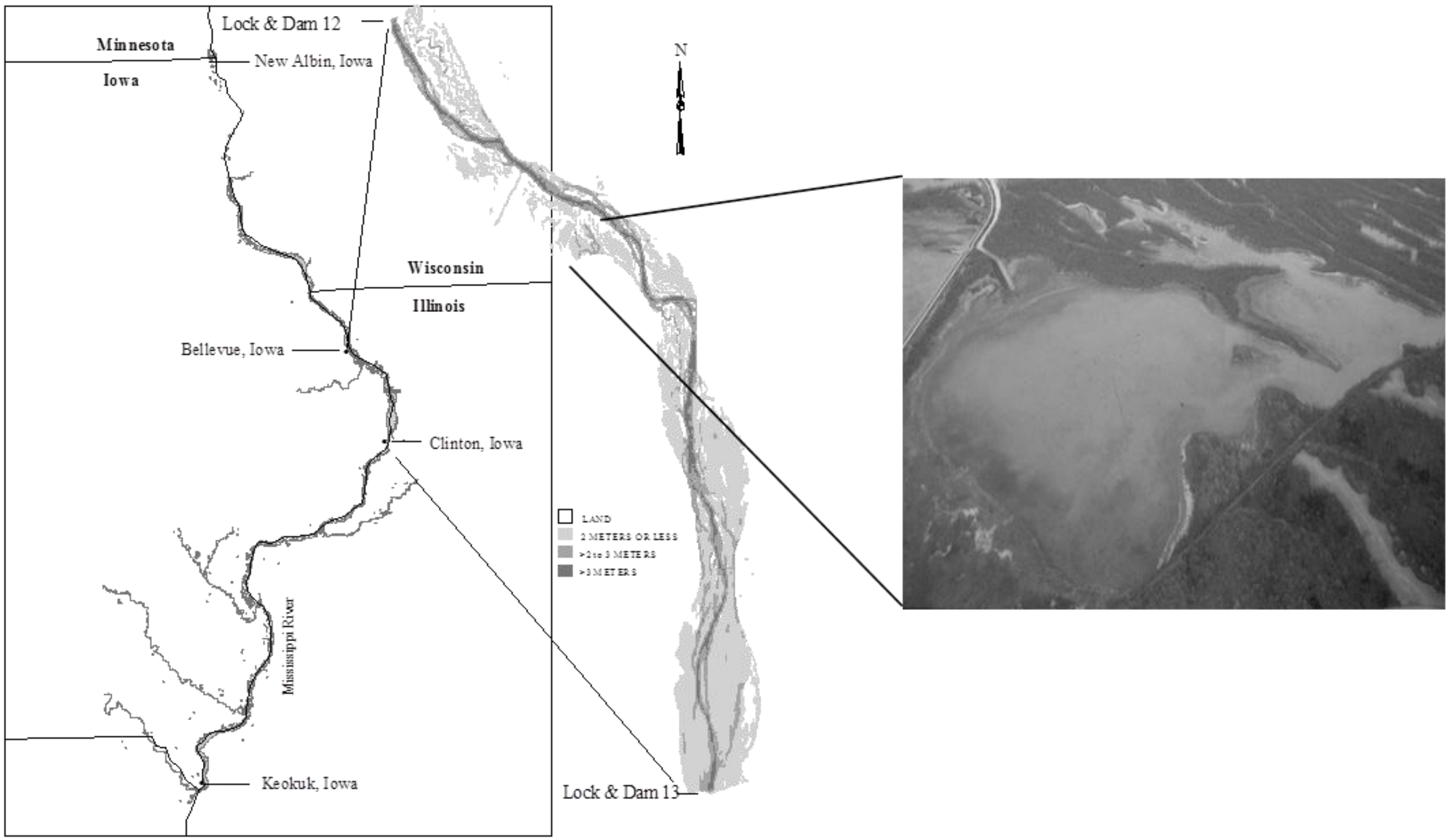


Figure 1. Map of eastern Iowa and aerial photo of Brown's Lake in Pool 13 of the Upper Mississippi River.

released. Subsequent recaptured fish from the current year were noted for population estimates.

Collections within Brown's Lake yielded two types of abundance estimates. Schumacher-Eschmeyer methods (Ricker 1975) were used to derive annual population estimates of largemouth bass $\geq$ 229 mm. Confidence limits of 95% were calculated using tables of the Poisson distribution (Ricker 1975). A six-year pre-regulation mean and an eight-year post-regulation mean of the annual population estimates ($\pm$ SE) were estimated for comparisons. We regarded all data collected in 1998 as pre-regulation data, for the fact that conservation officers were instructed to not enforce violations of the C-R regulation until January 1, 1999. Assumptions of normality were not met with these data, so a Mann-Whitney *U*-test (Zar 1999) was used to determine the pre- and post-regulation difference in the mean population size within Brown's Lake. Additionally, annual catch-per-unit-effort (CPUE; fish/h) was also calculated to serve as an index of abundance.

The second source of data was from routine LTRMP fish collections conducted annually with pulsed-DC electrofishing during daylight at randomly-selected sites throughout Pool 13 from 1993-2006. Site selections were stratified by habitat type (e.g., main channel border, contiguous backwater) following the methods of Gutreuter et al. (1995). Voltage and amperage were adjusted based on water temperature and conductivity at each random site to achieve a uniform base power of 3,000 W (Burkhardt and Gutreuter 1995) via a Wisconsin-type control box. Pulse frequency was set to 60 Hz and duty-cycle was set to 25%. Typical power setting ranged from 170-200 V and 17-20 A. A pilot and two dip netters operated the two-ringed anode electrofishing boat, and individual electrofishing runs had durations of 15 min.

All fish encountered by the dip netters were collected (community sampling) as per LTRMP fish sampling procedures. Only largemouth bass collected within contiguous backwater sites, excluding sites within Brown's Lake, from September 16 to October 30 were retained for this analysis. When LTRMP fall sampling occurred in Brown's Lake, those largemouth bass catches constituted high percentages (e.g., 37% in 2001) of the total annual largemouth catches for the pooled backwaters. Inclusion of these fish would have potentially biased the pooled abundance and size structure estimates of largemouth bass toward the Brown's Lake population in certain years. Annual mean CPUE estimates (Gutreuter et al. 1995) for largemouth bass (fish/h) were calculated and plotted.

Largemouth bass from both data sources were enumerated, measured (TL mm), weighed (g), and assigned into length categories following Gablehouse (1984) for each site. Length categories included stock to quality (S-Q, 200-299 mm), quality to preferred (Q-P, 300-379 mm), preferred to memorable (P-M, 380-509 mm), memorable to trophy (M-T, 510-629 mm), and trophy (T, >630 mm) lengths. Historically, few largemouth bass in the UMR have attained memorable lengths (Pitlo 1992; Raibley et al. 1997) hence, memorable and trophy length groupings were not included in this analysis due to small sample sizes from both data sources.

We examined the relationship of categorical, annual CPUE of Brown's Lake and other randomly selected backwaters in Pool 13 using Spearman rank correlations, with correlation significance determined at α = 0.05. Proportional size distributions (PSD) (e.g., PSD P-M; Guy et al. 2007) were calculated by year, and 80% confidence intervals (Gustafson 1988) were constructed to facilitate size structure assessments. Proportional size distributions of Brown's Lake and Pool 13 largemouth bass were compared on an annual basis using chi-square analysis (SAS Institute 1999; Neumann and Allen 2007). A Bonferroni correction (Manly 2001) was used to maintain α = 0.05 (i.e., 0.05/14 = $P \leq$ 0.0036). Relative weight (W_r) as described by Wege and Anderson (1978) was computed by year within size groups to assess body condition of largemouth bass in Brown's Lake. Values for the slope and intercept were obtained from Murphy et al (1991).

Six-year pre-regulation and eight-year post-regulation pooled means of categorical PSD values and W_r were also calculated for Brown's Lake largemouth bass to determine if size structure or fish condition had changed after the regulation. Two-sample paired *t*-tests were used to assess differences between pre- and post-regulation mean PSDs and W_r among stock, quality, and preferred-length largemouth bass in Brown's Lake. Significance was determined at α = 0.05 for all paired *t*-tests.

RESULTS AND DISCUSSION

Annual Schumacher-Eschmeyer population estimates of Brown's Lake largemouth bass (i.e., > 229 mm) were variable over the study period (Figure 2).

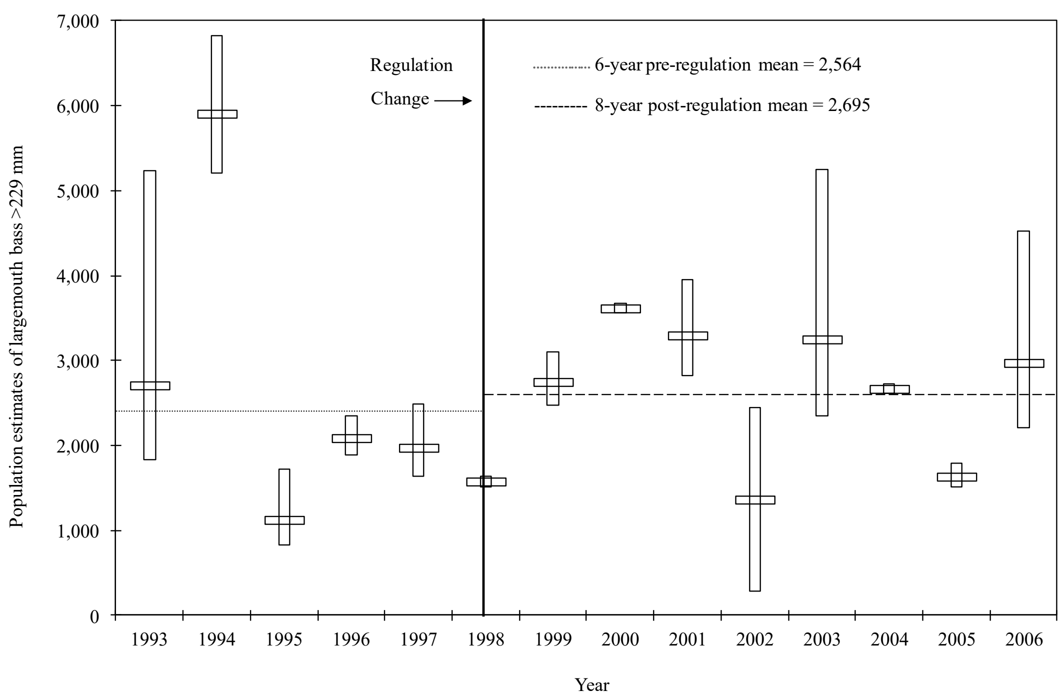


Figure 2. Schumacher-Eschmeyer population estimates with 95% confidence intervals (Ricker 1975) for largemouth bass in Brown's Lake, Pool 13, Upper Mississippi River, 1993-2006. Solid horizontal dashes indicate annual estimates with confidence intervals. Continuous dashed lines mark the 6-year pre-regulation (1993-1998) and 8-year post-regulation (1999-2006) means of the population estimates, and vertical solid line indicates starting year of catch-and-release regulation in Brown's Lake.

A peak estimate of 5,908 fish (CI = 5,207-6,827) occurred in 1994, and a low estimate of 1,126 fish (CI = 835-1,726) occurred in 1995. The eight- year post-regulation mean of 2,695 (SE ± 703) fish was slightly higher than the six-year pre-regulation mean of 2,564 (SE ± 283), and this modest increase was not significant (Mann-Whitney *U*-test: Z = -0.97; df = 1; *P* = 0.35). Annual sample sizes of stock-length and greater fish in Brown's Lake (range = 456-1,956; Table 1) were adequate to assess size structure. Miranda (2007) recommended 100-130 samples for estimating PSD of largemouth bass with 80% confidence. Post-regulation stock, quality, and preferred-length mean PSD values in Brown's Lake were 42, 41, and 17, respectively, while corresponding pre-regulation PSD values were 45, 43, and 12, respectively (Table 1).

Pre- and post-regulation mean PSD values for stock, quality, and preferred-length largemouth bass in Brown's Lake were not significantly different (*P* = 0.70, 0.76, and 0.19 respectively). The post-regulation mean PSD of 58 in Brown's Lake was not significantly different than the pre-regulation mean PSD of 55 (*t*-test: *t* = 0.40; df = 12; *P* = 0.69; Table 1).

We were unable to statistically test for natural variation in largemouth bass condition that may have occurred spatially, (i.e., comparisons in *Wr* between Brown's Lake and the collective backwaters in Pool 13) because the LTRMP did not take weights on largemouth bass until the year 2000. Pre- and post-regulation mean W_r values (Table 1) for stock and quality-length largemouth bass within Brown's Lake were not significantly different (*t*-test: *t* = 0.01 and -1.98; df = 12; *P* = 0.99 and 0.07 respectively); however, a significant decrease in mean W_r values was detected in preferred-length fishes (*t* = -2.43; df = 12; *P* = 0.03).

Tables 1 and 2. Mean proportional size distribution (PSD; Guy et al. 2007), and relative weight (W_r; Wege and Anderson 1978) values of pre- and post-regulation largemouth bass in Brown's Lake, and in randomly selected backwaters in Pool 13, UMR, 1993-2006. Confidence intervals (CI, ±) of PSD were calculated using Gustafson (1988).

Brown's Lake

	Year	Number fish ≥ stock length	PSD	CI ±	RSD S-Q	RSD Q-P	RSD P-M	W_r S-Q	W_r Q-P	W_r P-M
Pre-regulation	1993	679	41	3	59	37	3	108	107	107
	1994	456	75	3	25	66	8	112	111	111
	1995	739	70	2	30	47	23	117	114	112
	1996	945	43	2	57	27	16	103	105	107
	1997	1,092	42	2	58	34	8	102	105	101
	1998	524	59	3	41	47	12	103	102	101
Grand mean			55		45	43	12	108	108	107
Post-regulation	1999	644	81	2	19	50	31	111	107	106
	2000	1,850	57	2	43	43	14	107	105	103
	2001	1,946	73	1	27	56	18	109	106	104
	2002	520	48	3	53	35	12	108	103	98
	2003	600	51	3	49	29	22	108	106	104
	2004	492	60	3	40	41	19	104	101	98
	2005	890	57	2	43	47	10	108	103	100
	2006	1,753	38	2	62	27	10	106	98	96
Grand mean			58		42	41	17	108	103	101

Randomly selected backwaters in Pool 13

	Year	Number fish ≥ stock length	PSD	CI ±	RSD S-Q	RSD Q-P	RSD P-M	W_r S-Q	W_r Q-P	W_r P-M
Pre-regulation	1993	135	51	6	49	39	12	-	-	-
	1994	84	79	7	21	55	24	-	-	-
	1995	104	39	7	61	19	20	-	-	-
	1996	159	45	5	55	24	21	-	-	-
	1997	154	47	6	53	31	16	-	-	-
	1998	146	59	6	41	44	15	-	-	-
Post-regulation	1999	277	44	4	56	27	17	-	-	-
	2000	218	44	5	56	33	11	-	-	-
	2001	71	65	8	35	44	21	-	-	-
	2002	108	52	7	48	31	20	-	-	-
	2003	180	37	5	63	26	12	-	-	-
	2004	153	60	6	40	36	24	-	-	-
	2005	175	55	5	45	38	17	-	-	-
	2006	176	44	5	56	26	18	-	-	-

An explanation for the decrease in body condition of preferred-length fishes may be attributed to the onset of largemouth bass virus (LMBV) in Pool 13. Largemouth bass virus was documented in Pools 10 and 11 of the UMR in 2002, and was subsequently verified in Brown's Lake largemouth bass in 2006 by the Fish Health Center (U. S. Fish and Wildlife Service) in La Crosse, Wisconsin. Maceina and Grizzle (2006) associated LMBV infections in Alabama reservoirs to reduced growth, lower relative weights, and increased mortality of older fishes (> age 3). Their results also indicated that predicted peak infections of LMBV occurred in fishes from 280-330 mm. However, they could not definitively substantiate that LMBV actually caused this phenomenon of growth retardation and W_r reduction.

Additionally, Maceina and Grizzle (2006) speculated that individuals with slower growth rates and lower body condition may be immunodeficient, and perhaps were more likely to contract LMBV. Although the reduction in body condition of the post-regulation, preferred-length largemouth bass in Brown's Lake was significant (i.e., from 107 to 101), relatively few fish were observed to be in poor health. We did not test fish from this study for presence of LMBV, but we suspect that the biological significance of the modest decrease in W_r of preferred-length fishes in Brown's Lake is most likely nominal, and most likely not an effect of the C-R regulation.

Other factors that could have contributed to the decline in W_r include forage availability and efficiency, size specific density dependent growth, and changes in environmental conditions (Wege and Anderson 1978; Pope and Willis 1996; Blackwell et al. 2000). Maceina and Bettoli (1998) and Pitlo (2002) have indicated that dynamic rate functions (e.g. growth) of large-river fish populations are generally associated with combinations of climate, hydrology, and physical habitat. A dynamic range of hydrologic and winter conditions occurred in Pool 13 over the study period.

Seasonally variable water levels frequently occurred in the UMR (mostly due to spring flooding events) in which current flows encroached into some backwaters including Brown's Lake; however, other backwaters in Pool 13 would have been subjected to similar lotic conditions. Lower river stages typified summer months and reduced water levels most often persisted into the fall and winter months. Gutreuter et al. (1999) found that certain littoral species in the UMR, including largemouth bass, experienced increased growth during atypical warm-season flooding events but had reduced growth during low-water years.

Winter conditions (i.e., ice and snow cover) in some years were atypically long in duration and may have also contributed to the decrease in body condition. Brown and Murphy (2004) evaluated seasonal condition indices and energy allocation of largemouth bass in Florida, and illustrated general declines in muscle index values (primarily lipid) and in *Wr* of larger fish to meet metabolic requirements during winter months. Largemouth bass in the UMR may be affected likewise, although latitudinal variation in temperature would likely affect physiological mechanisms across the North American range of this species.

Catch rates for Brown's Lake largemouth bass (CPUE; stock, quality, and preferred-lengths) were higher than the collective backwaters in Pool 13; however, the trends in abundances between the two were very similar except for the years 2000 and 2001 (Figure 3). Post-regulation Brown's Lake CPUE for stock, quality, and preferred-length largemouth bass exhibited peak abundance in 2000 and 2001 (a divergence from the trends in the other randomly selected backwaters).

We chose not to statistically compare the annual catch effort in Brown's Lake to the other randomly selected backwaters in Pool 13 because Brown's Lake was rehabilitated

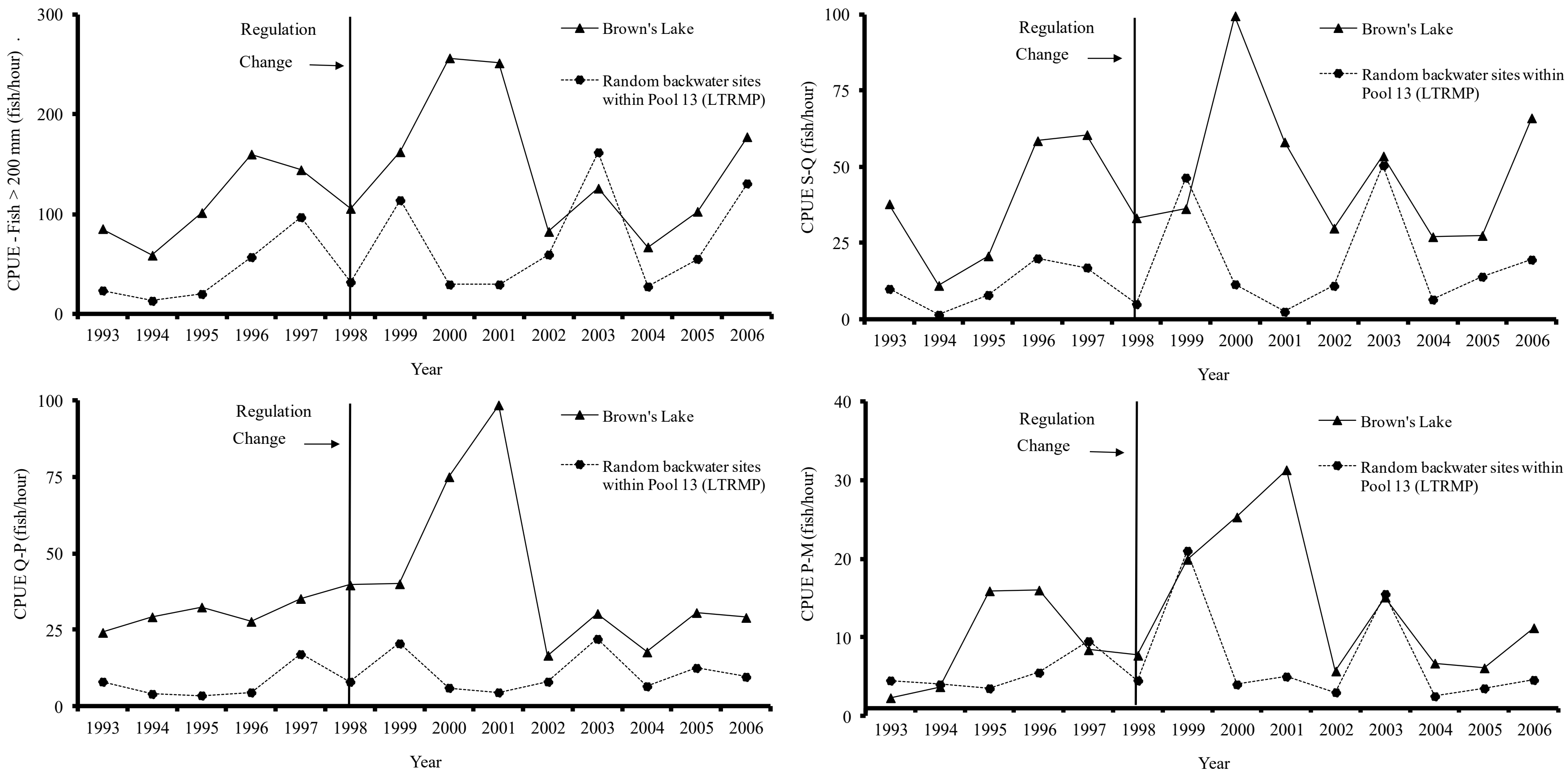


Figure 3. Trends of largemouth bass abundance (CPUE) in Brown's Lake and in randomly selected backwater sites in Pool 13 of the Upper Mississippi River, 1993-2006.

in 1989. These improvements in habitat availability and suitability likely biased largemouth bass abundance in Brown's Lake before the mandatory C-R regulation, as the majority of backwater complexes in the navigation pool had not had similar habitat restorations.

The suggested sample size recommended by Miranda (2007) was not met from LTRMP sampling for 1994 and 2001 (84 fish in 1994 and 71 in 2001; Table 2), therefore inferences to those yearly comparisons in size structure between Brown's Lake and the randomly selected backwaters in Pool 13 should be made with caution. The smaller sample sizes for these two years are reflective of the Pool 13 random samples that occurred within Brown's Lake and were omitted from the dataset.

Analogous to the trends in abundance, similar trends were observed in the size structure of the Brown's Lake largemouth bass and the other backwaters in Pool 13 (Figure 4). Pre-regulation proportions of stock, quality, and preferred-length largemouth bass in Brown's Lake were not significantly higher than in other backwaters of in Pool 13, with the exception of quality-length fish in 1995 (Figure 4; Table 3). Preferred-length largemouth bass in Brown's Lake comprised a significantly lower proportion in years 1993, 1994, and 1997. A significant increase in the size structure of quality-length largemouth bass from Brown's Lake occurred in only 1 of the 8 years post-regulation (1999: $\chi^2 = 44.0$; df = 1; $P < 0.01$; Table 3) and significant increases in preferred-length largemouth bass from Brown's Lake occurred in 2 of the 8 years post-regulation (1999 and 2003: χ^2 = 19.2 and 9.1; df = 1 and 1; $P < 0.01$). However, preferred-length largemouth bass in Brown's Lake were significantly lower in proportion in 2006 ($\chi^2 = 9.5$; df = 1; $P = 0.002$).

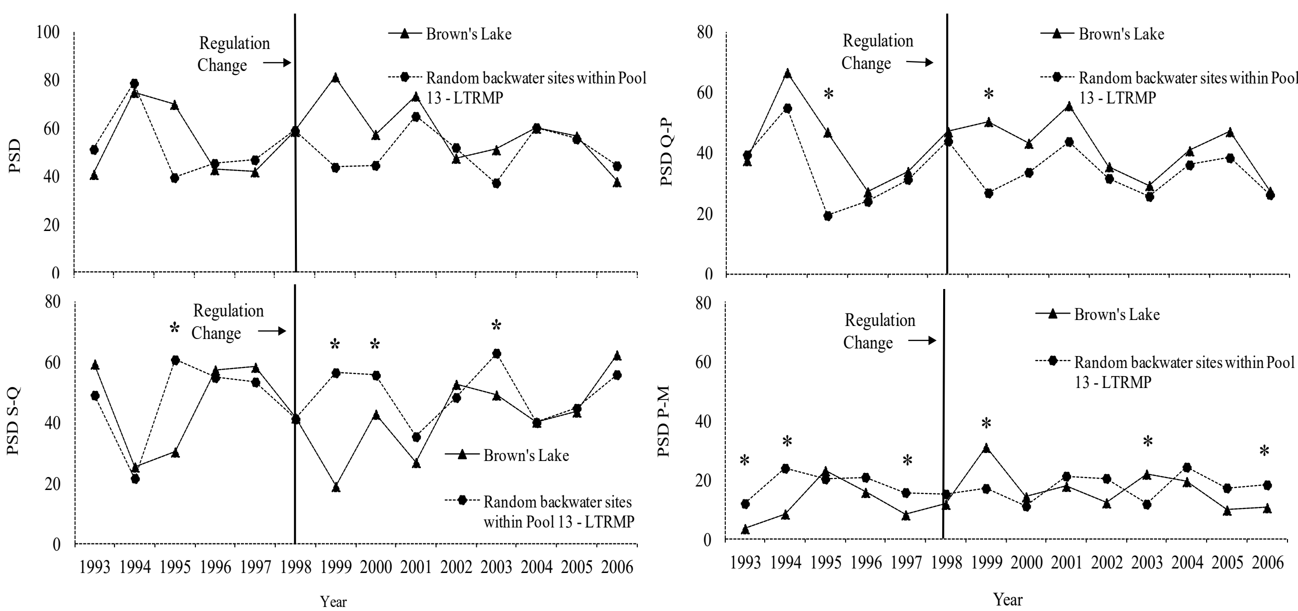


Figure 4. Trends of largemouth bass proportional size structure indices (Guy et al. 2007) in Brown's Lake and randomly selected backwater sites in Pool 13 of the Upper Mississippi River, 1993-2006. Asterisks denote significant differences ($P < 0.0036$) in size structure.

Table 3. Resulting *P*-values (chi-square) from among year comparison of proportional size distribution (PSD; Guy et al. 2007) between Brown's Lake largemouth bass and largemouth bass from randomly selected backwater sites in Pool 13, 1993-2006. The mandatory catch-and-release regulation in Brown's Lake was invoked in 1998. Insufficient sample sizes prevented comparisons of memorable-trophy and trophy length fishes in any given year.

Length designations	(mm)	Level of significance 1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Stock	200-299	0.027	0.459	0.001^{y}	0.551	0.249	0.945	0.001^{y}	0.001^{y}	0.114	0.410	0.001^{y}	0.970	0.770	0.088
Quality	300-379	0.685	0.040	0.001^{z}	0.400	0.519	0.505	0.001^{z}	0.006	0.048	0.438	0.346	0.299	0.035	0.748
Preferred	380-509	0.001^{y}	0.001^{y}	0.521	0.109	0.002^{y}	0.266	0.001^{z}	0.202	0.463	0.023	0.003^{z}	0.192	0.004	0.002^{y}
Memorable	510-629	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trophy	>630	-	-	-	-	-	-	-	-	-	-	-	-	-	-

^{z} Brown's Lake largemouth bass significantly higher at Bonferroni critical value=0.05/14=0.0036

^{y} Pool 13 largemouth bass significantly higher at Bonferroni critical value=0.05/14=0.0036

We examined the relationship of length-based CPUE between Brown's Lake and other randomly selected backwaters in Pool 13 (Figure 5) using Spearman rank correlation. The CPUE of all fish ≥ 200 mm, S-Q, Q-P, and P-M fishes in Brown's Lake were positively correlated to the collective backwaters in Pool 13, although correlations were not significant (R = 0.48, 0.51, 0.02, 0.48 respectively; N = 14; P = 0.09, 0.06, 0.93, and 0.08 respectively) with all fourteen years of data included in the analysis.

However, Brown's Lake and LTRMP CPUE were positively and significantly correlated for all fish ≥ 200 mm, stock, and preferred-length fish (R = 0.76, 0.71, and 0.59 respectively; N = 12; P = 0.005, 0.009, and 0.04 respectively), once we removed 2000 and 2001 data following the C-R regulation data set (i.e., where we observed post-regulation CPUE trends within Brown's Lake diverging from the CPUE of the collective Pool 13 backwaters). The abundance of quality-length fish were not significantly correlated between datasets when 2000 and 2001 data was omitted (r = 0.37; N = 12; P = 0.24).

These abundance analyses suggest that: (1) the mandatory C-R regulation initially had a positive, but short-termed effect (< 3 years) on categorical largemouth abundances in Brown's Lake; (2) natural variation over time, rather than restrictive angling, was more influential on long-term trends in largemouth bass abundance in Brown's Lake; (3) the differences between the focused and community sampling methods were small enough to allow valid length-based statistical comparisons of largemouth bass abundance; and (4) spurious conclusions would have been reached if the data collection had been limited to the two or three years immediately following the C-R regulation or if the LTRMP dataset was unavailable. For instance, if the period of data collection was limited to 1996-2001 (i.e., three years of pre- and post-regulation focused sampling) we would have concluded that there was a significant improvement in mean post-regulation largemouth bass abundance in Brown's Lake (t-test: t = 4.52; df = 4; P = 0.01). Likewise, the lack of the LTRMP dataset would have prevented us from differentiating between regulatory effects and natural population variability.

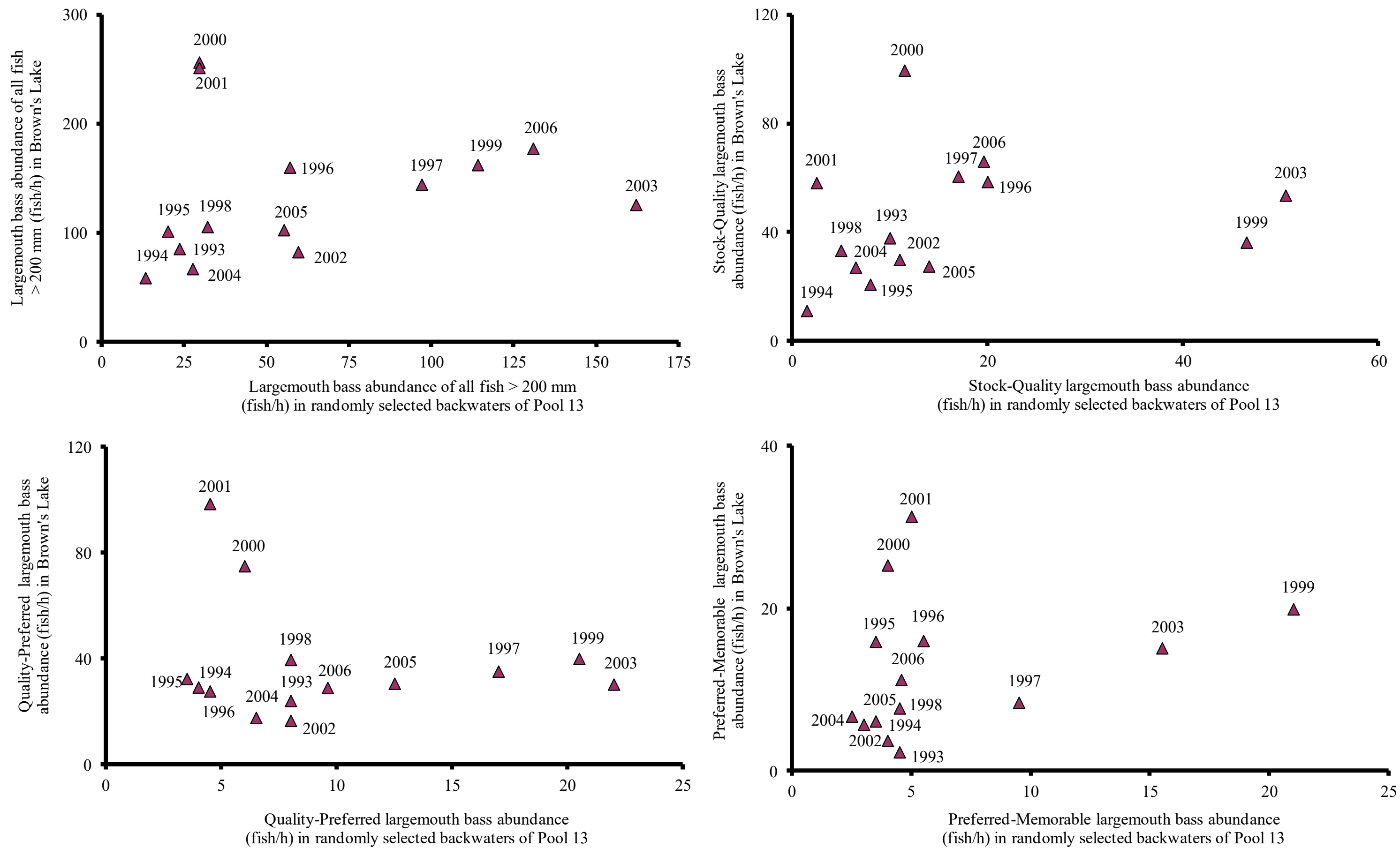


Figure 5. Relationships of largemouth bass abundance (CPUE fish/hr) between Brown's Lake and randomly selected backwaters in Pool 13 of fish ≥ 200 mm, stock, quality, and preferred-length.

Because of popular catch-and-release angler tendencies, the black bass possession restriction in Brown's Lake may have provided limited benefits to local largemouth bass populations and may have factored into negating the desired effects of the regulation. Studies of various angler types revealed that more specialized anglers tend to be more likely to practice C-R (Allen and Miranda 1996; Quinn 1996; Margenau and Petchenik 2004). Schramm et al. (1995) suggested that the limited effects of largemouth bass regulations are because many anglers already practice catch-and-release.

Conversely, Carlson and Isermann (2010) suggested that despite increases in voluntary catch and release of largemouth bass, angler exploitation is still an important factor regulating size structure in some Minnesota lakes and more intensive harvest regulations can improve size structure in certain populations. Pitlo (1992) offered some support for inhibited benefits of C-R lentic largemouth bass populations, as historic creel surveys conducted in five UMR pools (1988-1991) estimated that 87% of largemouth bass caught recreationally, were released. Pitlo (1992) also indicted that anglers in 1989 had as high as 90% release rates of largemouth bass and they chose to release larger fish when no length limits were in effect. Clark (1983) speculated that the effects of voluntary C-R could be assumed as negligible if less than 10% of the legal-length fish caught were released.

Boland (2002) quantified pre- and post-regulation angling pressure (species unspecific) and angler catch rates for largemouth bass in Brown's Lake by conducting expandable creel surveys from May through July (pre-years = 1989, 1991, and 1998; post-years = 1999-2001), and reported a 1.5-fold increase in post-regulation angler catch rates of largemouth bass (from .25 to .40 fish/hr.) and substantial increases of post-regulation angling trips and angler hours (pre-regulation mean angling trips = 1,855, mean angling hours = 4,554; post-regulation mean angling trips = 2,796, mean angling hours = 8,601). However, Boland's post-regulation creel survey did not distinguish between the catches of legal (pre-regulation ≥ 356-mm) and sublegal-length largemouth bass, and did not differentiate between recreational and tournament angling.

The implementation of the Brown's Lake catch and release regulation has noticeably reduced bass tournament angling pressure, although some tournament anglers opt to pre-fish Brown's Lake for pending tournaments (personal observations and communications with tournament anglers). We considered looking at the trends in the number of black bass tournaments and anglers pre vs. post C-R regulation to assess changes in tournament angling pressure; however we did not feel that we could get accurate estimates because the Mississippi River is a border river and angling tournaments are permitted differently between the states of Illinois and Iowa. Presently, we are uncertain to what degree the decrease in recreational and tournament angling pressure in Brown's Lake has been reduced over time and how this decrease may have affected our results. However, Allen et al. (2004) concluded that tournament mortality probably has small impacts to most largemouth bass populations, but could be an important component of mortality in fisheries where tournament catches greatly exceeded harvest.

Low angler compliance with restrictive regulations has also been shown to counter the intended objectives of C-R fisheries.

Gigliotti and Taylor (1990) estimated a 24% illegal harvest rate of catchable largemouth bass would reduce all benefits of a C-R regulation. Although it is undetermined to what extent illegal harvest may have biased our assessments, communications with local conservation officers had indicated there has been high compliance with the mandatory C-R regulation. The two officers interviewed served fewer than five warning or possession infractions in the eight-year post-regulation period and they indicated that the regulation was well received by nearly all anglers that were checked. Thusly, we speculate that illegal harvest of largemouth bass in Brown's Lake was minimal.

We acknowledge that emigrations and immigrations of largemouth bass in Brown's Lake could have potentially masked any detectable changes in population metrics, and subsequently, confounded our assessments in any given year. Sufficient connectivity from Brown's Lake to Pool 13 allows fish migrations to occur without impediment. Telemetry studies on adult largemouth bass have provided evidence for this species' propensity to migrate within large river systems, particularly during spring and fall months (Carlson 1992; Nack et al. 1993; Richardson-Heft et al. 2000; Karchesky and Bennett 2004).

Gent et al. (1995) showed that most radio-tagged largemouth bass exhibited short-duration migrations from Brown's Lake in response to low levels of dissolved oxygen (i.e., fish returned to the backwater complex after the water control structure was opened and suitable oxygen concentration were restored into the lake) and all long distance movements of fishes that were tagged outside of Brown's Lake that moved into the Brown's Lake complex occurred in late October and early November. By improving habitat and managing actively for suitable dissolved oxygen in Brown's Lake, Pitlo (1992) speculated the habitat requirements for largemouth bass were likely being met seasonally, because no long distance movements of fish tagged within Brown's Lake were observed migrating from the lake.

This was not the case in other study lakes that were prone to oxygen depletion and had no means to manipulate water inputs, as largemouth bass annually and seasonally migrated long distances to more suitable habitats. Additionally, the short-distance migrations of Brown's Lake largemouth bass mainly occurred in winter during periods of prolonged snow and ice cover (Gent et al. 1995), and fish moved into an adjacent side channel where sufficient oxygen existed. The post-HREP telemetry studies of Brown's Lake largemouth bass provides likely evidence that Brown's Lake had a relatively sedentary population of resident fishes, and the fishes that migrated into the lake were usually gone soon after ice-out and did not return until late October or early November.

Of the 15,270 largemouth bass used in these analyses, two fish were of memorable length (one pre-, and one post-regulation) and no fish were of trophy length. Historic riverine research within the UMR drainage has shown that largemouth bass rarely attain memorable lengths (Raibley et al. 1997) and there appears to be other unknown environmental factors that limit largemouth bass growth in the UMR system. Therefore, it is highly unlikely that a memorable- or trophy-length largemouth bass fishery will be realized in Brown's Lake, regardless of the no possession regulation.

While there was no substantiation of long-term improvements in density and size structure of the largemouth bass fishery in Brown's Lake, there also was no evidence of adverse effects of the regulation. Brown's Lake has maintained a stable and healthy population of largemouth bass with acceptable size structure, although PSD values were somewhat variable during the study period.

Annual PSD values for Brown's Lake largemouth bass have been within or near the suggested ranges of 40-70, with W_r values approximately 100 or greater for balanced and healthy largemouth bass populations (Anderson 1980; Anderson and Neumann 1996), and post-regulation fish exhibited little evidence of "stock-piling" to the point of inadequate physiologic condition. Similarly, Carlson and Isermann (2010) found little evidence in the reduction of largemouth bass growth rates in response to increased harvest regulations in Minnesota populations.

Understanding the social dynamics leading to voluntary C-R behavior or acceptance of regulatory C-R is crucial for improving the implementation of C-R management policies (Arlinghaus et al. 2007). Biological objectives for fisheries managers are to mutually attain suitable population numbers, while maintaining acceptable size structure with adequate angler satisfaction (Hayes et al. 1995; Weithman 1999). Perry et al. (1995) suggested that management goals catered to angler satisfaction may not require the production of large fish, and instead, could be achieved by a balance of fish size and abundance. Similarly, Cooke and Schramm (2007) noted that some recreational anglers are willing to forego harvest to improve the quality of the fishery.

A special opinion survey concerning the need and value of the mandated catch-and-release regulation was conducted in Brown's Lake in 2001 (Boland 2002). Although the majority (58%) of the anglers surveyed were not sure if the C-R regulation had improved the largemouth bass fishery in Brown's Lake, most (71%) felt that the regulation should be continued. The results of the special survey in Brown's Lake are indicative of other trends in angler perspectives as Quinn (1996) found that the genre of largemouth bass anglers are more likely to practice C-R, and more likely to support C-R regulations. These favorable attitudes likely serve as a good index of acceptance of the many anglers who practice, promote and value catch-and-release, but may be unsure of the subsequent biological ramifications of such regulations.

We recognize the merit of having two, fourteen-year datasets for assessing the long-term effects of the Brown's Lake C-R regulation. When facets of two independent fisheries datasets are used in collaboration, they can be particularly valuable to evaluate responses in abundance and size structure to angling regulations. We recommend that, when possible, design of future research projects in the UMR utilize existing long-term datasets available through the LTRMP. However, we acknowledge that project goals, logistics, personnel availability, and monetary constraints dictate the amount, type, and practicality of fisheries data that can be realistically collected on a large-scale system such as the Upper Mississippi River.

CONCLUSIONS

We conclude the mandatory black bass C-R regulation in Brown's Lake is biologically inconsequential as it did not have a prolonged effect on improving the abundance or size structure in quality- and preferred-length fish. Annual fluctuations observed in the size structure of Brown's Lake largemouth bass can largely be explained by the natural variation in the size structures of the local largemouth stocks within Pool 13. We suspect the current 356-mm minimum harvest length regulation in Pool 13 is sufficient for managing largemouth bass populations in Brown's Lake, while the sociological management of this particular riverine fishery warrants additional consideration.

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Attachment D

HH Observations and Data

Brown’s Lake HREP
Site Visit 7/26/2017
HH Observations and Data

1. Spur dike

Spur dike was built from side-cast dredge material and not designed to provide protection from inundation. Allows access to site.

2. Dredge cuts

Dredge cuts were designed with vertical side slope and no buffer between cut and toe of Green Island Levee or toe of spur dike. Embankments are vulnerable to wave wash erosion.

2. Brown's Lake inlet

90 degree bend in Brown's Lake inlet channel causes heavy sedimentation. The inlet has been dredged at least three times since project completion – including one emergency dredging to clear sediment plug and prevent winter fish kill.

3. Water control structure

Water control structure was significantly oversized. One gate (of four) is typically cracked all winter to allow oxygenated water into the Lake. Gate is closed prior to first high water (high sediment) event in the spring. Open gate is alternated yearly to prevent debris buildup. Sponsor is happy with operation of WCS.

At inlet to water control structure, water appears to have a high sediment load.

At outlet of water control structure, water appears clear with algae. Denitrification benefits are suspected at Brown's Lake.

4. Deflection levee

High water elevations at Brown's Lake since project completion are shown. As-built elevation for top of deflection berm is 598.4 feet MSL 1912. Sponsor noted overtopping of deflection berm July 1993 which inundated saplings in the northern terrestrial site. An additional overtopping of the berm likely occurred April 2001.

High Water Elevations Since Project Completion http://water.weather.gov/ahps2/hydrograph.php?wfo=dvn&gage=blvi4 WS slope from 50-year flood profile (2004 Mississippi River FFS)	
Date	Elevation at Brown's Lake, ft MSL 1912
4/22/2001	599.4
7/1/1993	598.3
4/20/2011	597.4
4/17/1997	597.0
6/14/2008	595.5
7/3/2014	595.4
4/28/2008	595.1

5. Brown's Lake

Water appears clear inside Brown's Lake.

6. Brown's Lake outlet

Near outlet of Brown's Lake, Lanesville Slough contributes a heavy sediment load following high water events. Mixing of sediment can be observed.