SWCA
ENVIRONMENTAL CONSULTANTS

NEW MEXICO INTERSTATE STREAM COMMISSION MIDDLE RIO GRANDE RIVERINE RESTORATION PROJECT PHASE I 2007 MONITORING REPORT

Prepared for

NEW MEXICO INTERSTATE STREAM COMMISSION,
ALBUQUERQUE OFFICE

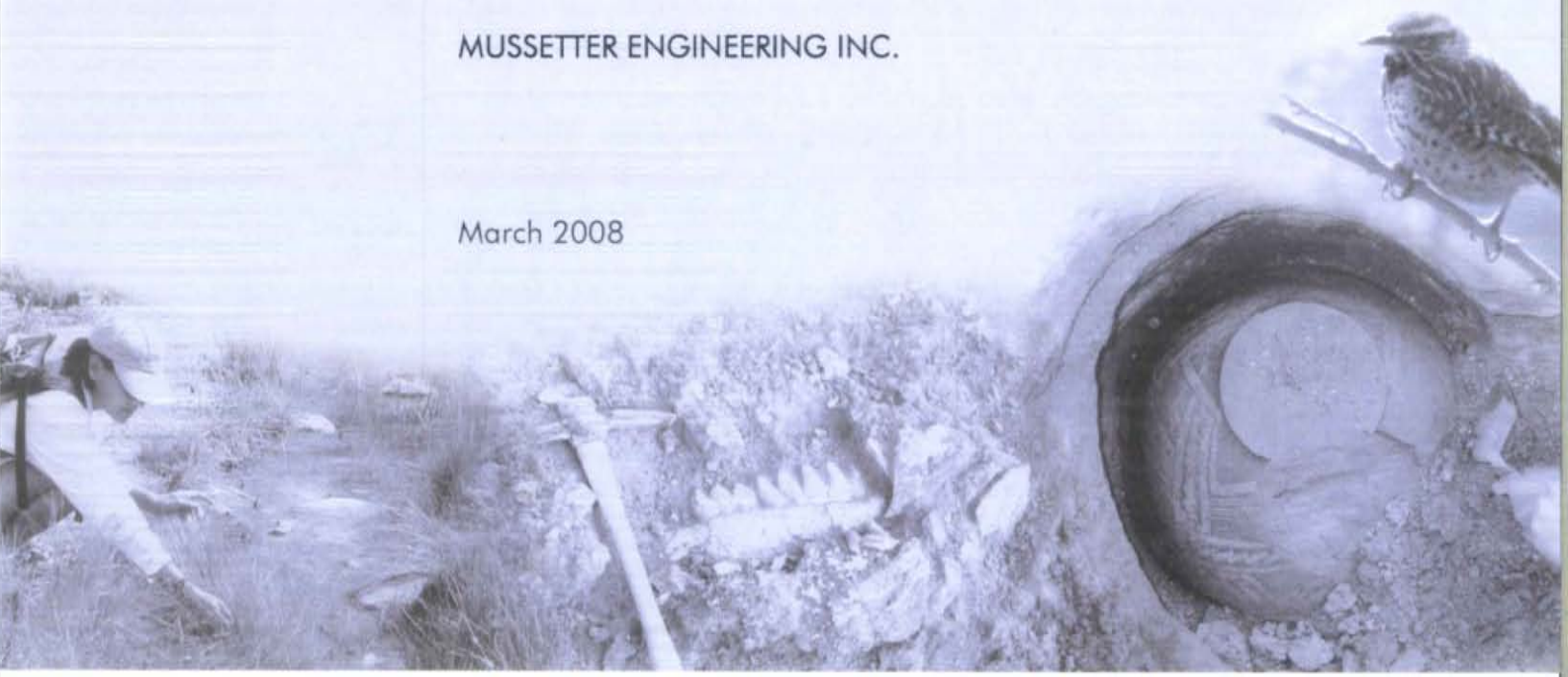
Prepared by

SWCA ENVIRONMENTAL CONSULTANTS

and

MUSSETTER ENGINEERING INC.

March 2008



NEW MEXICO INTERSTATE STREAM COMMISSION
MIDDLE RIO GRANDE
RIVERINE RESTORATION PROJECT PHASE I
2007 MONITORING REPORT

Prepared for

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SWCA Project No. 13307

March 2008

EXECUTIVE SUMMARY

The New Mexico Interstate Stream Commission (NMISC), contracting to SWCA Environmental Consultants, here presents the Phase I 2007 Monitoring Report. This project, termed the Middle Rio Grande Riverine Habitat Restoration Project, is led by the NMISC and applied several habitat restoration techniques in three subreach locations of the river in the Albuquerque Reach to create and improve habitat for the Rio Grande silvery minnow. The Project is primarily funded by the State of New Mexico with partial funding by the Collaborative Program, and additional funding from other federal and non-federal sources. Construction for this Project was initiated in January 2006, with monitoring conducted in the fall of 2006 and the fall of 2007.

The purpose of the Project is to develop, construct, and evaluate egg retention, larval rearing, young of year, and over-wintering habitat for the Rio Grande silvery minnow utilizing various techniques at several locations within the Albuquerque Reach of the river, and to determine if these techniques can improve habitat suitability for the four critical life stages of the Rio Grande silvery minnow: egg, larvae, juvenile, and adult. The Project is also evaluating the benefit of each technique in contributing to the large-scale goals for suitable habitat development for the Rio Grande silvery minnow in the Albuquerque Reach of the Middle Rio Grande. Techniques were implemented on islands, bars, and banklines to evaluate the river's ability to naturally mobilize sediments and create Rio Grande silvery minnow habitat under a variety of flow conditions. Each of the restoration techniques considered incorporates both passive and active restoration elements, an approach which works with the river instead of against it. The adoption of passive restoration techniques provides the best opportunity for long-term success and should be considered whenever possible.

The Project effectiveness monitoring consists of three general activities:

- Fisheries monitoring to characterize the community structure of fish at restoration sites and to determine how well specific types of restoration sites help to retain eggs during spring runoff.
- Geomorphic and mesohabitat monitoring to determine how flows have recontoured the sites to create varied mesohabitat features.
- Vegetation monitoring to assess Southwestern willow flycatcher habitat suitability, how species composition and community types are responding to disturbance, and whether native riparian habitats are successfully regenerating.

Wetlands and water quality data were also collected.

The table below lists specific project objectives and describes the intended monitoring level and survey type for each objective, including regeneration of native riparian species and creation of silvery minnow habitat.

Objective	Monitoring Level	Monitoring Activity	Type of Survey
Regeneration of native riparian species	Effectiveness	Vegetation	Vegetation class, composition, and structure surveys
Prevention & monitoring the diffusion of invasive deciduous species	Implementation & Effectiveness	Vegetation	Removal of invasive species during construction; vegetation surveys and monitoring
Creation of silvery minnow nursery habitat	Implementation & Effectiveness	Fisheries	Nursery habitat surveys
Increasing silvery minnow habitat	Implementation & Effectiveness	Fisheries & Geomorphic	Topographical survey; mesohabitat survey; fisheries survey
Increasing active channel width	Implementation & Effectiveness	Geomorphic	Cross-section surveys
Creation of low-velocity habitats	Implementation & Effectiveness	Geomorphic	Topographical survey; mesohabitat survey; depth and substrate
Destabilization of islands & bars	Implementation & Effectiveness	Geomorphic	Modification of sites during construction; topographical surveys & inventory

Initial findings following implementation monitoring and two years of effectiveness monitoring include:

- The Project has contributed to creating silvery minnow habitat in an effort to stabilize the population while protecting existing and future water uses
- The Project is consistent to recovery goals for down-listing and de-listing the silvery minnow as outlined in the Draft Recovery Plan
- The constructed treatment areas were completed in accordance with project design; implementation monitoring was successful
- Adaptive management principles were used, as necessary, in order to obtain successful restoration of silvery minnow habitats
- The constructed treatment areas improved the following existing conditions: increased native vegetation, decreased invasive vegetation, increased area of wetlands, improved fish mesohabitat, and increased inundation area
- Island destabilization has not been a successful technique
- All of the islands being monitored, treated and control islands, experienced similar patterns of erosion and deposition
- Deposition has been common within the constructed channels
- Erosion has been common along bank cuts, including scallops
- All constructed treatments continue to function at designed flows
- No constructed feature has been deemed non-functional due to sediment deposition
- Native vegetation has increased, while invasive vegetation has decreased
- Wetland acreage has increased throughout the Project area

- No significant changes in water quality were detected during monitoring, other than anticipated daily or seasonal fluctuations
- Fisheries data are inconclusive, although the majority of adult silvery minnows have been found in the SDC subreach with many found at or near bank cuts

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1.0 BACKGROUND

The New Mexico Interstate Stream Commission (NMISC) has begun implementing portions of the Reasonable and Prudent Alternative (RPA) of the March 2003 U.S. Fish and Wildlife Service Biological and Conference Opinions on the Effects of Actions Associated with the Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, the U.S. Army Corps of Engineers' Flood Control Operations, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico (hereafter referred to as the 2003 Biological Opinion [BiOp]) (U.S. Fish and Wildlife Service [USFWS] 2003), which involves addressing priority habitat restoration (HR) goals of the Middle Rio Grande (MRG) Endangered Species Act (ESA) Collaborative Program (Collaborative Program). The HR being conducted is aimed at satisfying the federal requirements under 2003 BiOp RPA Element S, specifying that agencies, in coordination with the USFWS, shall "…conduct habitat/ecosystem restoration projects in the Middle Rio Grande to increase backwaters and oxbows, widen the river channel, and/or lower river banks to produce shallow water habitats, over-bank flooding, and regeneration of stands of willows and cottonwood to benefit the Rio Grande silvery minnow (*Hybognathus amarus*), the southwestern willow flycatcher (*Empidonax traillii extimus*), or their habitats" (USFWS 2003:95–96).

The NMISC applied several HR techniques during Phase I of the Riverine Restoration Project in the Albuquerque Reach of the Rio Grande (Project Area) to create or improve habitat for the Rio Grande silvery minnow (silvery minnow). The project was designed to evaluate selected HR techniques and is primarily funded by the State of New Mexico. However, a portion of the Phase I project was funded by the Collaborative Program under Grant Agreement #04-FG-40-2253, "Preliminary Evaluation of a Habitat Restoration Technique for Development of Mesohabitats for the Federally Endangered Rio Grande Silvery Minnow in the Middle Rio Grande, New Mexico." This is the final report under that grant and is intended to satisfy both the annual and final reporting requirements.

This report includes information from construction activities conducted between January and April 2006, and monitoring activities conducted between the fall of 2006 and fall of 2007. A 2006 annual report summarizing construction and fall 2006 monitoring efforts was submitted in 2007 (SWCA Environmental Consultants [SWCA] 2007). The following reports were submitted previously and contain additional information on planning, environmental compliance, and construction details pertaining to Phase I of the project.

- Beck and Fluder, 2006, Silvery Minnow Egg and Larval Fish Monitoring in Constructed Embayment
- Mussetter Engineering Inc., 2006, Evaluation of Bar Morphology, Distribution and Dynamics as Indices of Fluvial Process in the Middle Rio Grande, NM
- Reclamation, 2005, Middle Rio Grande Riverine Restoration Biological Assessment
- Reclamation, 2005, Middle Rio Grande Riverine Restoration Environmental Assessment
- SWCA, 2007, Riverine Restoration Project 2006 Annual Report

- SWCA, 2006, Summary of Construction Activities in the Interstate 40 Subreach
- SWCA, 2006, Summary of Construction Activities in the North Diversion Channel Subreach
- SWCA, 2006, Summary of Construction Activities in the South Diversion Channel Subreach
- USFWS, 2005, Biological Opinion of the Effects of the Middle Rio Grande Riverine Habitat Restoration Project Proposed by the NM Interstate Stream Commission

The NMISC outlined four potential phases of restoration that would occur between 2005 and 2009 in an Environmental Assessment that was prepared by the U.S. Bureau of Reclamation (Reclamation 2005). A phased approach has been applied to restoration activities, with monitoring and evaluation of the outcomes used in subsequent phases. Phase I construction in the Albuquerque Reach began in 2006. A second phase (Phase II) of construction was implemented in 2007, but will not be reported in this document.

2.0 INVOLVED PARTIES

This project was led by the NMISC, but numerous agencies and entities contributed to its success. Agencies that contributed to the successful compliance, coordination, and implementation of the project include Reclamation; the Collaborative Program; the New Mexico Environment Department (NMED); Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA); the City of Albuquerque, Open Space Division; the Middle Rio Grande Conservancy District (MRGCD); the New Mexico Office of the State Engineer (OSE); the New Mexico Department of Game and Fish (NMDGF); the U.S. Army Corps of Engineers (USACE); the Pueblo of Sandia; Pueblo of Isleta; University of New Mexico; and the USFWS. Collaboration with the aforementioned parties was essential to the success of the project and ongoing monitoring efforts.

3.0 INTRODUCTION

3.1. THE PROJECT

The long-term goal of the habitat restoration project is to promote egg retention, and increase larval rearing, young-of-year, and over-wintering habitat for the silvery minnow in support of the RPA, Element S of the 2003 BiOp. The objective of the restoration process is to modify the existing river channel to increase measurable habitat(s) complexity that supports various life stages of the silvery minnow by facilitating lateral migration of the river across islands, bars, and river banks during various mid-level and high flows. Monitoring goals include both implementation (monitoring during and immediately following construction activities) and effectiveness (post-construction, long-term monitoring) monitoring. This project is directed at documenting and evaluating the effectiveness of specific HR techniques in establishing diverse mesohabitats at a range of river flows between 500 cubic feet per second (cfs) and 3,500 cfs. It should be noted that the Phase I project is a preliminary study that investigates potential trends in habitat restoration and is not directed at developing statistically testable data.

The project consists of HR techniques applied in three subreaches of the Albuquerque Reach of the MRG. These subreaches include the North Diversion Channel (NDC) Subreach, the I-40/Central (I-40) Subreach, and the South Diversion Channel (SDC) Subreach (Figure 3.1). The project comprises several techniques for improving aquatic habitats at an intermediate scale (mesohabitats), as discussed and adapted from the *Habitat Restoration Plan for the MRG* (Tetra Tech 2004). Specific techniques were implemented, monitored, and evaluated, and the HR plans of subsequent phases will be adjusted to increase treatments that are most effective in meeting the habitat needs of the silvery minnow.

Four primary restoration/rehabilitation techniques (Table 3.1) were selected in Phase I for their potential to improve available over-wintering, egg retention, and larval-rearing habitat for the silvery minnow at flows ranging from 500 to 3,500 cfs. The four techniques were: 1) island modification or destabilization, 2) high-flow ephemeral side channels, 3) high-flow bank-line embayments, scours or scallops, and 4) bank-line lowering or terracing. Island modifications included mechanically disturbing either the upstream one-third of an island or the middle one-third of an island and creating terraces on the upstream one-half of an island. The mechanical disturbance was an attempt to help the river mobilize the island sediments to alleviate channel narrowing. The creation of terraces on islands would create aquatic habitat of varying depths at different flows. High-flow ephemeral side channels were constructed to create shallow, low-velocity habitat off the main channel when flows in the river are especially high. Bank-line embayments, scours or scallops were constructed at points where the river flow intersects the bank line at near perpendicular angles in an effort to promote lateral migration of the river. Finally, bank lines were lowered and terraced in order to both promote overbank flooding and to create shallow habitat along previously steep banks. Photo points and survey transects were established for the project for monitoring purposes (Appendix A and Appendix B).

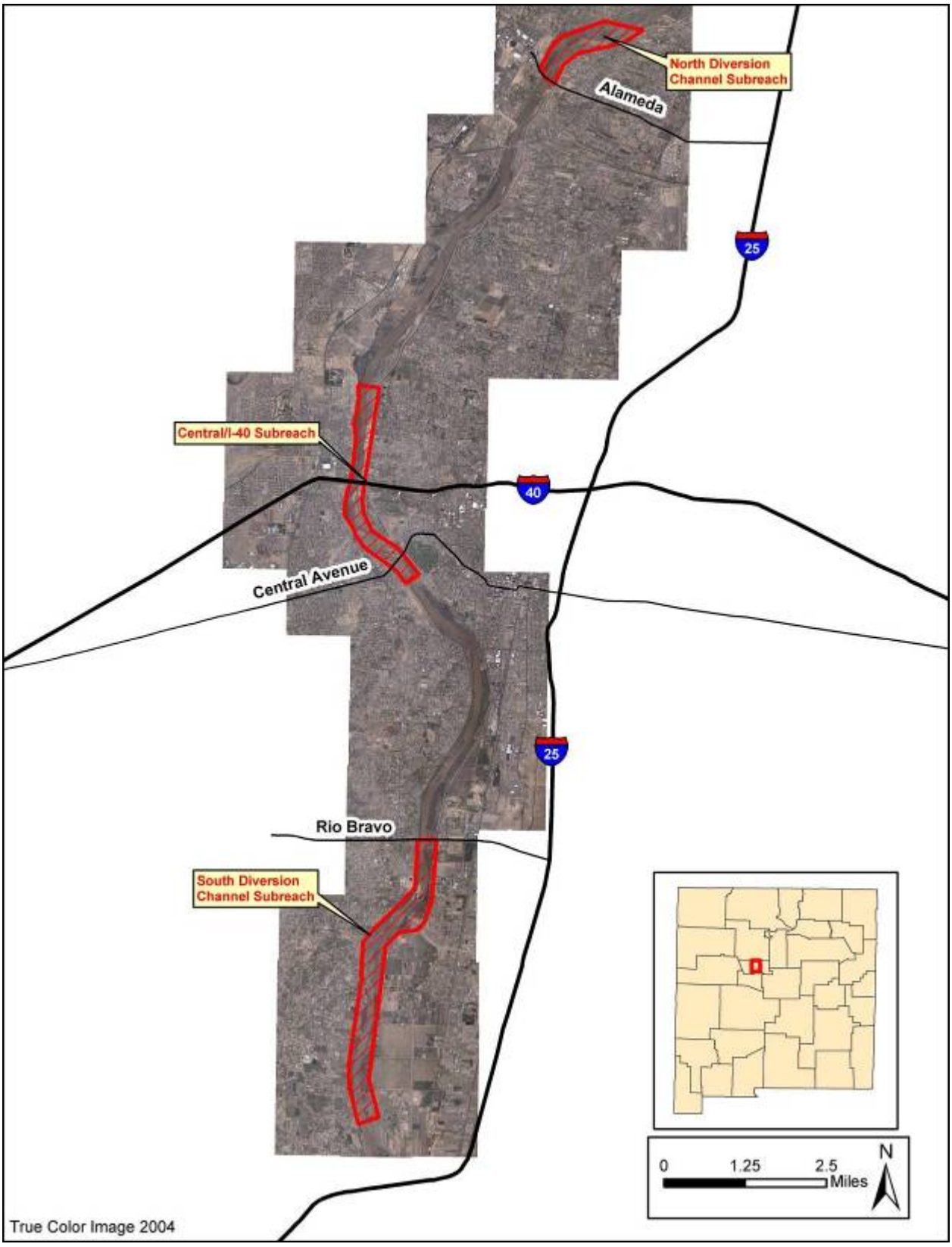

Figure 3.1. Middle Rio Grande riverine habitat restoration subreaches.

Table 3.1. Potential Restoration Benefits of Implemented Techniques

Technique	Description	Benefits of Technique
Modification of islands and bars	Physical disturbance (disking, mowing, root-plowing, raking) of islands or bars to remove vegetation and mobilize features during high flows	Creates more complex habitat for silvery minnow by reducing average channel depth, widening the channel, and increasing backwaters, pools, eddies, and runs of various depths and velocities. Increased inundation will benefit native vegetation and potentially increase habitat for SWFL.
High-flow ephemeral channels	Construction of ephemeral channels on islands to carry flow from the main river channel during high-flow events	Creates shallow, ephemeral (normally dry), low-velocity aquatic habitats important for silvery minnow egg and larval development during high-flow time periods. Increased inundation will benefit native vegetation, potentially increasing habitat for SWFL.
High-flow bank-line embayments	Areas cut into banks where water enters, primarily during high-flow events, including spring runoff and floods	Intended to retain drifting silvery minnow eggs and to provide rearing habitat and enhance food supplies for developing silvery minnow larvae. Increased inundation will benefit native vegetation, potentially increasing habitat for SWFL.
Terrace and bank lowering	Removing vegetation and excavating soils adjacent to the main channel to create potential for over-bank flooding	Could provide for increased retention of silvery minnow eggs and larvae. Increased inundation will benefit native vegetation, potentially increasing habitat for SWFL.

Source: Tetra Tech 2004
SWFL = Southwestern willow flycatcher

3.2. ENVIRONMENTAL COMMITMENTS

All applicable land access and environmental permits were obtained by the NMISC prior to implementation of the Project. A Biological Assessment (BA), which was completed in accordance with provisions of the ESA, evaluated and analyzed potential impacts of the Project on listed threatened, endangered, or other special status species that may have occurred within the Project Area during Phase I. Specific details of the environmental commitments and an analysis of the effects on species were included in the 2006 annual report (SWCA 2007).

3.3. PROJECT LOCATIONS AND PHASE I TREATMENTS

As shown in Figure 3.1, three general locations in the Albuquerque Reach of the Rio Grande were chosen for application of restoration/rehabilitation techniques: (1) from the NDC to the Alameda Bridge, (2) from approximately 0.5 mile north of I-40 to Central Avenue, and (3) from the Rio Bravo Bridge to approximately 2.0 miles south of the SDC.

Specific sites on vegetated islands, bars, and river banks were chosen for testing the effectiveness of these techniques. Approximately 18.24 acres of root plowing occurred in the three subreaches at the treatment sites. The treated area and adjacent surrounding area is termed the *effective area*, which is the combined construction area and impacted area for a habitat restoration site. For example, an 8-acre island may have only the upstream half (4 acres) modified, but the entire island will be monitored and could provide beneficial habitat. The total effective area for Phase I was 74.41 acres (Table 3.2).

Table 3.2. Phase I Restoration Technique Treatment Areas

Subreach	Phase I Acres Treated		
	Construction	Effective Area	Total
NDC	10.54	13.47	24.01
I-40/Central	2.73	18.76	21.49
SDC	4.97	23.94	28.91
Total	**18.24**	**56.17**	**74.41**

Conceptual engineering designs were developed for each restoration site, showing a topographical representation of the site and cross sections of the river channel before restoration as well as the design for modification. These engineering designs took into account potential increased sediment retention in the modified sections of the river, as well as potential flow-through velocities and depths. As-built plan and profile maps were developed immediately after construction for all sites. Appendix C contains detailed descriptions for each restoration site.

3.3.1. North Diversion Channel Subreach

Four islands were modified in the NDC Subreach, as shown in Figure 3.2. In this subreach, three types of island treatments were implemented. One undisturbed (control) island was monitored for comparison with modified islands. One bankline site was scalloped, and three ephemeral channels were constructed.

3.3.2. I-40 to Central Subreach

Two vegetated island modification sites, two bank scour and scallop sites, and one ephemeral channel site were created within the I-40 Subreach, as shown in Figure 3.3. Some sites were modified or eliminated from the original design due to time and access constraints.

3.3.3. South Diversion Channel Subreach

Three islands were modified and three banklines were lowered in the SDC subreach, as shown in Figure 3.4. One island in this subreach was left undisturbed as a control island and was monitored for comparison with modified islands.

3.4. Topographical Designs and Survey

During the planning stage, topographical contours of the selected sites and the surrounding river channel were mapped using survey data collected at selected cross sections in conjunction with orthorectified aerial photography and digital elevation models (DEMs) with 1-foot contours. These data were collected over at least two flows to develop a stage-to-discharge relationship to help quantify the available low-velocity habitat at different river flows. This relationship also provided the basis for determining the elevations at which modifications should be excavated for each site. Table 3.3 shows the flow at which each site is designed to be inundated. Please note that some embayments and bank scours were designed to be inundated at 400 to 500 cfs.

Table 3.3. 2007 Effectiveness Monitoring and Designed Inundation Level per Site

Site ID	Effectiveness Monitoring			Designed Inundation Level				
	Fisheries	Geomorphic	Vegetation	1,000 cfs	1,500 cfs	2,000 cfs	2,500 cfs	3,500 cfs
NDC_1b	X	X	X	X				
NDC_1ch	X	X	X		X			
NDC_2ch			X	X				
NDC_3ch			X	X				
NDC_2i		X	X			X		
NDC_3i	X		X		X		X	X
NDC_4i		X	X			X		
NDC_5i			X		X		X	X
I-40_2i			X			X		
I-40_1b			X			X		
I-40_4i			X		X		X	X
I-40_3b			X			X		
SDC_2i		X	X			X		
SDC_3i	X	X	X			X		
SDC_1b		X	X			X		
SDC_4i	X	X	X		X		X	X
SDC_2b			X			X		
SDC_3b	X		X			X		

Figure 3.2. Treatment locations for the North Diversion Channel Subreach.

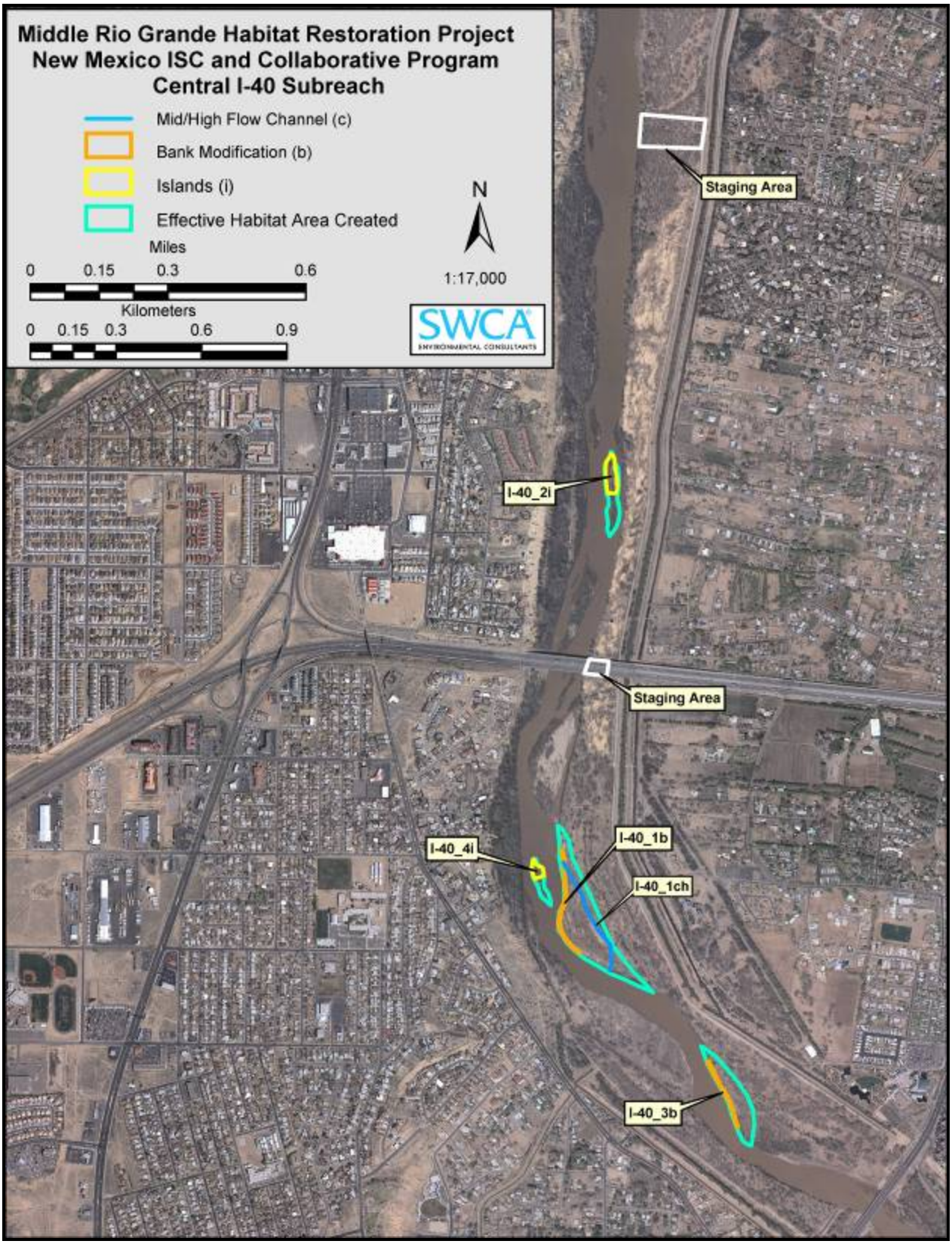

Figure 3.3. Treatment locations for I-40/Central Subreach.

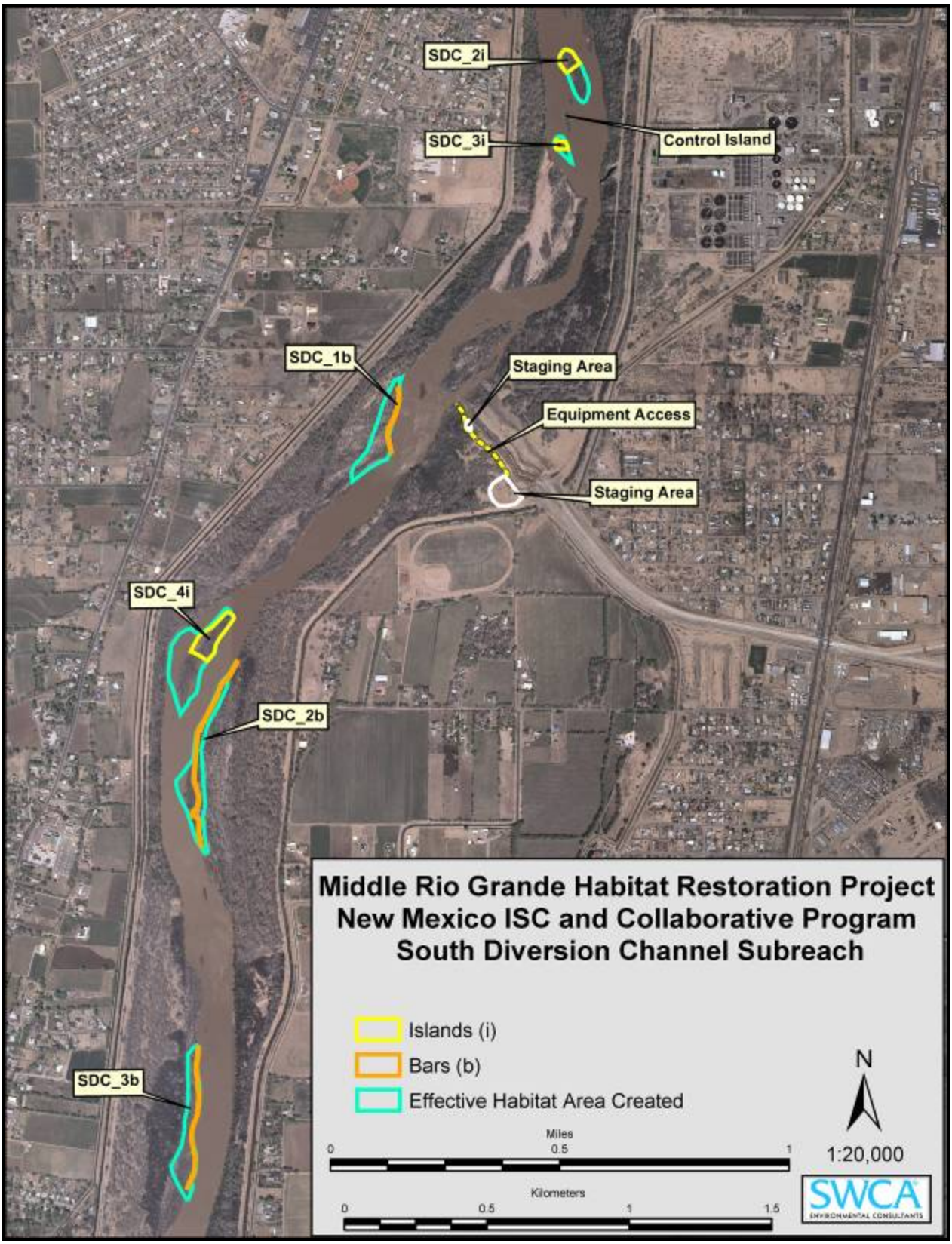

Figure 3.4. Treatment locations for South Diversion Channel Subreach.

3.5. FISHERIES MONITORING

Limited fisheries monitoring was conducted during the 2006 and 2007 spring runoff seasons to examine adult and larval fish use and egg retention at NDC and SDC habitat restoration sites. Because of low spring flows in 2006, few HR Phase I sites were inundated. Only shallow, low-velocity areas within constructed embayments were available for the study during the spring and summer of 2006. This data was reported in the 2006 Annual Report (SWCA 2007; Beck and Fluder 2006).

During the 2007 spring runoff additional fisheries monitoring was conducted. This component of the study was intended to be an initial look at which habitats might be most efficient at trapping or retaining silvery minnow eggs and whether adult silvery minnow use habitat restoration sites.

3.6. GEOMORPHOLOGY/HYDROLOGY MONITORING

The HR process was initiated to increase measurable habitat complexity in support of various life stages of the silvery minnow by facilitating lateral migration of the river across islands, bars, and river banks at a variety of river flows. Monitoring the effects of hydrology on HR sites within the MRG was initiated in the winter of 2006 and conducted again during the fall of 2007. The goal of monitoring was to determine whether spring and summer flows led to significant changes of the modified features and destabilization of the islands. Localized bank erosion and deposition at the NDC and SDC subreaches were also monitored.

4.0 2006 CONSTRUCTION MONITORING

Detailed construction monitoring reports for each of the three subreaches were included in the 2006 Annual Report (SWCA 2007). These reports include information and descriptions regarding the time period of work, details of work completed at each location, access and staging areas, and photographs of each site. Monitoring for water quality parameters, discharge, and biology are summarized in the document. Water quality parameters measured during construction activities were water temperature, turbidity, pH, salinity, dissolved oxygen (DO), DO by percent saturation, and specific conductivity. Discharge was recorded from upstream U.S. Geological Survey (USGS) gages. Biological commitments included monitoring for bald eagles, silvery minnow, and willow flycatcher.

5.0 2007 MONITORING

A monitoring plan has been developed by the NMISC to carry out monitoring activities for the Phase I subreach habitat restoration areas.

The monitoring consists of three general activities:

- Fisheries monitoring to determine the number of fish, identified by species, at restoration sites and to determine how well specific types of restoration sites help to retain eggs during spring runoff.

- Geomorphic and mesohabitat monitoring to determine how flows have recontoured the sites to create varied mesohabitat features.

- Vegetation monitoring to assess southwestern willow flycatcher habitat suitability, how species composition and community types are responding to disturbance, and whether native riparian habitats are successfully regenerating.

Table 5.1 lists specific project objectives and describes the intended monitoring level and survey type for each objective. "Monitoring Level" indicates whether the monitoring is intended to be "Implementation" or "Effectiveness" monitoring. Implementation monitoring measures whether the project was constructed or completed as planned, and effectiveness monitoring measures how well the project met its objective and restoration goal(s).

This section describes and presents the results of each of the monitoring activities. Results are also presented by site in Appendix C. All field data are also compiled in a Microsoft Access database (available on request from NMISC).

Table 5.1. Monitoring of Project Objectives

Objective	Monitoring Level	Monitoring Activity	Type of Survey
Regeneration of native riparian species	Effectiveness	Vegetation	Vegetation class, composition, and structure surveys
Prevention & monitoring the diffusion of invasive deciduous species	Implementation & Effectiveness	Vegetation	Removal of invasive species during construction; vegetation surveys and monitoring
Creation of silvery minnow nursery habitat	Implementation & Effectiveness	Fisheries	Nursery habitat surveys
Increasing silvery minnow habitat	Implementation & Effectiveness	Fisheries & Geomorphic	Topographical survey; mesohabitat survey; fisheries survey
Increasing active channel width	Implementation & Effectiveness	Geomorphic	Cross-section surveys
Creation of low-velocity habitats	Implementation & Effectiveness	Geomorphic	Topographical survey; mesohabitat survey; depth and substrate
Destabilization of islands & bars	Implementation & Effectiveness	Geomorphic	Modification of sites during construction; topographical surveys & inventory

5.1. FISHERIES MONITORING

Limited surveys were conducted during the 2007 spring runoff to examine adult and larval fish use and egg retention at NDC and SDC nursery habitat sites. Hoop and seine nets were used to collect adult and young-of-year (YOY) fish, while Moore egg collectors (MEC), quadrats, and D-frame invertebrate sampling kick nets were used to collect fish eggs and larvae. This component of the study was intended to be an initial look at which habitats might be most efficient at trapping or retaining silvery minnow eggs and whether adult silvery minnow use habitat restoration sites. The fisheries monitoring was not designed to develop statistically testable data, however methods and study design can be modified in the future to answer specific scientific questions.

5.1.1. METHODS

During the ascension of the spring runoff hydrograph and subsequent stable peak flow discharges (May 19 through June 7, 2007), quadrats and hoop nets were set at predetermined habitat restoration sites. Monitoring methods were modified from those of the 2006 monitoring (Beck and Fluder 2006; Michael Porter pers. comm. 2006) because of uncertainty with flows and the varying extent of inundation at individual sites. Ideal sites had low- or no-current velocity and depths between 0.2 and 0.3 meter (m). A series of ten standard quadrats (0.5 m by 0.5 m) and a single rectangular hoop net (0.5 m by 0.5 m; 6.4-millimeter [mm] mesh size) attached to metal posts (4-foot t-posts) were installed at each habitat restoration site. On June 5 and 6, fish were collected with a 12-foot by 4-foot by 1/8-inch mesh seine from the SDC-3i treatment site to document habitat use and to determine the presence of fish collected by the hoop nets.

The hoop nets were installed such that they captured fish entering the site from the river channel. The quadrats were installed either upstream of, or at a convenient location near, the hoop nets. Where there was no obvious entrance to the sites, hoop nets were installed in either an upstream or downstream orientation. Once the hoop nets and quadrats were installed, they were left over-night and sampled once each day. A total of eight sites were monitored utilizing hoop nets and quadrats. Sites that were monitored include NDC-1b, NDC-1ch, NDC-3i (east), NDC-3i (west), SDC-3i, SDC-4i, SDC-3b (1), and SDC-3b (2).

Throughout the fisheries monitoring other variables measured in each sampled habitat were: water depth, flow, water temperature, DO, pH, turbidity, conductivity, and salinity.

MECs were used intermittently to monitor for silvery minnow eggs from May 19 through June 1. MECs were placed upstream of the treatment to determine presence/absence of silvery minnow eggs or larval fish while crews were present in the field. At some locations MECs were placed within the thalweg parallel to a treatment site. MECs were used as a secondary component to the overall fisheries monitoring. MECs were placed facing upstream in water with adequate depth and velocity. During each sampling event, MECs were inspected and cleaned for silvery minnow and other fish eggs and larvae.

5.1.2. RESULTS

All captured fish and eggs were identified when possible, counted, and released. Captured silvery minnows were measured (standard length) and observed for elastomer tags; the presence of gravid females was also noted.

Fisheries data were summarized by number captured and percent composition for individual treatment sites, as well as by subreach. One hundred eighty-five fish, representing six species (not including larval fish), were collected with hoop and seine nets (Table 5.2). Silvery minnows were the dominant fish species present, making up 78% of the total number. Collectively, all other identifiable fish species made up less than 5% of the total. Eighteen percent of fish captured were larvae, which could not be identified.

Of the 145 silvery minnows caught and released, 12 were caught in the NDC Subreach and 133 in the SDC Subreach. In the NDC Subreach, 1 silvery minnow was caught at NDC-1b (bankline), 2 at NDC-1ch (ephemeral channel), 9 on the west side of NDC-3i (island), and 0 on the east side of NDC-3i. In the SDC Subreach, 34 silvery minnows were caught at SDC-3b upstream (bankline), 89 at SDC-3b downstream, 8 at SDC-3i (island), and 2 at SDC-4i (island).

When summarized by number of silvery minnows caught and released at the three types of restoration sites, most were found at bankline sites. One hundred twenty-four silvery minnows were caught at bankline sites, compared to 2 in ephemeral channel sites and 19 at island sites.

Notable differences were observed between subreaches for the number of identifiable fish captured but not species composition (Table 5.2). The majority of fish (92%) were captured from the sites in the SDC Subreach. Silvery minnows were the dominant fish species at both sites, comprising 77% and 85%, respectively.

The mean standard length of silvery minnows was 59 mm (standard error = 0.97, range 35–85 mm). The data suggests that there were a minimum of two age classes (Figure 5.1). Eighteen silvery minnows were gravid, and twenty had elastomer tags. No tagged fish were recaptured from the NDC nursery habitat site. Table 5.3 summarizes recaptures by tag color. The NMISC recorded the fish with elastometer tags to determine if silvery minnows were refugia or hatchery fish. The tags assist in determining the date the fish were tagged and where they were released into the Rio Grande. The NMISC presented this data to the Service following the field effort.

A total of 29 MEC sets were run: 16 at NDC and 13 at SDC sites. No silvery minnow eggs were collected. However, three larval fish were collected from the SDC sites.

Of the 80 quadrats, 72 were inspected for fish and eggs. Eight were buried by sediment and could not be inspected. No silvery minnow eggs were collected. Forty-seven larval fish were collected, the majority (41) from the SDC sites.

A total of 32 kick net samples were collected: 12 at NDC and 20 at SDC sites. No adult fish or silvery minnow eggs were collected. Forty larval fish were collected: 35 at SDC sites and 5 at NDC sites.

Table 5.2. Number and Percent Composition of Fish Species Captured Using Hoop and Seine Nets. Data are Summarized by Subreach and for Both Subreaches Combined.

Species	NDC		SDC		Both Subreaches Combined	
	Number Captured	Percent	Number Captured	Percent	Number Captured	Percent
Carpiodes carpio	1	7	0	0	1	0.5
Catostomus commersonii	0	0	1	1	1	0.5
Cyprinella lutrensis	0	0	1	1	1	0.5
Hybognathus amarus	**12**	**86**	**133**	**78**	**145**	**78**
Pimephales promelas	0	0	1	1	1	0.5
Platygobio gracilis	1	7	2	1	3	2
Larval species	0	0	33	19	33	18
Total	14	100	171	100	185	100

Table 5.3. Silvery Minnows Captured During Monitoring at SDC Sites by Tag Color.

Tag Color	SDC
Pink	15
Green	4
Red	1
Orange	0
Total	20

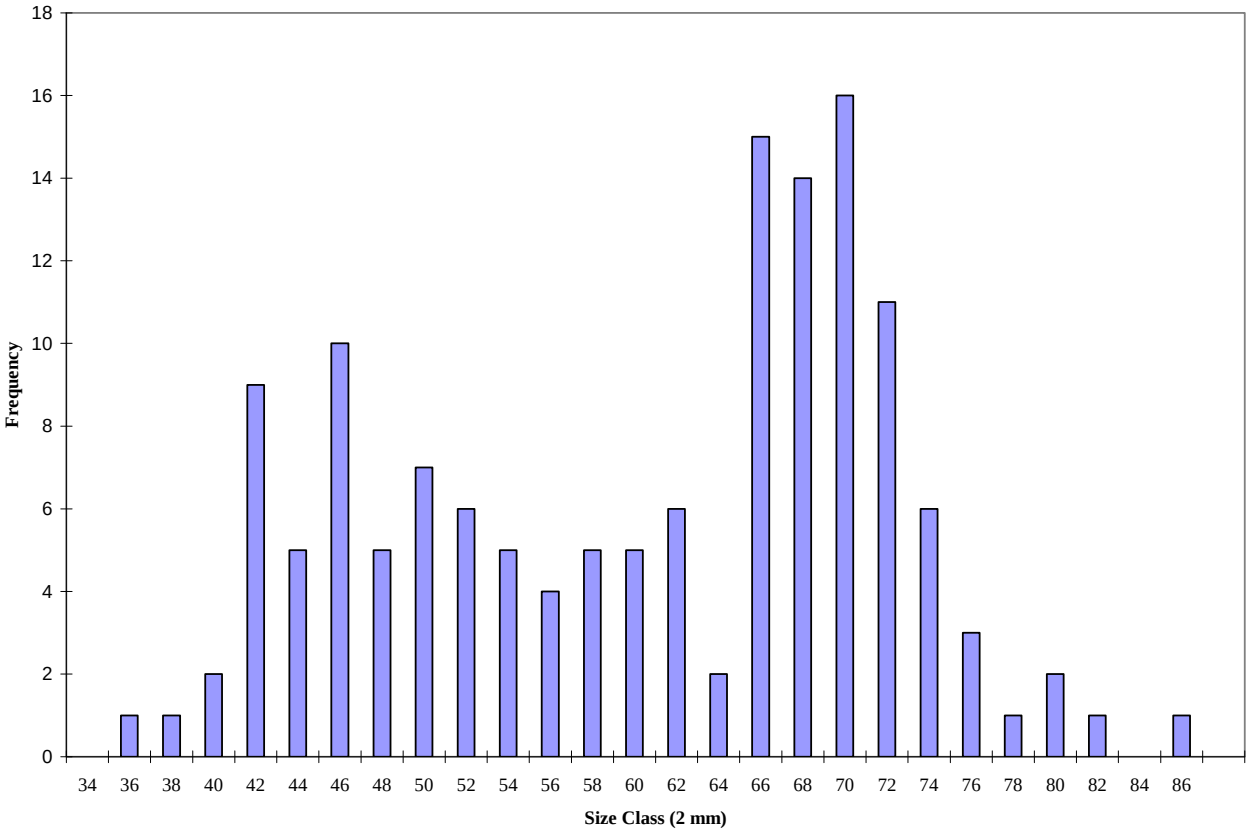

Figure 5.1. Length frequency of silvery minnows captured from both Phase I nursery habitat sites. Bars represent 2-mm size classes.

5.2. WATER QUALITY MONITORING

To ensure no indirect harm or mortality from reduced water quality in the critical habitat of silvery minnow from accidental introduction of contaminants or increases in turbidity, water quality data was collected during construction. This data is available in the construction monitoring reports that were included in the 2006 Annual Report (SWCA 2007). Water quality data continues to be collected during yearly monitoring events for the sake of continuity; however, we do not expect to see impacts to water quality from the project.

Monitored water quality parameters were turbidity, pH, salinity, water temperature, DO, DO by percent saturation, conductivity, and specific conductance. In addition, the water depth and flow were measured.

5.2.1. METHODS

The majority of the water quality data was collected using a YSI 556 MPS handheld instrument. Turbidity was recorded using a Hanna Instruments 93703 Microprocessor Turbidity Meter. The water depth and flow were measured using a Marsh-McBirney flow meter and wading rod. Water data recorded include:

- Turbidity (Formazine Turbidity Unit [FTU])
- pH
- Salinity (parts per thousand [ppt])
- Water temperature (degrees Celsius [°C])
- DO (percent saturation [%sat])
- DO (milligrams per liter [mg/L])
- Conductivity (microsiemens per centimeter [µS/cm])
- Specific conductance (microsiemens per corrected centimeter [$\mu S/cm^c$])
- Flow (feet per second [ft/sec])
- Depth (tenths of a foot [ft])

Monitoring location data was recorded using a Trimble Global Positioning System (GPS) device; therefore, precise replication could be achieved. Currently, water quality parameters are measured within the river channel closest to a vegetation monitoring site.

5.2.2. RESULTS

Water quality data was collected during monitoring in October 2006 and again during monitoring in September 2007. The 2006 and 2007 water quality data for each site was compiled and is displayed in Table 5.4. Within each subreach, some anomalous recordings can be found due to high flows, rain, low water level, etc. Overall, the water quality remains consistent throughout the post-construction period.

Table 5.4. Water Quality and Flow Data Collected During Monitoring in 2006 and 2007

Site Name	Turbidity (FTU*)		pH		Salinity (ppt)		Water Temp °C		DO (%)		DO (mg/L)		Conductivity (µS/cm)		Specific Conductance (µS/cm[c])		Flow (ft/s)		Depth (ft)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
North Diversion Channel Subreach																				
NDC_1b	66.0	82.0	8.4	9.5	0.2	0.2	15.8	21.1	85.1	73.2	8.4	6.6	313.5	310.0	258.3	335.0	0.7	1.8	2.8	1.0
NDC_1ch	66.0	87.0	8.4	8.4	0.2	0.2	15.8	21.4	85.1	75.9	8.4	6.7	313.5	314.0	258.3	339.0	0.7	2.4	2.8	2.1
NDC_2ch	80.0	101.0	8.2	9.7	0.2	0.2	22.4	26.8	85.7	70.8	7.3	5.7	325.9	355.0	309.5	344.0	0.7	2.5	0.7	1.6
NDC_2i	69.0	78.0	8.2	8.4	0.2	0.1	17.6	23.3	83.4	81.8	7.9	6.9	316.6	314.0	271.4	326.0	0.7	1.9	0.9	1.3
NDC_3ch	82.0	101.0	8.1	9.7	0.2	0.2	22.4	26.8	82.9	70.8	7.1	5.7	327.7	355.0	311.4	344.0	0.3	2.5	0.7	1.6
NDC_3i	86.0	86.0	8.1	8.4	0.2	0.2	19.7	25.3	86.5	68.9	7.7	5.8	322.6	346.0	289.8	344.0	0.4	1.9	1.0	1.9
NDC_4i	79.0	86.0	8.2	8.4	0.2	0.2	22.9	28.2	90.6	73.0	7.8	7.0	328.9	338.0	316.2	318.0	0.6	1.6	1.6	1.6
NDC_5i	84.0	95.0	8.2	8.5	0.1	0.2	16.7	27.5	81.3	78.2	7.8	6.2	297.0	340.0	250.0	324.0	0.3	2.2	0.4	1.7
Interstate 40 Central Subreach																				
I-40-1b	671.0	125.0	8.2	8.6	0.1	0.2	18.2	23.5	80.1	83.0	7.5	7.0	90.0	328.0	103.0	338.0	0.1	1.7	1.2	0.7
I-40_1ch	671.0	125.0	8.2	8.6	0.1	0.2	18.2	23.5	80.1	83.0	7.5	7.0	90.0	328.0	103.0	338.0	0.1	1.7	1.2	0.7
I-40_2i	696.0	134.0	8.3	8.5	0.1	0.2	17.4	21.6	81.1	81.2	7.8	7.2	100.0	321.0	116.0	343.0	1.0	1.1	2.3	1.6
I-40_3b	175.0	109.0	8.0	8.5	0.3	0.1	13.7	21.3	74.9	83.5	7.8	7.5	517.0	287.0	659.0	313.0	0.2	1.9	0.5	1.2
I-40_4i	140.0	119.0	8.2	8.5	0.3	0.2	12.8	22.8	73.1	81.0	7.7	6.8	506.0	317.0	659.0	324.0	0.7	1.8	2.1	1.0
South Diversion Channel Subreach																				
SDC_1b	612.0	644.0	8.0	8.3	–	0.3	12.9	21.3	85.5	75.4	9.0	6.6	521.0	505.0	678.0	544.0	0.4	0.5	2.9	2.3
SDC_2b	≥1000	104.0	7.7	8.5	0.3	0.2	19.3	25.2	84.0	74.8	7.7	6.1	501.0	448.0	562.0	446.0	0.8	1.7	3.8	1.7
SDC_2i	591.0	1000.0	8.0	8.3	0.4	0.2	12.1	23.3	83.6	72.3	9.0	6.2	536.0	473.0	713.0	489.0	0.8	0.2	1.2	0.8
SDC_3b	≥1000	867.0	8.0	8.4	0.3	0.3	17.2	17.4	90.8	75.6	8.7	7.2	462.0	479.0	543.0	560.0	1.1	0.5	2.2	1.1
SDC_3i	535.0	192.0	8.0	8.5	0.4	0.2	12.2	25.1	86.3	75.3	9.2	6.3	532.0	360.0	703.0	360.0	0.9	1.9	1.0	1.6
SDC_4i	715.0	180.0	8.0	8.3	0.3	0.2	13.8	20.3	87.4	74.0	9.0	6.8	510.0	329.0	650.0	362.0	0.4	1.9	1.1	1.0

* - FTU (Formazine Turbidity Unit) = NTU (Nephelometric Turbidity Unit)

5.3. HYDROLOGIC AND GEOMORPHIC MONITORING

The construction of Phase I restoration concluded in spring 2006, ahead of the anticipated spring runoff. The mean daily flows recorded at Central Avenue (USGS Gage No. 08330000) for the period since construction are shown in Figure 5.2. In 2006 the spring runoff was virtually non-existent but the summer monsoon season was extreme. Peak mean daily flows reached 2,300 cfs in August 2006 but were not sustained. Spring runoff in 2007 was considered normal. The Albuquerque gage reached a peak mean daily flow of 3,700 cfs on May 21, 2007. For nine days in March 2007 and for nearly one month from May 4 to June 1, 2007, the mean daily discharge remained above 2,000 cfs; at or within the inundation level for most habitat restoration sites (Figure 5.2). Table 5.5 shows the number of days of inundation by inundation level between the 2006 and 2007 survey periods. Table 5.6 shows the number of days of inundation by inundation level for the NDC and SDC subreach sites following construction in 2006.

Initial surveys were conducted prior to 2006 construction and at the end of construction (as-builts). The first post-construction topographic survey took place in December 2006, and the second post-construction topographic survey took place in November 2007. The synopsis below briefly describes changes between these survey periods. Detailed maps showing erosive and depositional results for each site surveyed are provided in Appendix D. Additional surveys will be conducted at least once a year following runoff to determine erosional and depositional trends and whether these tends are benefiting the development of silvery minnow habitat.

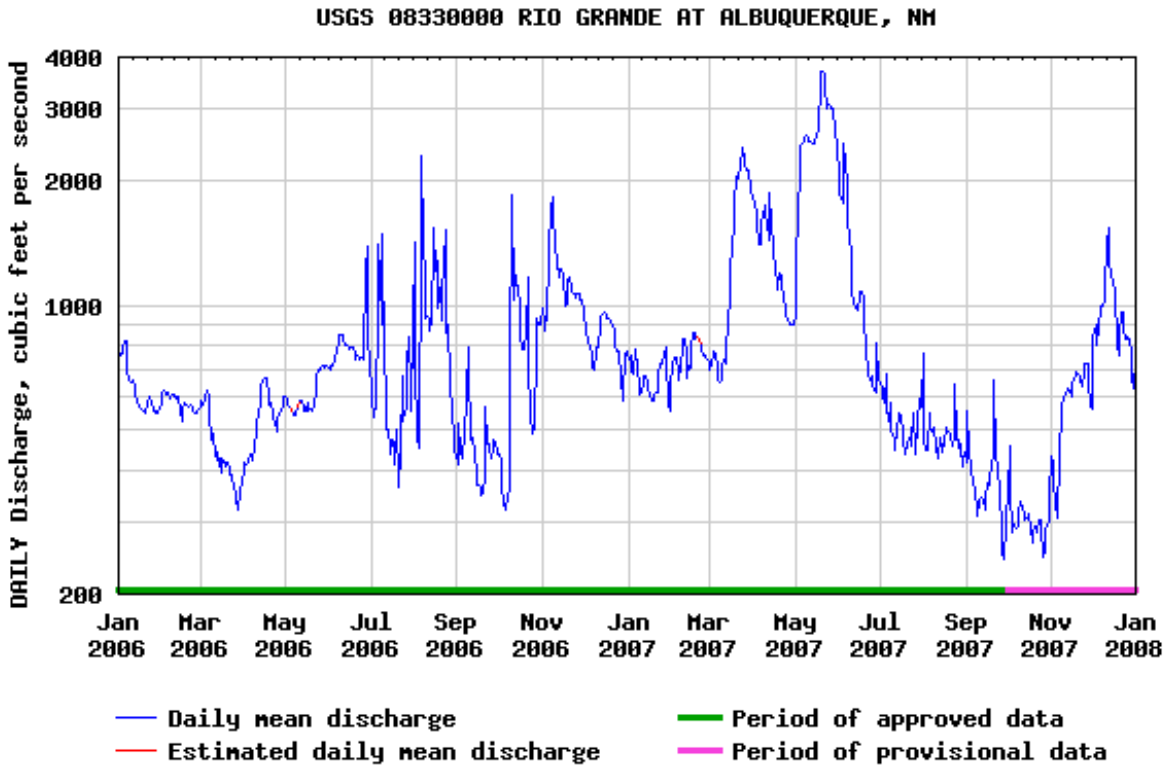

Figure 5.2. Mean daily flow record at Central Avenue USGS gage (no. 08330000), 2006 and 2007.

Table 5.5. Days of Inundation by Inundation Level for the Time Period between the 2006 and 2007 surveys (from 12/14/2006 to 10/28/2007)

Flow	Days MDQ* was equal or exceeded
500	226
1000	86
1500	62
2000	41
2500	20
3000	10
3500	3
4000	0

* MDQ is Mean Daily Discharge (Q)

Table 5.6. Days of Inundation by Inundation Level for NDC and SDC Subreach Site Following Construction in 2006

NDC Completion Date 02/28/2006 Period of Record 03/01/2006 to 12/10/2006	
Flow	**Days MDQ was equal or exceeded**
500	202
1000	50
1500	7
2000	1
2500	0
3000	0
3500	0
4000	0

SDC Completion Date 03/22/2006 Period of Record 03/23/2006 to 12/10/2006	
Flow	**Days MDQ was equal or exceeded**
500	195
1000	50
1500	7
2000	1
2500	0
3000	0
3500	0

5.3.1. RESULTS FOR THE NDC SUBREACH

NDC_1b &_1ch

A channel was cut down the middle of the bar with a scallop at the upstream end. The bed elevation of the scallop was lowered to the 400 cfs water surface elevation. The spoil was deposited primarily between the river and the cut channel with an additional pile to the south of the scallop feature. The December 2006 survey showed this feature has experienced widespread deposition of less than 0.5 foot. Some erosion of the spoil piles occurred along with some erosion of the main channel bank. Since the December 2006 survey, deposition of less than 0.5 foot has occurred in the channel. Some erosion of the spoil piles occurred along the main channel bank. Erosion occurred on the upstream end of the cut channel. On the downstream end of the cut channel, deposition up to 1.5 feet occurred, where the cut channel flows into the main channel.

NDC_2i

The upstream third of this island was cut to the 3,000 cfs water surface elevation. The December 2006 survey shows deposition between 0.1 and 0.5 foot over most of the island. Since the December 2006 survey, erosion, ranging from 0.5 foot to more than 2 feet occurred on the upstream end of the island. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows erosion along the northwest bank of the island and deposition along the right bank of the channel.

NDC_4i

This island was cut to the 2,000 cfs water surface elevation. The December 2006 survey shows deposition between 0.1 and 0.5 foot over most of the island. Comparison of the December 2006 survey with the November 2007 survey shows deposition in the range of 0.1 to 0.5 foot over the eastern half of the island. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows deposition in the channel bed southeast of the island.

NDC Control Island

The control island for this reach has shown erosion along the north bank and pockets of erosion in the interior of the island. The December 2006 survey shows little change since the September 2005 survey. The November 2007 survey shows deposition of between 0.1 and 0.5 foot occurred on most of the island since December 2006. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows erosion along the northwest bank of the island and deposition along the right bank of the channel.

5.3.2. RESULTS FOR THE SDC SUBREACH

SDC_1b

The bank was lowered to the 1,500 cfs inundation level and the spoil was simply piled adjacent to the lowered area. The summer flows of 2006 resulted in minor deposition over the upstream portion of the feature and bank erosion along the downstream half. Comparison of the November 2007 survey shows the bank experienced more than 2 feet of erosion in two areas on the upstream and downstream portions of the bar. Deposition of between 0.1 and 0.5 foot occurred on the majority of the bar in the over bank area. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows areas of erosion on the east side of the channel bed.

SDC_2i

The upstream third of this island was lowered approximately 2 feet to achieve inundation at 2,000 cfs, and the spoil was placed immediately downstream of the cut area. Since December 2006, deposition of more than 0.5 foot, and in some areas over 1 foot, occurred on most of the island. The western bank of the island eroded by more than 1.5 feet. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows deposition on the channel bed as well as the observed erosion along the western bank of the island.

SDC_3i

The middle third of this island was cut by approximately 1 foot to achieve inundation at 2,000 cfs, and the spoil was placed immediately downstream. The majority of the island showed deposition of between 0.1 to 0.5 foot between the December 2006 survey and the November 2007 survey. An area in the lower half of the island experienced erosion up to 1 foot. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows mixed areas of erosion and deposition along the channel bed. The channel on the west side of the island generally shows deposition. The portion of the channel directly adjacent to the east bank of the island shows erosion.

SDC_4i

The island was modified by cutting approximately 2 feet of material from the upstream end and tapering to a smaller amount of removal towards the middle creating terraces. The terraces correspond to the water surface elevations at flows of 1,500 cfs, 2,500 cfs, and 3,500 cfs. The December 2006 survey showed mostly deposition across the island since construction. Since the December 2006 survey, the island was eroded between 0.1 and 0.5 foot over the majority of the island. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows areas of erosion on the west side of the island and deposition on the east side (Appendix E).

SDC Control Island

The control island for the SDC reach has experienced areas of erosion on the upstream end and along the western bank since the December 2006 survey. About one-third of the island showed some deposition. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows erosion of the channel bed along the east side of the island and deposition in the channel bed along the west side of the island.

5.4. VEGETATION SURVEYS AND MONITORING

Riparian vegetation along the MRG is potentially suitable migratory and breeding habitat for southwestern willow flycatcher (*Empidonax traillii extimus*; SWFL). Removing suitable SWFL habitat with the preferred height, density, and species composition would decrease opportunities for breeding. Because portions of the project were adjacent to critical habitat for SWFL (FR 2005), vegetation surveys and monitoring were conducted over a three-year period. The surveys covered the treatment sites plus the entire subreach where work was to occur. Pre-construction vegetation surveys were conducted in the summer of 2005; post-construction vegetation monitoring occurred in late summer/early fall of 2006; finally, vegetation monitoring continued in the fall of 2007. Comparative results for all three years are provided in Section 5.4.2. Continued vegetation monitoring will be conducted at least once a year, depending on available funding.

The SWFL is an insectivore, foraging in dense shrub and tree vegetation along rivers, streams, and other wetlands (USFWS 2003), and prefers dense riparian thickets, typically willows with a scattered cottonwood overstory. Dense riparian woodlands are particularly important as breeding habitat. Non-native species can crowd out this native riparian habitat. At a broad scale, two non-native species are of higher concern than other non-natives due to their veracity and prevalence:

Russian olive (*Elaeagnus angustifolia*) and salt cedar (*Tamarix* spp.). These species are classified by the State of New Mexico as "Class C Noxious Weeds." The New Mexico Department of Agriculture (NMDA) defines "Class C" as those non-native noxious weeds that are widespread in the state (NMDA 1999). A noxious weed is defined by the Noxious Weed Management Act (NWMA) as "any weed or plant which … (is declared) to be harmful or to possess noxious characteristics" (NWMA 1978). Russian olive and salt cedar are prevalent throughout the MRG and their presence is a concern for any restoration effort.

5.4.1. METHODS

The Hink and Ohmart (1984) classification system (Figure 5.3) was used to determine riparian vegetation structure along the MRG. This method includes walking transects through the site using a line intercept method and recording observational variables. At regular intervals, the following variables were recorded:

- Percentage of herbaceous species
- Percentage of species in height classes 1, 2, 3, 4, 5, and 6
- Percentage of canopy cover in each height class
- Percentage of each species in each height class
- Most dominant species in each height class

Spatial/location data was recorded using a Trimble GPS device, and observational data was recorded by hand onto datasheets. Spatial and observational data was compiled into a singe spreadsheet for analysis.

Photodocumentation was performed using a digital camera at several photo control stations along each reach. Photographic aspects were taken by compass bearings first determined by the on-the-ground biologist and subsequently replicated. Photo control station locations were recorded using the Trimble GPS; therefore, precise replication could be achieved. Photo control stations were established in the fall of 2005, prior to construction.

5.4.2. COMPARATIVE RESULTS

To determine whether vegetation proposed for disturbance constituted suitable habitat for SWFL, a vegetation survey was conducted in July 2005 and each site has since been monitored. Survey information from 2005 was provided in the 2005 BA and the subsequent BO that was prepared in support of the EA for this project (USFWS 2005). Summary data of the 2005 baseline vegetation that was disturbed by the HR project appear in Table 5.7. The 2006 monitoring information was provided in the *NMISC Habitat Restoration 2006 Annual Report* (SWCA 2007) and is summarized in Table 5.8. Post-construction vegetation monitoring information for 2007 is summarized in Table 5.9.

Table 5.7. Pre-construction Existing Vegetation Structure and Composition in Project Area, by Subreach and Restoration Site Prior to Modification (Summer 2005)

Site Name	Hink & Ohmart Structural Types	Vegetation Composition Hink & Ohmart 2005	USFWS Resource Category	Acres
North Diversion Channel				
NDC_1b_1ch	C/CW4	Intermediate cottonwood/0–5 ft coyote willow	2	0.25
NDC_2ch_3ch	RO-CW-SC5	5–15 ft Russian olive–coyote willow–salt cedar	3	0.35
NDC_2i	CW5	5–15 ft coyote willow	2	0.58
NDC_3i	RO-CW-SC5	Russian olive–coyote willow–5–15 ft salt cedar	3	7.40
NDC_4i	CW-RO5	5–15 ft coyote willow–Russian olive	2	0.07
NDC_5i	C-RO/CW3	Intermediate cottonwood and Russian olive canopy w/ coyote willow understory	2	1.90
TOTAL NDC VEGETATION				**10.55**
I-40-Central				
I-40_2i	CW-SC5	Coyote willow–salt cedar 5–15 ft	3	1.08
I-40_1b	CW5	5–15 ft coyote willow	2	0.42
I-40_1ch	CW5 and H6	Coyote willow 5–15 ft and herbaceous	2	0.48
I-40_4i	RO-CW5	Russian olive–coyote willow 5–15 ft	3	0.43
I-40_3b	H6	Herbaceous	4	0.26
TOTAL I-40-CENTRAL VEGETATION				**2.67**
South Diversion Channel				
SDC_2i	RO5	5–15 ft Russian olive	3	0.89
SDC_3i	RO5	5–15 ft Russian olive	3	0.27
SDC_1b	RO/SC-CW3	Intermediate Russian olive overstory w/ salt cedar and coyote willow understory	2	0.28
SDC_4i	RO/CW3	Intermediate Russian olive/coyote willow	2	2.77
SDC_2b	RO/RO-MB-SC3	Intermediate Russian olive canopy w/ Russian olive-mulberry-salt cedar understory	3	0.34
SDC_3b	CW-RO-SC5	Coyote willow–Russian olive–salt cedar understory	2	1.19
TOTAL SDC VEGETATION				**5.74**
TOTAL VEGETATION, ALL SUBREACHES				**18.96**

Table 5.8. Post-construction Vegetation Structure and Composition in Project Area, by Subreach and Restoration Site after Modification (October 2006)

Site Name	Hink & Ohmart Structural Types	Vegetation Composition Hink & Ohmart 2006	USFWS Resource Category	Acres
		North Diversion Channel		
NDC_1b_1ch	C/CW4	Intermediate cottonwood/0–5 ft coyote willow	2	0.27
NDC_2ch_3ch	RO/CW5	Intermediate Russian olive/5–15 ft coyote willow	2	0.34
NDC_2i	CW5	5–15 ft coyote willow	2	0.58
NDC_3i	CW-C-RO5	5–15 ft coyote willow–cottonwood–Russian olive	3	7.40
NDC_4i	CW5	5–15 ft coyote willow	2	0.07
NDC_5i	CW5	5–15 ft coyote willow	2	1.90
TOTAL NDC VEGETATION				**10.56**
		I-40-Central		
I-40_2i	CW-SC5	5–15 ft coyote willow–salt cedar	3	1.08
I-40_1b	H6	Herbaceous	4	0.41
I-40_1ch	H6	Herbaceous	4	0.47
I-40_4i	CW5	5–15 ft coyote willow	2	0.43
I-40_3b	H6	Herbaceous	4	0.26
TOTAL I-40-CENTRAL VEGETATION				**2.65**
		South Diversion Channel		
SDC_2i	CW-RO5	5–15 ft coyote willow–Russian olive	3	0.89
SDC_3i	CW5	5–15 ft coyote willow	2	0.27
SDC_1b	H6	Herbaceous	4	0.35
SDC_4i	CW-RO5	5–15 ft coyote willow–Russian olive	3	2.77
SDC_2b	CW5	5–15 ft coyote willow	2	0.13
SDC_3b	CW5	5–15 ft coyote willow	2	0.34
TOTAL SDC VEGETATION				**4.75**
TOTAL VEGETATION, ALL SUBREACHES				**17.96**

Table 5.9. Post-construction Vegetation Structure and Composition in Project Area, by Subreach and Restoration Site after Modification (September 2007)

Site Name	Hink & Ohmart Structural Types	Vegetation Composition Hink & Ohmart 2007	USFWS Resource Category	Acres
North Diversion Channel				
NDC_1b_1ch	C/CW4	Intermediate cottonwood/0–5 ft coyote willow	2	2.28
NDC_2ch_3ch	RO/CW-CAT3	Intermediate Russian olive/5–15 ft coyote willow with cattail	2	1.09
NDC_2i	CW5	5–15 ft coyote willow	2	0.63
NDC_3i	CW-SC5	5–15 ft coyote willow–salt cedar	3	9.94
NDC_4i	CW5	5–15 ft coyote willow	2	0.07
NDC_5i	CW5	5–15 ft coyote willow	2	1.90
TOTAL NDC VEGETATION				**15.91**
I-40-Central				
I-40_2i	CW-SC5s	5–15 ft coyote willow–salt cedar (sparse)	3	1.09
I-40_1b	CW6	0–5 ft coyote willow	2	1.13
I-40_1ch	CW5s	5–15 ft coyote willow (sparse)	2	2.01
I-40_4i	CW5	5–15 ft coyote willow	2	0.43
I-40_3b	H6	Herbaceous	3	0.46
TOTAL I-40-CENTRAL VEGETATION				**5.12**
South Diversion Channel				
SDC_2i	CW5	5–15 ft coyote willow	2	0.89
SDC_3i	CW5	5–15 ft coyote willow	2	0.28
SDC_1b	CW6	0–5 ft coyote willow	2	1.95
SDC_4i	CW-RO5	5–15 ft coyote willow–Russian olive	3	2.43
SDC_2b	CW6	0–10 ft coyote willow	2	2.92
SDC_3b	CW6	0–5 ft coyote willow	2	2.66
TOTAL SDC VEGETATION				**11.13**
TOTAL VEGETATION, ALL SUBREACHES				**32.16**

In the MRG, SWFL are known to form territories and nest in very dense riparian vegetation ranging in height from about 12 feet to 29 feet, according to Moore and Ahlers (2004). These habitats are most frequently dominated by willow, but may also contain cottonwood, Russian olive, or salt cedar. The primary habitat structure requirement for SWFL is very dense twig structure at the 12-foot to 29-foot height. Hink and Ohmart vegetation structural classification data collected over the three-year period is compiled in a single table (Table 5.10). From this data, percentages of dominant vegetation cover were grouped and are illustrated in Figure 5.4.

During the three-year period (2005, 2006, and 2007), there was a decline in structural types containing non-native species, such as Russian olive and salt cedar (Figure 5.4). The 2005 vegetation structural classification data presents a dominant Russian olive/salt cedar overstory, 5 feet to 15 feet, in the majority of the project area, as well as several structural type 3 habitats dominated by Russian thistle and salt cedar. In contrast, the 2006 data shows no Russian olive or

salt cedar overstory for structural type 3 at any of the project sites. In 2007, a significant decrease of structural types 5 and 6 of Russian olive was recorded.

There is vegetation within the Project Area classified as Hink and Ohmart structural type 3, which may have had the height and structure used by SWFL. However, the survey found these habitats to have lower density than might be characteristic of flycatcher habitats. Removal of these habitats is temporary.

The percent of cover created by native vegetation had decreased slightly after construction in 2006 (Figure 5.4). This decline can be attributed to the equipment access, footprints, and staging areas, as well as the spreading of excess soil on site. The native vegetation has since increased to 56 percent of the total vegetative cover within the Project Area. With the removal and control of the non-natives, the native plants had the opportunity to repopulate the sites and the future potential for dense stands of native trees to develop in these areas has been improved. This will provide better support for SWFL in the future. However, short-term loss of vegetation, including potential suitable flycatcher habitat, has resulted from the project.

Cleared areas allow for the re-growth of non-natives as well as invasive species. We see this with the increase in salt cedar in 2007. Both in 2005 and 2006, this invasive species was only 6 percent of the dominant vegetative cover. In 2007, that percentage increased five-fold to 30 percent (Figure 5.4). The control of this species is often an uphill battle, and time can be of the essence. Among numerous other references, established and verified eradication methods, as well as information on the obstacles during removal of this species, can be found in the *Practical Guidebook for the Identification and Control of Invasive Aquatic and Wetland Plants of the San Francisco Bay-Delta Region*, 2003.

In 2005, the pre-construction dominant percent cover containing Russian olive was 33 percent. After construction, that increased to 63 percent (Figure 5.4), with the majority of that vegetation present on two islands within the NDC Subreach. Russian olive, although abundant, was not the dominant species on those two islands; coyote willow and cottonwood were more abundant.

Perhaps the most encouraging result revealed by vegetation monitoring was the fact that after construction, no area had a dominant cover comprised of both salt cedar and Russian olive. Prior to construction, 26 percent of the project area was dominated by the combination (Figure 5.4). In 2006 and 2007, the invasive combination no longer existed within the project area. This result is encouraging because, although the two invasive species are still widespread in the MRG, they are no longer shaping the landscape within the project areas. Eradication can occur in force without the threat of clearing large swaths of cover, thereby permitting local fauna to continue utilizing remaining natural habitats.

Table 5.10. Hink and Ohmart (H&O) Vegetation Data and Acreages Over Three Years

Site Name	H&O Veg & Structure	Acres 2005	Acres 2006	Acres 2007
North Diversion Channel Subreach				
NDC_1b_1ch	C4	0.22		1.12
	C/CW4		0.27	
	CW6	0.03		1.16
NDC_2ch_3ch	CW5	0.30		
	RO-CW-SC5	0.05		
	RO/CW-CAT3			1.09
	RO/CW5		0.34	
NDC_2i	CW5	0.58	0.58	0.63
NDC_3i	CW5	4.20		
	RO-CW-SC5	3.19		
	CW-C-RO5		7.40	
	RO-CW6			0.95
	CW-SC5			8.99
NDC_4i	CW-RO5	0.07		
	CW5		0.07	0.07
NDC_5i	RO/CW-C3	1.90		
	CW5		1.90	1.90
Interstate 40 / Central Subreach				
I-40_2i	CW-SC5	1.08	1.08	0.60
	CW5			0.44
	CW6			0.05
I-40_1b	CW5	0.42		
	6 (herbaceous)		0.41	
	CW6			1.13
I-40_1ch	CW5	0.10		2.01
	6 (herbaceous)	0.38	0.47	
I-40_4i	RO-CW5	0.43		
	CW5		0.43	0.43
I-40_3b	6 (herbaceous)	0.26	0.26	0.46
South Diversion Channel Subreach				
SDC_2i	RO5	0.89		
	CW-RO5		0.89	
	CW5			0.89
SDC_3i	RO5	0.27		
	CW5		0.27	0.28

Table 5.10. Hink and Ohmart Vegetation Data and Acreages Over Three Years, continued

Site Name	H&O Veg & Structure	Acres 2005	Acres 2006	Acres 2007
South Diversion Channel Subreach, continued				
SDC_1b	6 (herbaceous)	0.13	0.35	
	CW6			1.95
	RO/SC-CW3	0.14		
SDC_4i	RO/CW3	2.77		
	CW-RO5		2.77	2.43
SDC_2b	RO/RO-MB-SC3	0.34		
	CW6			1.47
	CW5		0.13	1.45
SDC_3b	CW-RO-SC5	1.19		
	CW5		0.34	
	CW6			2.66

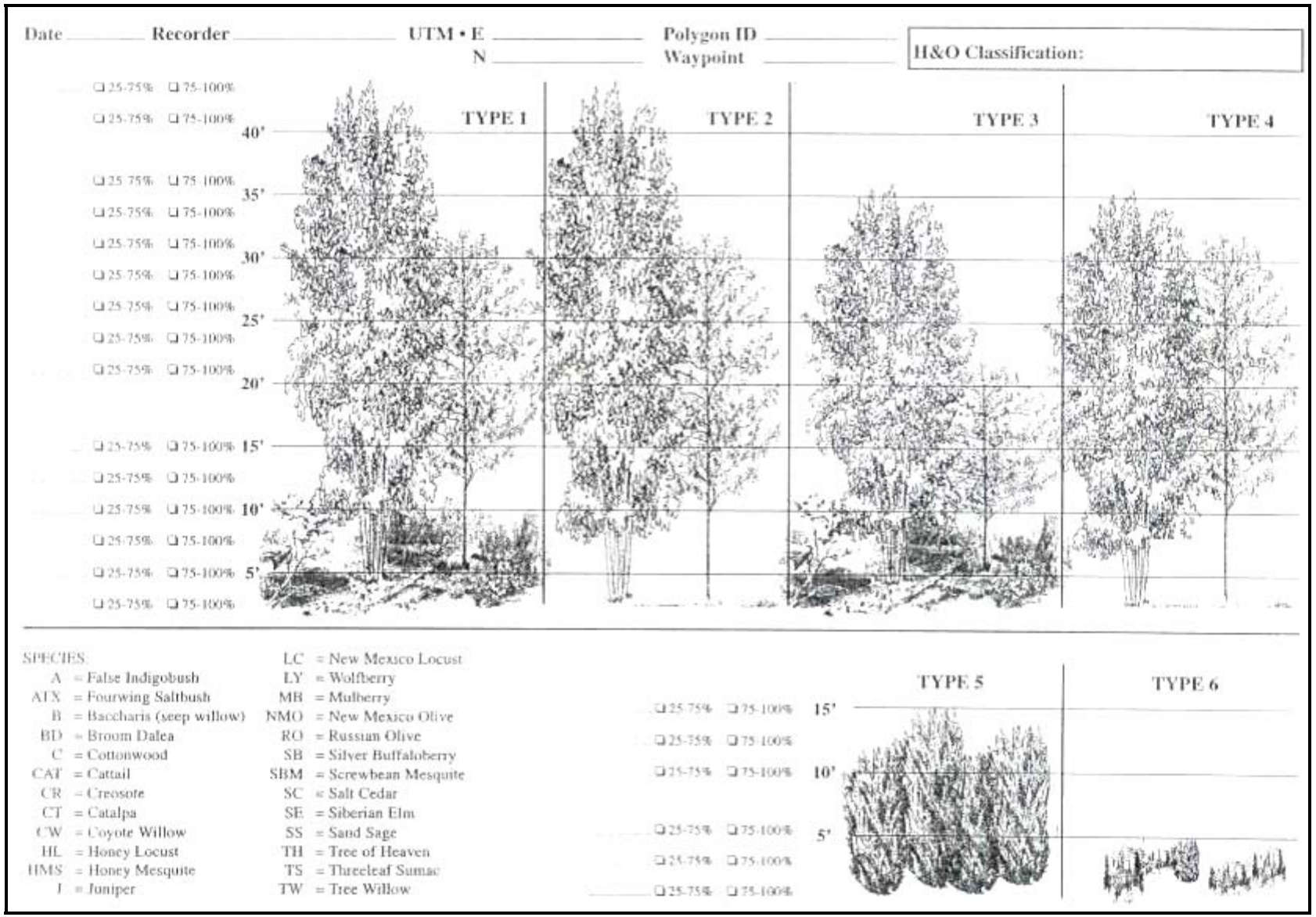

Figure 5.3. Hink and Ohmart vegetation structure classification.

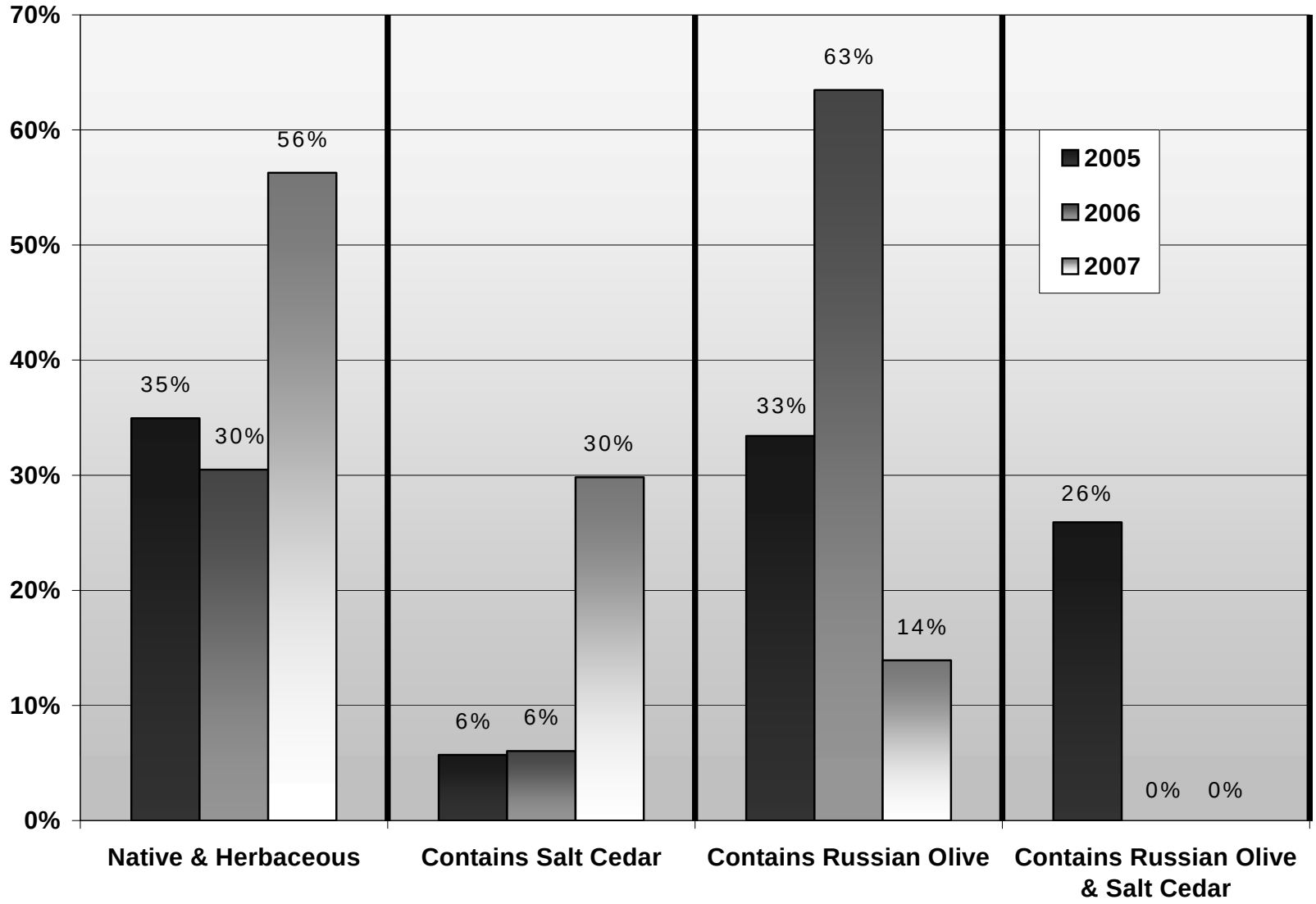

Figure 5.4. Percentages of restoration site areas containing predominately native and herbaceous species and of non-native species throughout vegetation monitoring (2005, 2006, and 2007).

5.5. WETLAND DELINEATIONS

As a component of preliminary site visits in 2005 and construction monitoring in 2007, wetland delineations were conducted at proposed treatment and modification sites. Wetland areas are those that are "inundated or saturated by surface or groundwater at a frequency and saturation sufficient to support… a prevalence of vegetation typically adopted for life in saturated soil" (USACE 1987). However, if a wetland area is not saturated, but dry at the time of a survey, multiple indicators that are characteristic of wetland areas can be used to determine wetland status. These characteristics include indicators such as hydric soil types, evidence of surface hydrology in the area, and hydrophytic vegetation types (USACE 1987). Preconstruction vegetation surveys were conducted in the December 2004 and July 2005 and all wetland indicators were recorded. Wetlands were again analyzed in September 2007. Continued wetland delineations will be conducted once every year as a component of vegetation monitoring, depending on available funding.

5.5.1. METHODS

While conducting Hink and Ohmart vegetation surveys throughout the modification sites, hydrology indicators and evidence of overbank flooding were also assessed. Based on the vegetative communities and hydrology indicators recorded during the surveys, potential wetlands were further investigated using USACE technical guidelines. All observational data was recorded by hand onto USACE datasheets. Data recorded included the following variables:

- Disturbance of the area
- Dominant vegetation species, strata, and indicator status
- Percentage of obligate or facultative vegetation species (hydrophytic)
- Wetland hydrology indicators such as water marks and drift lines
- Soil profiles and hydric indicators

In 2005, wetland presence or absence was recorded and the area was estimated at each subreach and site. In 2007, wetland areas were digitized. Spatial/location data was recorded using a Trimble GPS device.

Photographic documentation was performed using a digital camera at each wetland area surveyed at each treatment site.

5.5.2. RESULTS

In 2005, wetland delineations were performed at two SDC modification sites (SDC_2ch and SDC_4b). Primary wetland hydrology indicators on SDC_2ch included watermarks, drift lines, and sediment deposits. Hydrophytic vegetation was present; however, the soil consisted of unconsolidated, loose sand characterized as Torrifluents (frequently flooded, stratified alluvial soils adjacent to the Rio Grande [USDA 1997]). Because there was no significant organic surface layer, streaking, or mottling present in the soil, the area is not considered a wetland.

Primary wetland hydrology indicators on SDC_4b included sediment deposits and hydrophytic vegetation, but the soil profiles did not meet criteria for hydric soils. Therefore, the site is not considered to comprise any wetland areas. Other sites with possible wetlands could not be analyzed at the time of the survey due to inundation. No other sites were considered to have wetland areas present outside the ordinary high water mark.

In 2007, wetland delineations were conducted at several areas of the MRG modification sites and a total of approximately 3.039 acres of wetlands were digitized. Wetlands were present at modification sites within all three subreaches and are summarized in Table 5.11 below. Maps of each site are provided in Appendix F.

Table 5.11. 2007 Wetland Acreages by Subreach

Subreach	Modification Site(s)	Wetland Acres
North Diversion Channel	NDC_1b and NDC_1ch	0.178
	NDC_2ch and NDC_3ch	0.171
	NDC_2i	0.056
	NDC_3i	0.122
	NDC_4i	0.082
	NDC_5i	0.298
North Diversion Channel Subreach Total		0.907
Interstate 40 Central	I-40_1b	0.120
	I-40_2i	0.221
	I-40_3b	0.071
	I-40_4i	0.123
Interstate 40 Central Subreach Total		0.535
South Diversion Channel	SDC_1b	0.063
	SDC_2b	0.304
	SDC_2i	0.053
	SDC_3b	0.271
	SDC_3i	0.159
	SDC_4i	0.747
South Diversion Channel Subreach Total		1.597
Total Wetland Acres		3.039

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1. CONSTRUCTION ACTIVITIES

There were no direct effects to silvery minnow, SWFL, or bald eagle during modification of the three subreaches. There were, however, indirect effects to the silvery minnow and SWFL. Bald eagles were observed in the vicinity of construction activities, but none were present on the morning before construction began. Therefore, they were not displaced or harassed as a result of construction activities. Likewise, silvery minnow were not directly affected by construction activities. Detailed information regarding construction activities can be found in the 2006 Annual Report. Implementation monitoring was successful.

Future construction activities for Phase I of the Project may include maintenance.

6.2. FISHERIES

Fisheries monitoring in 2007 focused on documenting which habitats are most efficient at trapping or retaining silvery minnow eggs and if adult silvery minnow are using habitat restoration sites. Future monitoring of constructed embayments would build upon the monitoring work completed in 2006 and 2007 that may include more rigorous investigations and testing hypotheses. To explore these hypotheses in the future, a greater number and more densely placed array of hoop nets or another method of capture should be placed within HR sites. As HR sites mature and support native riparian emergent vegetation, the conditions that support the life histories of silvery minnow could be present, and increased use of the HR sites may occur by the fishes.

It is recommended that a fisheries monitoring plan for all NMISC habitat restoration sites through the Albuquerque Reach be developed.

6.3. HYDROLOGY AND GEOMORPHIC MONITORING

One of the original hypotheses was that islands could be destabilized by planned physical disturbance such as vegetation mowing and root-plowing and that river flows will then mobilize and redistribute the island sediments. Results to date seem to indicate that flows in the MRG are not sufficient to mobilize island sediments. MEI, 2006 determined that shear stresses in the MRG are not high enough to mobilize islands that already have established vegetation and that mechanical intervention would be necessary. Even with the mechanical intervention used in Phase I of this project, island sediments were barely moved. There was no difference is sediment mobilization between the islands that were plowed on the upper one-third versus the middle one-third. Unfortunately the spring runoff immediately following vegetation removal in 2006 was very low and the vegetation had time to re-establish itself before the monsoonal high flows in late summer 2006. This and subsequent high flow events produced very little movement of disturbed sediments. If island mobilization is possible at all, timing is of extreme importance. Vegetation removal and deep root plowing would have to be followed immediately by very high river flows, before vegetation has a chance to re-establish itself.

It should also be recognized that mechanically reducing the elevation of islands and banklines in order to increase the frequency and duration of inundation will have a limited lifespan. The lower the surface is cut, the more frequently it will be inundated and the higher the rate of sediment deposition and vertical accretion will be (MEI 2006). To date, deposition on lowered surfaces has been minimal and all modifications continue to function as designed, with the possible exception of NDC-2ch and NDC-3ch, where the outflow area has been blocked by sediment build up and growing vegetation.

The lack of sustained high flows during 2006 led to minimal changes of the modified features and resulted in no significant destabilization of the islands. Localized bank erosion occurred at NDC 1b, NDC 1ch, SDC 1b, and SDC 2i between the as-built surveys and the December 2006 survey. Most of the other features experienced small amounts, generally less than 0.5 foot on average, of widespread deposition.

The December 2007 survey showed localized bank erosion occurred at NDC 2i, NDC Ci, SDC 1b, and SDC 2i. Most of the other features experienced small amounts of deposition, which was usually less than 0.5 foot, with the exception of SDC 4i. The most widespread erosion occurred on SDC 4i, but it was still generally less than 1 foot.

It is recommended that geomorphic monitoring be conducted once a year, preferably in the fall or winter. Mesohabitat data were collected along surveyed transects in 2006 and 2007 (Appendix E).

6.4. WATER QUALITY MONITORING

Water quality monitoring was most important during the construction phase of the project. There was a potential for increased turbidity during construction due to equipment moving in the river channel and sediment dispersal at individual restoration sites. However, it is unlikely that there will continue to be any impacts to water quality as a direct result of project modifications. Water quality data collection has continued simply because it was easy to perform as part of the normal vegetation surveys. It is recommended that the current water quality monitoring procedures be discontinued and replaced with detailed monitoring of water depth and velocity at inundated restoration sites. If water quality monitoring is continued, water quality parameters such as temperature, dissolved oxygen, specific conductance, total dissolved solids, turbidity, salinity, and pH should be measured as a part of fisheries monitoring.

6.5. VEGETATION MONITORING

While a healthy riparian area and bosque would consist of all height classes, the tables show that the amount of some non-native species has diminished in the modified areas. In order for native vegetation to be represented in multiple height classes, competition with non-native species must be mitigated. Removing salt cedar and Russian olive, as well as noxious weeds, would allow native species to compete more successfully and grow to maturity. Non-native vegetation maintenance is too cost-prohibitive to be conducted for this project and is not a recommendation in this report. Willows, cottonwood saplings, and herbaceous vegetation is now established at some modified sites that previously had extensive non-native species.

Currently Hink and Ohmart (1984) methodology is used to conduct vegetation monitoring. While the Hink and Ohmart classification system is useful for monitoring SWFL habitat, it may not be the most appropriate monitoring protocol for measuring vegetation suitability in aquatic habitats. It is recommended that this methodology be reevaluated in an attempt to use a more quantifiable vegetation monitoring protocol tailored towards aquatic habitat analysis.

6.6. WETLAND DELINEATIONS

Wetland delineations were completed for select sites prior to construction in 2005, noted in 2006, and completed for sites in 2007. Prior to construction many of the sites did not exhibit evidence of wetlands since many of the project sites were isolated from normal flow regimes. Following modification in 2006, the sites became inundated and the presence of hydrophytic vegetation was noticeable.

It is recommended that wetland delineations be conducted on an annual basis.

6.7. FUTURE MONITORING

Post-construction monitoring will continue for at least two more years (using existing Collaborative Program and NMISC funding). The NMISC has initiated fisheries-related monitoring for the spring and summer of 2008. The monitoring may include the presence and absence of silvery minnow eggs and gravid females, presence/absence of larval fish, and mesohabitat use by adult silvery minnow depending and spring and summer flows. Monitoring will occur within each subreach and will attempt to capture results from different HR treatment sites. Vegetation, water quality, and wetland monitoring will be conducted at least once a year depending on funding, with geomorphic monitoring on an annual basis. Initial results of 2006 and 2007 effectiveness monitoring are located in Table 6.1.

Table 6.1. Results of Monitoring of Project Objectives

Objective	Monitoring Level	Monitoring Activity	Results
Regeneration of native riparian species	Effectiveness	Vegetation	Monitoring has indicated an increase in native vegetation and a decrease in deciduous invasive vegetation.
Prevention & monitoring the diffusion of invasive deciduous species	Implementation & Effectiveness	Vegetation	Weedy exotics and invasive species colonized spoil piles and disturbed areas surrounding treatments. They were more common in areas that were not inundated and remained isolated from flows. These species were more noticeable the first year following monitoring and less noticeable the second year.
Creation of silvery minnow nursery habitat	Implementation & Effectiveness	Fisheries	Surveys conducted during implementation monitoring indicate that silvery minnows were using constructed embayment and scallops along island and bank modifications. Initial results from effectiveness monitoring indicate silvery minnow are using constructed habitats with emergent vegetation or low-velocity habitats such as embayments, scallops, and bank cuts (terraces), although further monitoring is needed before conclusions can be made.
Increasing silvery minnow habitat and creation of low-velocity habitat	Implementation & Effectiveness	Fisheries & Geomorphic	Many of the constructed treatments were previously isolated above flows during runoff. These treatment areas are now inundated at targeted flow levels, creating low-velocity habitat and refugia habitat at high flows.
Increasing active channel width	Implementation & Effectiveness	Geomorphic	Further data need to be collected to determine if the channel width has increased in subreaches within the Project area. Eroding bank cuts have contributed to a localized increase in channel width.
Destabilization of islands & bars	Implementation & Effectiveness	Geomorphic	The islands and bars have not been destabilized following two years of monitoring. Similar erosion and deposition patterns can be found at and around treated and control islands.

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8.0 CONTRIBUTORS

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APPENDIX A
PHOTOPOINT AND SURVEY TRANSECT MAPS

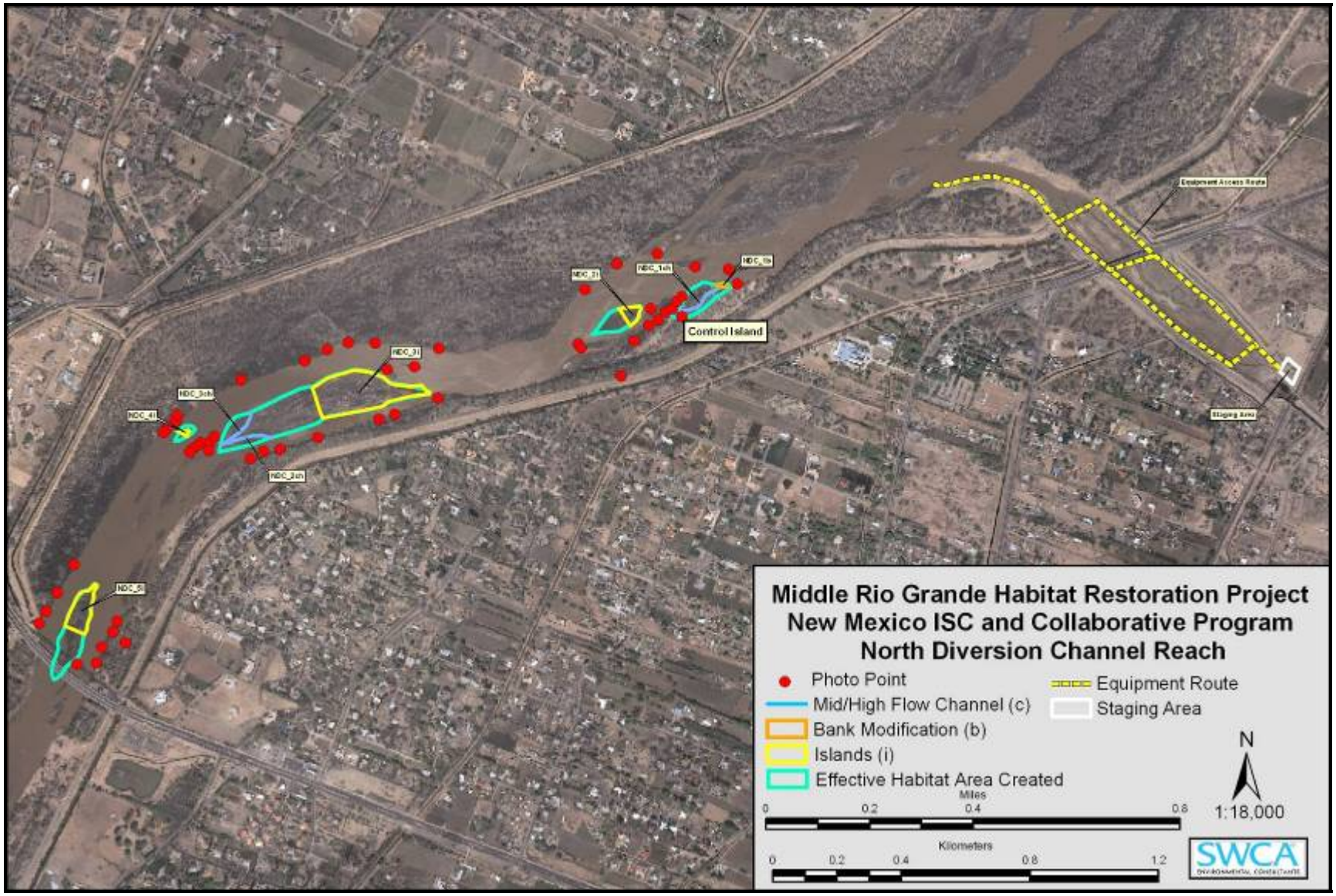


Figure A.1. North Diversion Channel Subreach photo points and access locations.

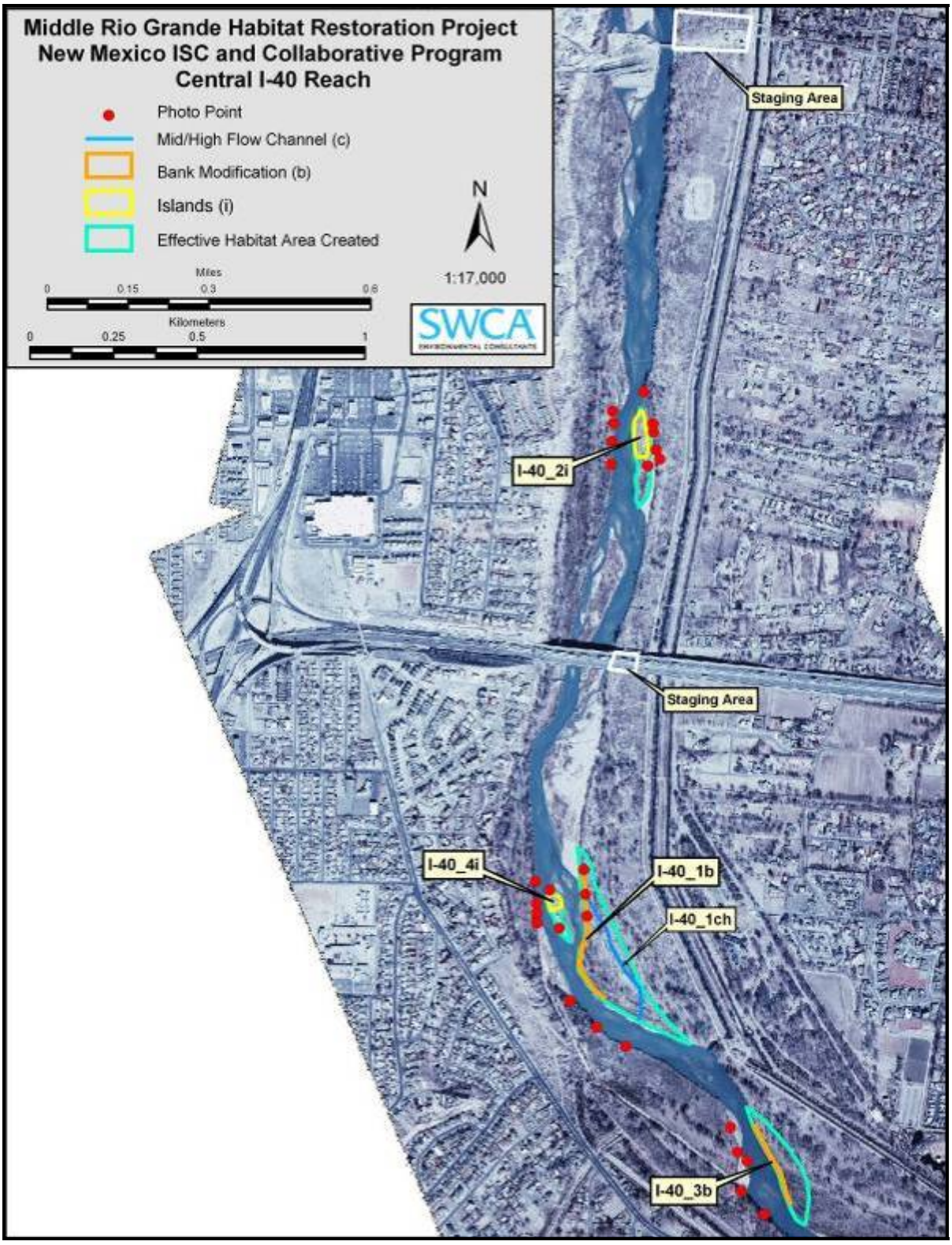


Figure A.2. I-40 Subreach photo points.

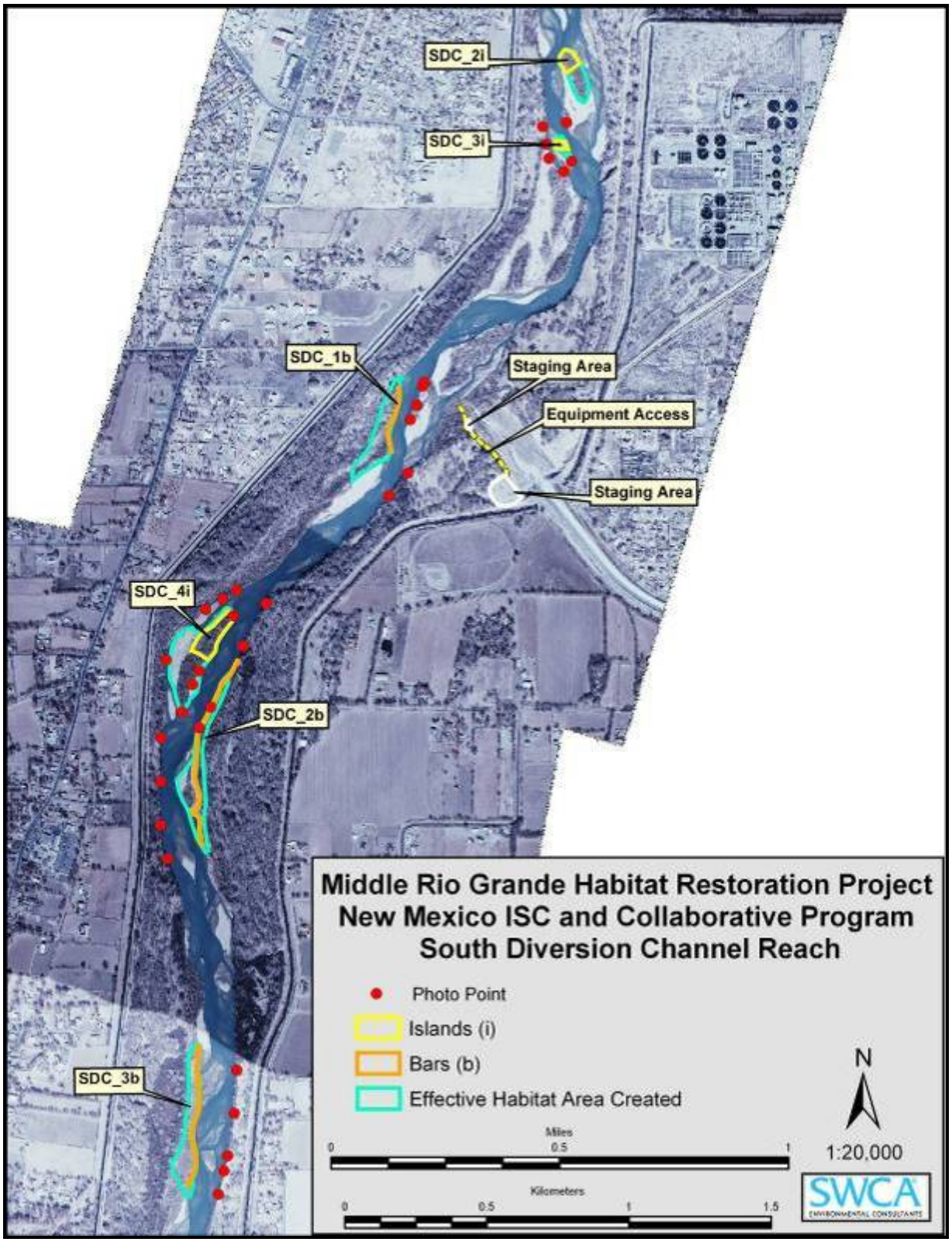


Figure A.3. South Diversion Channel Subreach photo points and access locations.

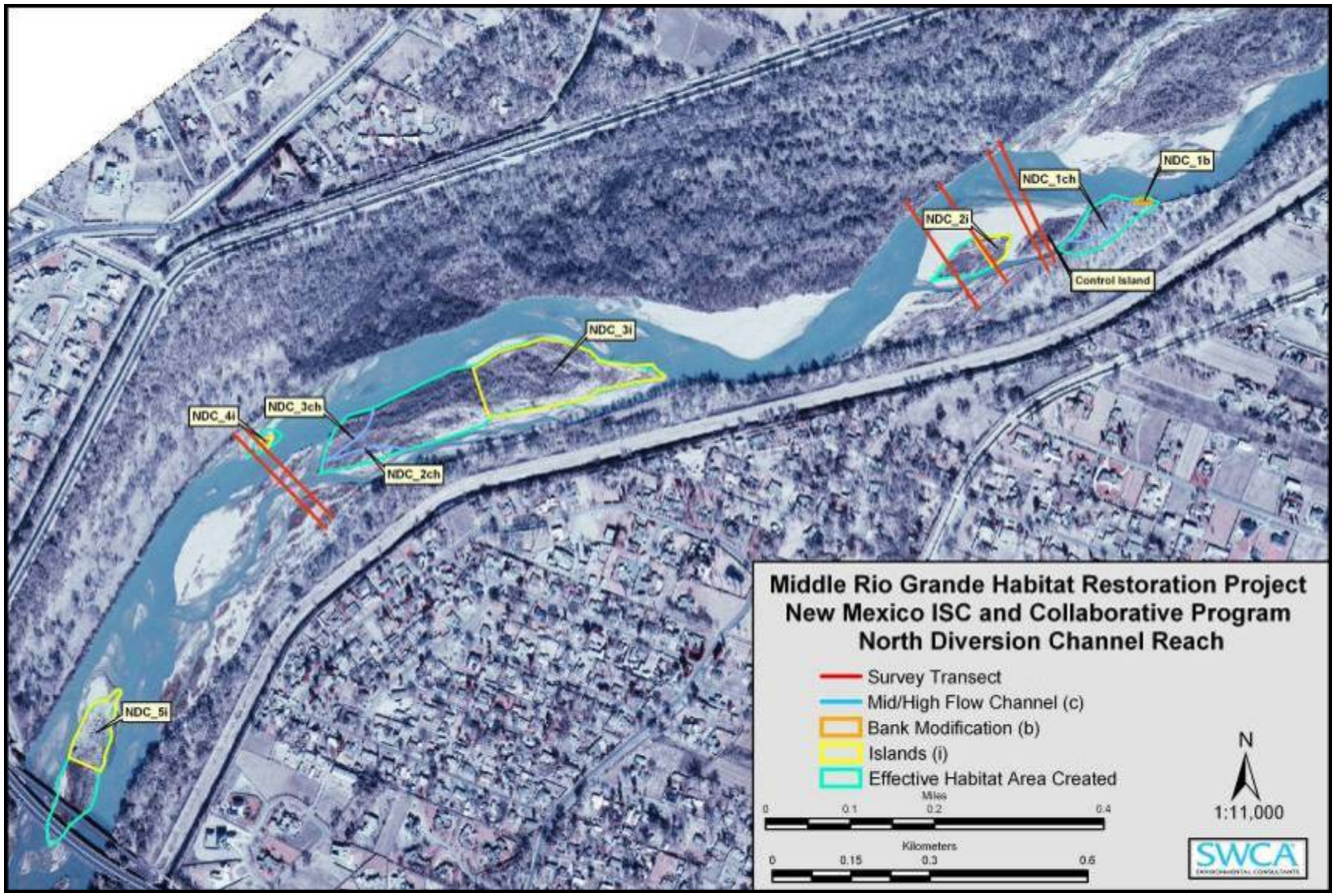


Figure A.4. North Diversion Channel Subreach survey transects.

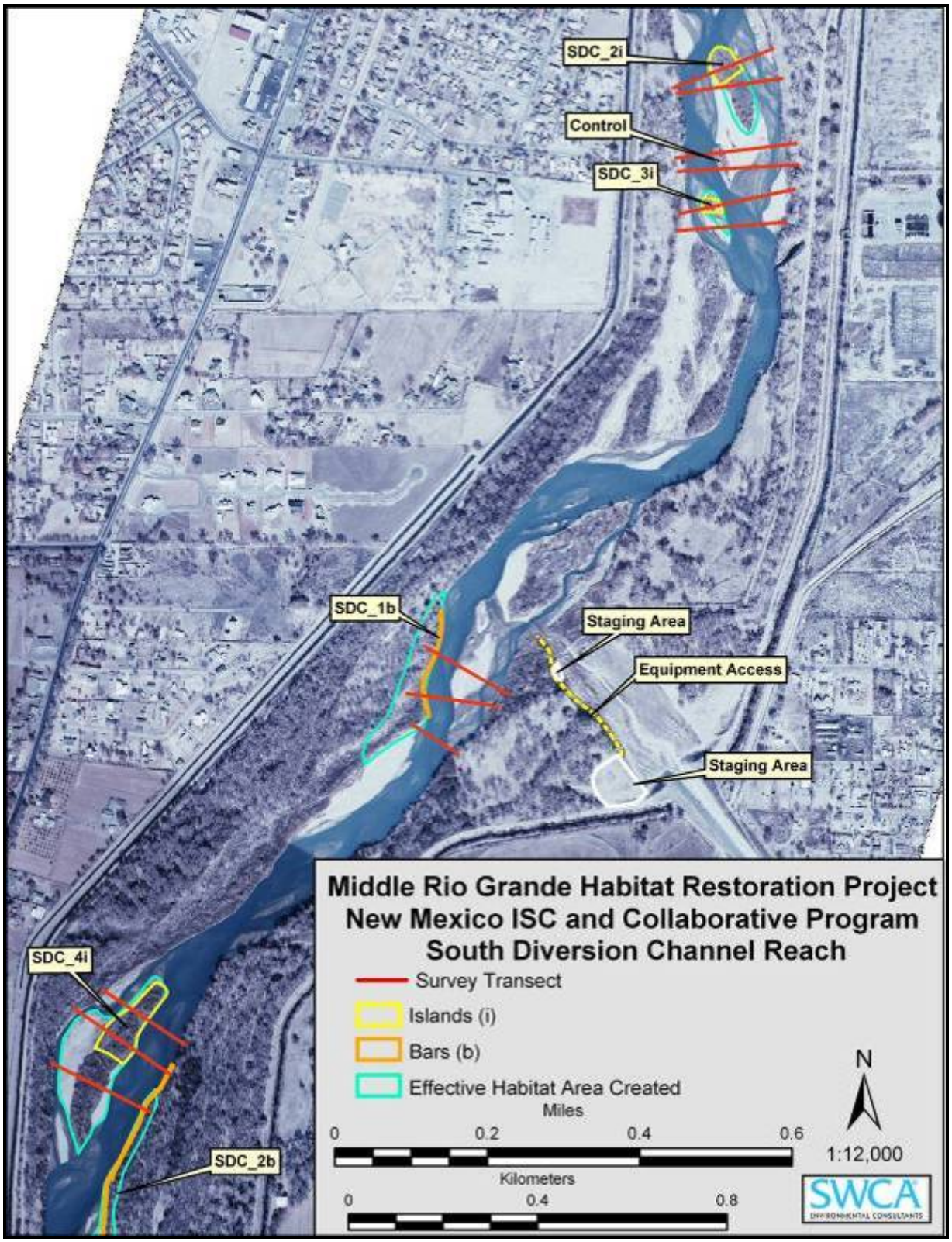


Figure A.5. South Diversion Channel Subreach survey transects.

APPENDIX B
EXAMPLE PHOTOS FROM PROJECT AREA

North Diversion Channel Subreach Site Photos

Figure B.1. Site NDC-1b_1ch; Bank scallop and ephemeral channel, East Bank. Southwest aspect.

Figure B.2. Site NDC-1ch, Bank modification. Northwest aspect.

Figure B.3. Site NDC-2i, Island destabilization and modification. East aspect.

Figure B.4. Site NDC-3i, Island modification; terracing. West aspect.

Figure B.5. Site NDC-2ch_3ch, Ephemeral channels, downstream end of island NDC-3i. Northeast aspect.

Figure B.6. Site NDC-4i, Island destabilization and modification; reduced elevation and spoil spreading. West aspect.

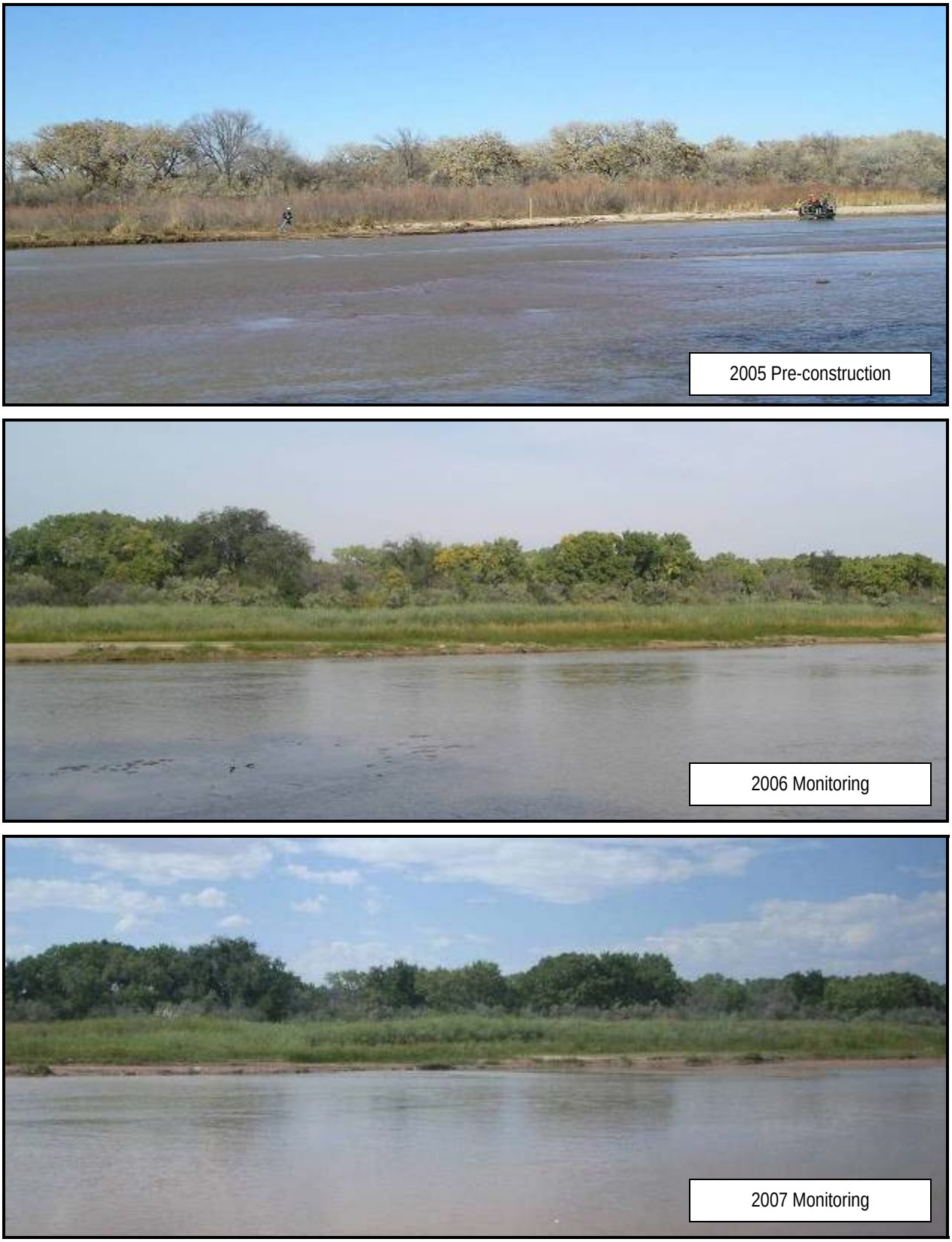


Figure B.7. Site NDC-5i, Island modification; terracing, upstream half. West aspect.

Interstate 40 Subreach Site Photos

Figure B.8. Site I-40_2i, Island modification. South aspect.

Figure B.9. Site I-40_4i, Island modification Northeast aspect.

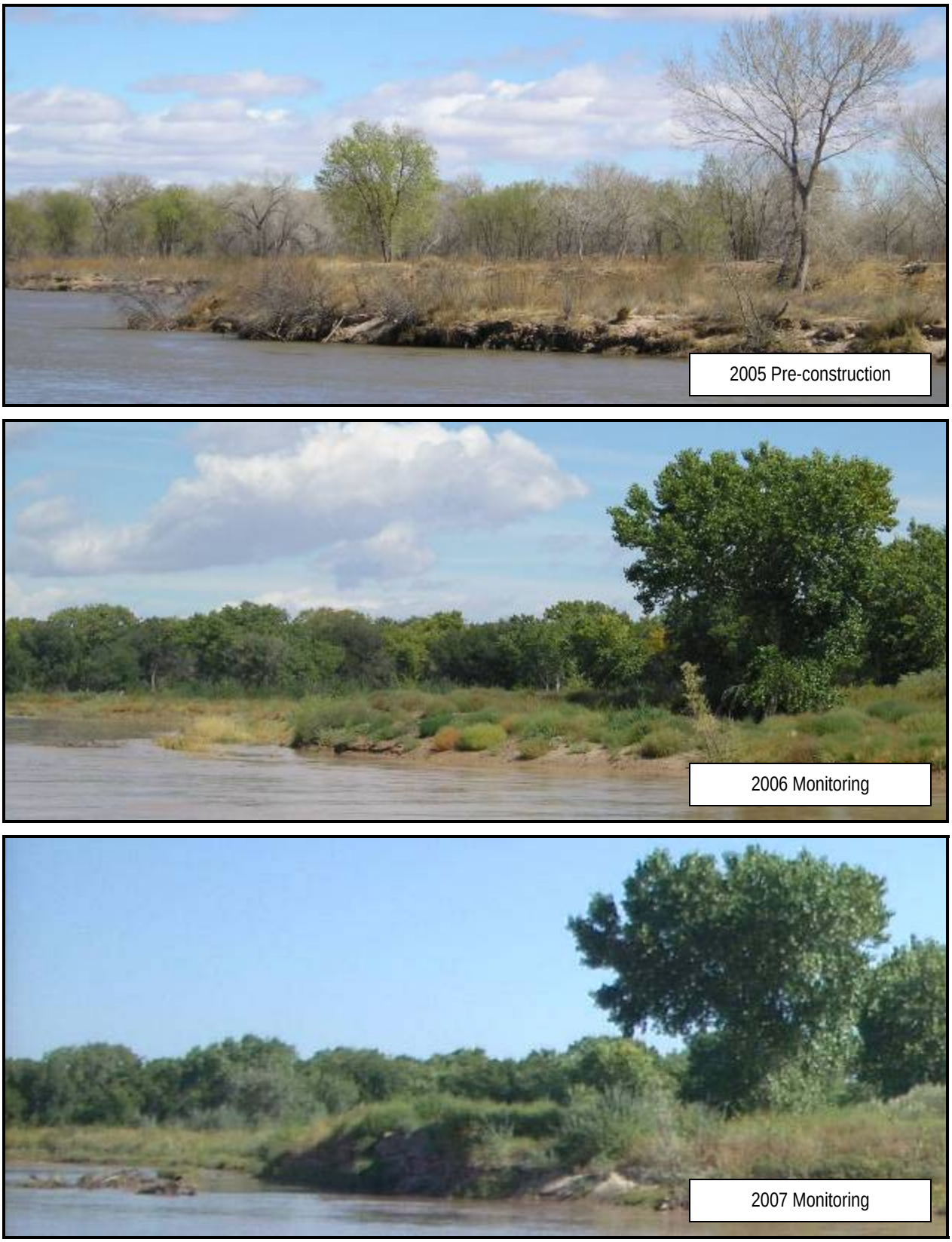


Figure B.10. Site I-40_1b, Bank modification. East aspect.

Figure B.11. Site I-40-1ch, Channel modification. East aspect.

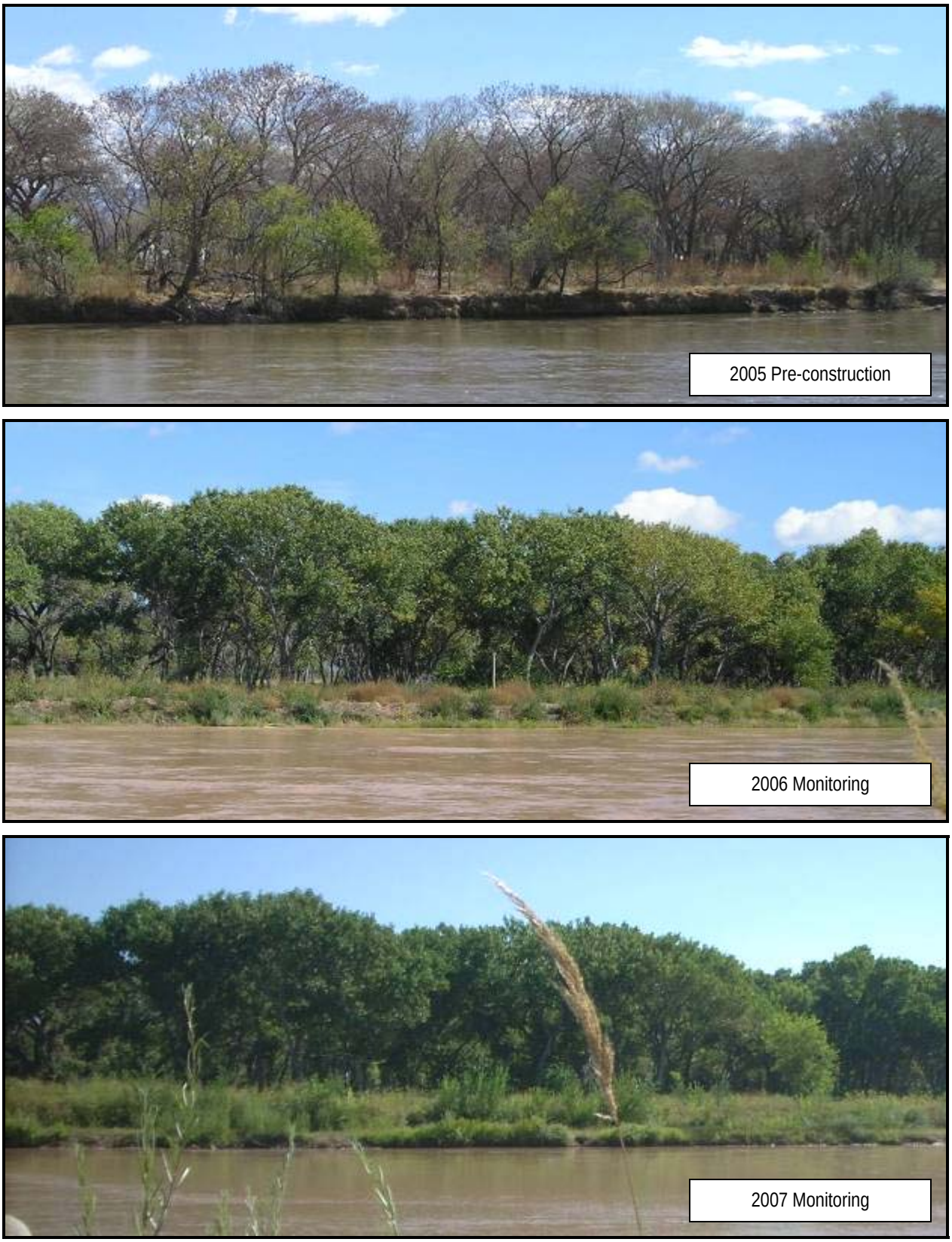


Figure B.12. Site I-40-3b, Bank modification. East aspect.

South Diversion Channel Subreach Site Photos

Figure B.13. SDC-2i, Island modification. East aspect.

Figure B.14. Site SDC-3i, Island modification. Southwest aspect.

Figure B.15. Site SDC-1b, Bank modification. South aspect.

Figure B.16. Site SDC-4i, Island modification. Southwest aspect.

Figure B.17. Site SDC-2b, Bank modification. Southeast aspect.

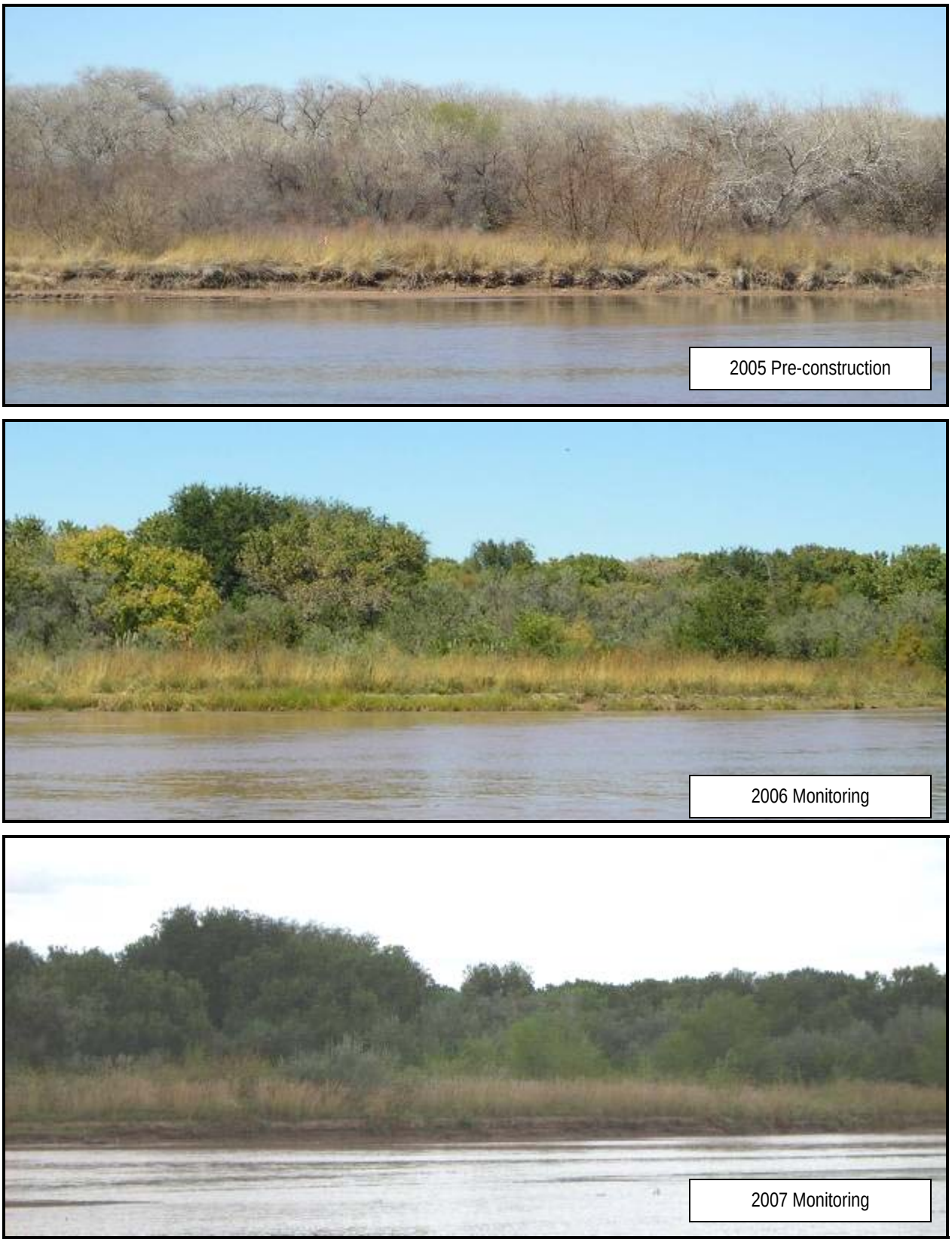


Figure B.18. Site SDC-3b, Bank modification. Southwest aspect.

APPENDIX C
HABITAT RESTORATION SUMMARIES

NDC_1b: Bank Scallop

Constructed: February 2006

Treatment: The bank scallop was constructed on the east bank of the Rio Grande, northeast of NDC-2i and north of NDC-1ch. The scallop was constructed as an embayment to function at 1,000 cfs, with an outflow channel (NDC-1ch) that will be inundated and flowing at approximately 1,500 cfs. The channel returns to the Rio Grande downstream of the scallop.

Water Quality: No constituents showed major differences. pH was 8.4 in 2006 and 9.5 in 2007. Depth was 2.8 feet in 2006 and 1.0 feet in 2007. The water quality constituents may vary depending on time of day and flow.

Wetlands*: There were zero acres of wetlands prior to construction. In 2007, 0.18 acres of wetlands were recorded.

Vegetation*: **2005** – C4 was the dominate structure type with 0.22 acres and CW6 was 0.03 acres. **2006** – C/CW4 was the dominate structure type with 0.27 acres. **2007** – C4 (1.12 acres) and CW6 (1.16) were the dominate structure types. Native vegetation increased 2.03 acres from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** – No fisheries data collected. **2007** - One silvery minnow was captured in a hoop net and released during 2007 spring monitoring.

Geomorphology*: **2006** - Since construction, this feature has experienced widespread deposition of less than 0.5 feet. Some erosion of the spoil piles occurred along with some erosion of the main channel bank. **2007** - Deposition of less than 0.5 feet has occurred in the channel. Some erosion of the spoil piles occurred along the main channel bank. Erosion occurred on the upstream end of the cut channel including the scallop area. On the downstream end of the cut channel, deposition up to 1.5 feet occurred, where the cut channel flows into the main channel.

Spring Runoff 2006: The site had no to minimal inundation during 2006 runoff.

Summer 2006 Inundation: Inundation of almost one foot on 27 June. Debris and pieces of loose vegetation have accumulated at the upstream end.

Fall 2006 Inundation: The scallop has had sediment deposition and developed a shelf along the eastern side as of 24 August. The water level has reached the top level of the scallop and the current water level (829 cfs) was approximately 6 inches below the surface level. Some herbaceous vegetation has grown within the scallop and along the waters edge.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

Conclusions: Deposition of sediment was noticeable following monsoon rains and increased flows during the fall of 2006 and again following spring runoff in 2007. Following 2006 monsoonal flows, vegetation and debris littered the scallop. The site appeared to be functioning throughout 2006 and 2007 when inundated, although fish surveys were not conducted. Silvery minnow habitat surveys were conducted during the spring of 2007, with one silvery minnow being captured in a hoop net. Vegetation surveys show an increase in cottonwood and coyote willow, and the formation of a wetland.

* Includes data for NDC-1b and NDC-1ch 2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

NDC_1ch: High Flow Channel

Constructed: February 2006

Treatment: The channel was constructed on the east bank of the Rio Grande, northeast of NDC-2i. It was constructed as an ephemeral channel, about 25 feet wide, with inundation to occur at approximately 1,500 cfs.

Water Quality: No constituents showed major differences. Turbidity and specific conductance were both higher in 2007, but so was flow. Depth was 2.8 feet in 2006 and 2.1 feet in 2007. The water quality constituents may vary depending on time of day and flow.

Wetlands*: There were zero acres of wetlands prior to construction. In 2007, 0.18 acres of wetlands were recorded.

Vegetation*: **2005** – C4 was the dominate structure type with 0.22 acre and CW6 was 0.03 acre. **2006** – C/CW4 was the dominate structure type with 0.27 acre. **2007** – C4 (1.12 acres) and CW6 (1.16) were the dominate structure types. Native vegetation increased 2.03 acres from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** – No fisheries data collected. **2007** - Two silvery minnows were captured in a hoop net and released during 2007 spring monitoring.

Geomorphology*: **2006** - Since construction, this feature has experienced widespread deposition of less than 0.5 feet. Some erosion of the spoil piles occurred along with some erosion of the main channel bank. **2007** - Erosion occurred on the upstream end of the cut channel; on the downstream end where the channel flows into the main channel, deposition up to 1.5 feet occurred.

Spring Runoff 2006: The site had no to minimal inundation during 2006 runoff.

Summer 2006 Inundation: Inundation of almost one foot on 27 June, with flows evident by water-line on the slope of the bank. Ponding was evident as flows have receded. A piece of large woody debris was downed across the channel. Debris and pieces of loose vegetation have accumulated at the upstream end.

Fall 2006 Inundation: The channel has had sediment deposition mainly from the inflow of the scallop and from the eastern slope of the channel. The water level has reached the top level of the channel on both sides and over-banked on parts of the eastern side, as evident by the water-line. Two cottonwoods have fallen (from beaver activity) into the middle section of the channel and have caused sediment deposition to develop just downstream. Small pools have also developed in the same area. Some herbaceous vegetation has grown within the channel as well as on the banks where the spoil was spread out. The outflow area also has some sediment deposition and vegetation growth just at the water's edge.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

Conclusions: Deposition of sediment was noticeable following monsoon rains and increased flows during the fall of 2006 and again following spring runoff in 2007. Following 2006 monsoonal flows, vegetation and debris littered the scallop. The site appeared to be functioning throughout 2006 and 2007 when inundated, although fish surveys were not conducted. The scallop just upstream of the channel, which provides acts as an inlet, has more evidence of deposition than the channel. With continued deposition, the scallop may fill in. The channel would then function as a backwater channel at low to mid-flows. This scenario would depend on future flows and deposition. Silvery minnow habitat surveys were conducted during the spring of 2007, with one silvery minnow being captured in a hoop net. Vegetation surveys show an increase in cottonwood and coyote willow, and the formation of a wetland.

* Includes data for NDC-1b and NDC-1ch 2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

NDC_2I: Island Modification (CP)

Constructed: February 2006

Treatment: NDC-2i is part of the island destabilization project funded by the Collaborative Program. The upper third of the island was modified (1) to create an elevation at which inundation at approximately 2,000 cfs could support various life stages of the silvery minnow and (2) to test the efficacy of destabilizing an island.

Water Chemistry: No constituents showed significant differences. Depth was 0.9 feet in 2006 and 1.3 feet in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.06 acre of wetlands was recorded.

Vegetation: **2005** – CW5 was the dominate structure type with 0.58 acre. **2006** – CW5 was the dominate structure type with 0.58 acre. **2007** – CW5 was the dominate structure type with 0.63 acre. Vegetation increased 0.05 acre from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** – No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006** - Since construction, a very small amount of deposition has occurred over much of the modified areas. The island has not yet been destabilized as intended. **2007** - The upstream third of this island was lowered by approximately 0.5 feet to the 2,000 cfs inundation level. Since the December 2006 survey, erosion, ranging from 0.5 feet to more than 2.0 feet occurred on the upstream end of the island. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows erosion along the northeast bank of the island and deposition on the interior of the island.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: Island appeared to be inundated across the modified feature. Field crew did not ford the river.

Fall 2006 Inundation: Island has a large amount of sediment deposition on the northern tip of the island where it is connected to a bar (at low flows) that borders the northeastern and western sides of the island. The entire project area had been inundated during high flows and only on the downstream central section was there water remaining in a few spots. Most of the area had *Salix exigua* (5 – 10 ft.) growing back along with some patches of young *Populus deltoides*, *Elaeagnus angustifolia*, and *Tamarix ramosissima*, which was primarily restricted to the northern tip of the island.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

Conclusions: Deposition of sediment was noticeable following surveys in the fall of 2006. Following a period of sustained inundation in 2007, erosion was noticeable across most of the treatment area. Erosion was most noticeable on the upstream, outside edges of the island where as much as 2.0 feet had been eroded since the 2006 survey. Although erosion has occurred, the island has not been destabilized. The control island just upstream experienced erosion – 2.0 or more feet - on the outside (western) edges of the island and minimal deposition across the interior of the island. Vegetation structure has been consistent each year. A small wetland has formed at the upstream, outside edge of the island.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

NDC_3i: Island Modification

Constructed: Late January and early February 2006

Treatment: The upstream half of the island was modified to create three terraces at different elevations at which inundation could help support various life stages of the silvery minnow. The terraces will be inundated at approximately 1,500, 2,500, and 3,500 cfs.

Water Chemistry: No constituents showed significant differences. Depth was 0.4 feet in 2006 and 1.0 feet in 2007. Water quality constituents may vary depending on time of day, temperature, and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.12 acre of wetlands was recorded.

Vegetation: **2005** – RO-CW-SC5 was the dominate structure type with 4.20 acres, closely followed by CW5 with 3.19 acres. **2006** – CW-C-RO5 was the dominate structure type with 7.40 acres. **2007** – CW-SC5 was the dominate structure type at 8.99 acres with some (0.95 acre) RO-CW6 recorded as well. Dominant native vegetation increased 6.75 acres from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** – No fisheries data collected. **2007** - Of the 145 silvery minnows caught and released, 12 were caught in the NDC Subreach. In the NDC Subreach, 9 silvery minnow were caught on the west side of NDC-3i

Geomorphology: **2006 –** This site was not monitored during this phase due to lack of funding. Based on the data collected in the other NDC sites and those at the SDC subreach, it is likely that HR features at this site underwent similar morphological changes following late summer and early fall precipitation events. **2007** – Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: The island appeared to be inundated across the lowest section of the modified feature at approximately 2000 cfs. Field crew did not ford the river.

Fall 2006 Inundation: Sediment deposition was extensive on the northern tip of the island as flows pushed in about 20 feet. High flows had sustained inundation on both outer terraces whereas the inner terrace was inundated, but had already begun to dry out in spots. There was some ponding throughout the project area with the majority in the southeast corner, which still had 2 – 3 inches of standing water. The vegetation was primarily *S. exigua* with young *P. deltoides*, *Ulmus pumila*, and *T. ramosissima*. The vegetation on most of the project area is approximately 3 – 5 ft. tall with exception to the *T. ramosissima*, which was 5 – 15 ft tall. The vegetation in the northern part of the project area was also about 5 – 15 ft. tall.

Spring 2007 Inundation: Much of the site was inundated for nearly a three month period from mid-March until mid-June.

Conclusions: Geomorphic monitoring began during winter 2007/2008. Sediment deposition was noticeable following monsoon rains late in the summer/fall 2006. Initial fisheries monitoring indicate the presence of adult silvery minnow on the inundated terraces. Vegetation increased 6.75 acres between 2005 and 2007, including 0.17 acres of wetlands.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

NDC_2ch: High Flow Channel

Constructed: February 2006

Treatment: The channel is on the downstream end of the large island, NDC-3i. It was constructed as one of two ephemeral channels, about 25 feet wide, with inundation to occur at approximately 1,000 cfs.

Water Chemistry: No constituents showed major differences. Turbidity, acidity, temperature, and specific conductance were all higher in 2007, but so was flow. Depth was 0.7 feet in 2006 and 1.6 feet in 2007. The water quality constituents may vary depending on time of day and flow.

Wetlands*: There were zero acres of wetlands prior to construction. In 2007, 0.17 acre of wetland was recorded.

Vegetation*: **2005** – CW5 was the dominate structure type with 0.30 acre and RO-CW-SC5 was 0.05 acre. **2006** – RO/CW5 was the dominate structure type with 0.35 acre. **2007** – RO/CW-CAT3 was the dominate structure type at 1.09 acres. Dominant native vegetation increased 0.79 acre from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** – No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology*: **2006 –** This site was not monitored during this phase due to lack of funding. Based on the data collected in the other NDC sites and those at the SDC subreach, it is likely that HR features at this site underwent similar morphological changes following late summer and early fall precipitation events. **2007** – Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site was inundated during the spring 2006 runoff.

Summer 2006 Inundation: The site was inundated during the summer 2006 runoff.

Fall 2006 Inundation: Channel 2ch has had sediment deposition at the inflow area, which has caused the bank level to be higher. A remarkable amount of 5 – 10 ft. vegetation (mainly *Salix exigua* and herbaceous) is also present at the inflow of the channel and extends downstream to approximately the convergence with 3ch. South of the convergence herbaceous vegetation has grown within the channel as well as on the banks where the spoil was spread out. Channel 2ch was inundated with at least 2 – 3 inches throughout most of the channel. The outflow area has been blocked by sediment buildup and the growing vegetation, although mainly herbaceous, may anchor and prevent the channel from functioning properly.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

Conclusions: Deposition of sediment was noticeable following fall 2006 inundation, primarily at the inflow and outflow areas. Sediment lips have formed and ponding may occur when flows recede. Fisheries monitoring did not occur in 2006 or 2007 at this site. Vegetation increased from 0.30 acres of mixed natives and invasive species prior to construction to 1.09 acres in 2007. The area also had 0.17 acres of wetlands that were not present prior to construction.

* Includes data for NDC-2ch and NDC-3ch 2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

NDC_3ch: High Flow Channel

Constructed: February 2006

Treatment: The channel is on the downstream end of the large island, NDC-3i. It was constructed as one of two ephemeral channels, about 25 feet wide, with inundation to occur at approximately 1,000 cfs.

Water Chemistry: No constituents showed major differences. Turbidity, acidity, temperature, and specific conductance were all higher in 2007, but so was flow. Depth was 0.7 feet in 2006 and 1.6 feet in 2007. Flow was 0.3 ft/sec in 2006 and 2.5 ft/sec in 2007. The water quality constituents may vary depending on time of day and flow.

Wetlands*: There were zero acres of wetlands prior to construction. In 2007, 0.17 acre of wetland was recorded.

Vegetation*: **2005** – CW5 was the dominate structure type with 0.30 acre and RO-CW-SC5 was 0.05 acre. **2006** – RO/CW5 was the dominate structure type with 0.35 acre. **2007** – RO/CW-CAT3 was the dominate structure type at 1.09 acres. Dominant native vegetation increased 0.79 acre from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** – No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology*: **2006 -** This site was not monitored during this phase due to lack of funding. Based on the data collected in the other NDC sites and those at the SDC subreach, it is likely that HR features at this site underwent similar morphological changes following late summer and early fall precipitation events. **2007** – Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site was inundated during the spring 2006 runoff.

Summer 2006 Inundation: The site was inundated during the summer 2006 runoff.

Fall 2006 Inundation: The inflow for channel 3ch had received sediment deposition increasing the bank height. However, the vegetation throughout the channel is approximately 3 ft. tall and is mainly herbaceous. Channel 3ch is inundated throughout most of the channel, but is deeper than 2ch having up to 1 foot of water. The outflow area has been blocked by sediment buildup and the growing vegetation, although mainly herbaceous, may anchor and prevent the channel from functioning properly.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

Conclusions: Deposition of sediment was noticeable following fall 2006 inundation, primarily at the inflow and outflow areas. Sediment lips have formed and ponding may occur when flows recede. Noticeable more water was in 3ch and than 2ch. Fisheries monitoring did not occur in 2006 or 2007 at this site. Vegetation increased from 0.30 acres of mixed natives and invasive species prior to construction to 1.09 acres in 2007. The area also had 0.17 acres of wetlands that were not present prior to construction.

* Includes data for NDC-2ch and NDC-3ch 2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

NDC_4i: Island Modification

Constructed: January 2006

Treatment: NDC-4i is part of the island destabilization project funded by the Collaborative Program. The middle third of NDC-4i was modified to create an elevation at which inundation at approximately 2,000 cfs can take place to help support various life stages of the silvery minnow and to test the efficacy of destabilizing an island.

Water Chemistry: No constituents showed significant differences. Dissolved oxygen decreased from 2006 to 2007, but this is likely due to the increase in water temperature during the surveys. Depth remained at 1.6 feet in both 2006 and 2007; however flow increased from 0.6 in 2006 to 1.6 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.08 acre of wetlands was recorded.

Vegetation: **2005** – CW-RO5 was the dominate structure type with 0.07 acre. **2006** – CW5 was the dominate structure type with 0.07 acre. **2007** – CW5 was the dominate structure type with 0.07 acre. Dominant native vegetation remained the same from the pre-construction 2005 survey to the 2007 survey, however, the non-natives within the 0.07-acre area decreased.

Fisheries: **2006** – No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** The island was to be lowered to the 2,000 cfs inundation level. Comparison of the original and as-built data showed no appreciable modification to the elevation to the island was made, but during the monitoring survey it was clear that the area was grubbed during construction. A very small amount of deposition has occurred over much of the modification area. **2007 -** Comparison of the December 2006 survey with the November 2007 survey shows deposition in the range of 0.1 feet to 0.5 feet over the eastern half of the island. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows deposition in the channel bed southeast of the island.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: Island appeared to be inundated across the modified feature. Field crew did not ford the river.

Fall 2006 Inundation: This small island was inundated during high flows and sediment deposition was extensive on the entire island especially along the eastern and western sides of the island (bar connected to the west bank during low flows). The vegetation was primarily 3 – 6 ft tall *S. exigua* and various types of herbaceous vegetation.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

Conclusions: Deposition occurred on the modified portion of the island, as well as around the island. Herbaceous vegetation was extensive during the first year of monitoring, although coyote willow was the dominant community in both 2006 and 2007. Wetlands increased from 0.0 in 2005 acres to 0.08 acres in 2007. The island has not been destabilized.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

NDC_5i: Island Modification

Constructed: January 2006

Treatment: The upstream half of the island was modified to create terraces at different elevations that can be inundated to help support various life stages of the Rio Grande silvery minnow. The three created terraces will be inundated at approximately 1,500, 2,500, and 3,500 cfs discharge. The embayment created downstream of the silt curtain will be inundated at flows less than 500 cfs.

Water Chemistry: No constituents showed significant differences. Turbidity and conductivity both increased from 2006 to 2007, however, so did flow. Depth was at 0.4 feet in 2006 and 1.7 feet in 2007. Flow increased from 0.3 in 2006 to 2.2 in 2007.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.3 acre of wetlands was recorded.

Vegetation*:* **2005** – RO/CW-C3 was the dominate structure type with 1.90 acres. **2006** – CW5 was the dominate structure type with 1.90 acres. **2007** – CW5 was the dominate structure type with 1.90 acres. Dominant native vegetation increased from the pre-construction 2005 survey to the 2007 survey within the 1.90-acre area.

Fisheries*:* **2006** – During the course of work on NDC-5i, several silvery minnows were positively identified in the embayment. The embayment created a low-velocity habitat different than the relatively deep and constricted mesohabitats that predominate on the east and west sides of the island. On 25 January, two sample seine hauls run by SWCA and the NMISC collected 56 fish; 52 were identified as silvery minnows and 4 were fathead minnows (*Pimephales promelas*). Nursery habitat monitoring also occurred in the embayment during the spring of 2006. **2007** - No fisheries data collected.

Geomorphology: **2006 -** The upstream half of this island was modified with approximately 2 feet of cut at the upstream end tapering to very little cut toward the middle, creating terraces corresponding to levels of inundation corresponding to flows of 1,500 cfs; 2,500 cfs; and 3,500 cfs. Since construction, there has been deposition up to 1 foot. **2007 -** Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: Island appeared to be inundated across the modified feature. Field crew did not ford the river. The embayment that was created was hardly evident.

Fall 2006 Inundation: Sediment deposition was significant on the north and eastern sides of the project area. The embayment area is almost entirely filled in and there is only a small amount of water at the southern end. Although the innermost terrace showed little signs of recent inundation (mostly dry), high flows inundated all three terraces and the outer two had sustained inundation with the lowest terrace still very saturated. The vegetation was primarily young *S. exigua* about 6 feet tall along with young *E. angustifolia* and *P. deltoides*.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

Conclusions*:* Deposition occurred on the northeastern edge of the island, while the embayment was filled in completely. Seine hauls in January 2006 resulted in 52 silvery minnows identified in the embayment. Nursery habitat monitoring was conducted in the spring of 2006 with limited results. Vegetation did not noticeably change, although Russian olive at the site decreased and 0.3 acres of wetlands were added following construction.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

I-40_2i: Island Modification

Constructed: Late February through early March, 2006

Treatment: The upper third of the island was modified to create an elevation to be inundated in support of various life stages of the silvery minnow and to test the efficacy of destabilizing an island. The modified area will be inundated at approximately 2000 cfs.

Water Chemistry: Turbidity and conductivity showed significant differences from 2006 to 2007. Turbidity significantly decreased from 696.0 to 194.0 FTU between 2006 and 2007 while conductivity increased from 100 to 321 µS/cm. Depth was at 2.3 feet in 2006 and 1.6 feet in 2007. Flow was 1.0 in 2006 and 1.1 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.2 acre of wetlands was recorded.

Vegetation*:* **2005** – CW-SC5 was the dominate structure type with 1.08 acres. **2006** – CW-SC5 was the dominate structure type with 1.08 acres. **2007** – CW-SC5 was the predominate structure type with 0.60 acre, followed by CW5 with 0.44 acre and CW6 with 0.05 acre. Dominant native vegetation remained the same from the pre-construction 2005 survey to the 2007 survey, however, the non-natives within the 1.08-acre area decreased.

Fisheries*:* **2006** - No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** Islands within the I-40 reach were not monitored during this phase due to lack of funding. Based on the data collected in the NDC and SDC subreaches, it is likely that HR features in the I-40 subreach underwent similar morphological changes following late summer and early fall precipitation events. **2007 -** Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: At I-40-2i the high flows came onto the east side of the island, which was dry during implementation.

Fall 2006 Inundation: Island 2i did not have a great deal sediment deposition except for along the northeastern side and within the channel along the eastern side of the island (connected to the east bank during low flows). The embayment area had been completely filled in during construction and very little sediment deposition occurred within this area. However, the entire project area had been inundated during high flows and there was standing water on all the terraces. The innermost terrace in the middle of island had standing water leading to southern boundary of the project and most of the southwestern section (including the embayment) of the project area was inundated with 2 – 3 inches of water. Most of the vegetation in the project area is composed of *S. exigua* (5 – 10 ft.) with some patches of young *Populus deltoides*, and *Tamarix ramosissima*.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

I-40_4i: Island Modification

Constructed: March 2006

Treatment: The upstream half of the island was modified to create terraces at different elevations to be inundated in support of various life stages of silvery minnow. The three created terraces will be inundated at approximately 1,500, 2,500, and 3,500 cfs. The embayment created downstream of the silt curtain will be inundated at low flows, including less than 500 cfs

Water Chemistry: No constituents showed significant differences. Turbidity and conductivity decreased from 2006 to 2007. Depth was at 2.1 feet in 2006 and 1.0 feet in 2007. Flow was 0.7 in 2006 and 1.8 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.1 acre of wetlands was recorded.

Vegetation: **2005** – RO-CW5 was the dominate structure type with 0.43 acre. **2006** – CW5 was the dominate structure type with 0.43 acre. **2007** – CW5 was the dominate structure type with 0.43 acre. Dominant native vegetation remained the same from the pre-construction 2005 survey to the 2007 survey, however, the non-natives within the 0.43-acre area decreased.

Fisheries: **2006** - No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** Islands within the I-40 reach were not monitored during this phase due to lack of funding. Based on the data collected in the NDC and SDC subreaches, it is likely that HR features in the I-40 subreach underwent similar morphological changes following late summer and early fall precipitation events. **2007 -** Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: The island appeared to be inundated across the lowest section of the modified feature at approximately 2000 cfs. Field crew did not ford the river.

Fall 2006 Inundation: Sediment deposition was primarily along the northeastern side of the project area on the island. Although the whole island had been inundated, the southern boundary probably did not receive sustained inundation. The vegetation on the northern tip of the project area primarily consists of 5 feet t tall *S. exigua,* whereas on the rest of the island is mixed with young *P. deltoides*, *E. angustifolia* and *T. ramosissima*.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

I-40_1b: Bankline Modification

Constructed: March 2006

Treatment: This bank modification was constructed on west bank of the Rio Grande north-northeast of island 4i and spanned 369 meters. The bank modification was cut with the elevation dropping 0.0009 feet per linear foot from northern to southern end. Inundation of this modification should occur at approximately 2000 cfs.

Water Chemistry*: Turbidity and conductivity showed significant differences from 2006 to 2007. Turbidity significantly decreased from 671.0 to 125.0 FTU between 2006 and 2007 while conductivity increased from 90 to 328 µS/cm. Depth was at 1.2 feet in 2006 and 0.7 feet in 2007. Flow was 0.1 in 2006 and 1.7 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.1 acre of wetlands was recorded.

Vegetation: **2005** – CW5 was the dominate structure type with 0.42 acre. **2006** – 6 (herbaceous) was the dominate structure type with 0.41 acre. **2007** – CW6 was the dominate structure type with 1.13 acres. Dominant native vegetation increased 0.71 acre from the pre-construction 2005 survey to the 2007.

Fisheries: **2006** - No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** Modifications within the I-40 reach were not monitored during this phase due to lack of funding. Based on the data collected in the NDC and SDC subreaches, it is likely that HR features in the I-40 subreach underwent similar morphological changes following late summer and early fall precipitation events. **2007 -** Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: This bankline modification was inundated to the edge of the slope.

Fall 2006 Inundation: Erosion into the river specifically in the northern and middle sections is noticeable. Also some of the sediment along the slope has eroded onto the bank line creating small areas of standing water throughout the modification. The force of the river has had a significant affect in the middle section of the bank modification where a small section of the bank has been separated by a channel. Much of the sediment from this bank was moved just south of this feature, which is at the bend in the river. Several pieces of woody debris may be holding the small section of the bank from eroding into the river. The modification has had sustained inundation to the top of the slope and standing water was evident in areas throughout the modification. Most of the vegetation is herbaceous plants along the bank line and also located sparsely between the slope and the bank line. However in the southern section, young *S. exigua* also dominates.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

* Includes data for I-40-1b and I-40-1ch 2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

I-40_3b: Bankline Modification

Constructed: March 2006

Treatment: This bank modification was constructed on the west bank of the Rio Grande. The bank modification was cut with the elevation dropping 0.0009 feet per linear foot from northern to southern end. Inundation of this modification should occur at approximately 2,000 cfs.

Water Chemistry: No constituents showed significant differences. Turbidity and conductivity decreased from 2006 to 2007. Depth was at 0.5 feet in 2006 and 1.2 feet in 2007. Flow was 0.2 in 2006 and 1.9 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, less than 0.1 acre of wetlands was recorded.

Vegetation: **2005** – 6 (herbaceous) was the dominate structure type with 0.26 acre. **2006** – 6 (herbaceous) was the dominate structure type with 0.26 acre. **2007** – 6 (herbaceous) was the dominate structure type with 0.46 acres. Dominant native vegetation increased 0.2 acre from the pre-construction 2005 survey to the 2007.

Fisheries: **2006** - No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** Modifications within the I-40 reach were not monitored during this phase due to lack of funding. Based on the data collected in the NDC and SDC subreaches, it is likely that HR features in the I-40 subreach underwent similar morphological changes following late summer and early fall precipitation events. **2007 -** Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: This bankline modification was inundated to the edge of the slope.

Fall 2006 Inundation: The sediment deposition at this bank modification is mostly in the northern section, but a small amount does exist in the southern section. The erosion of the sediment from the slope has filled in the bank modification and added to the height of the bank. The modification has had sustained inundation to the top of the slope and standing water was evident in the middle section. Most of the vegetation is herbaceous plants along the bank line and also located sparsely between the slope and the bank line. Although at this bank modification, *U. pumila* saplings are found throughout.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

SDC_2i: Island Modification (CP)

Constructed: From late February through early March 2006

Treatment: SDC-2i is part of the Collaborative Program funded island destabilization project. The upper third of the island was modified to create an elevation to be inundated in support of various life stages of the silvery minnow and to test the efficacy of destabilizing an island. The modified area will be inundated at approximately 2,000 cfs.

Water Chemistry: No constituents showed significant differences. Depth was at 1.2 feet in 2006 and 0.8 in 2007. Flow was at 0.8 in 2006 and at 0.2 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, less than 0.1 acres of wetlands were recorded.

Vegetation: **2005** – RO5 was the dominate structure type with 0.89 acre. **2006** – CW-RO5 was the dominate structure type with 0.89 acre. **2007** – CW5 was the dominate structure type with 0.89 acre. Dominant native vegetation took over the 0.89-acre area from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** - No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** The upstream third of this island was lowered by between 1 foot and 2 feet to achieve inundation at 2,000 cfs, and the spoil was placed immediately downstream of the cut area. Since construction, the modified area has experienced widespread deposition of less than 0.5 foot. There was also deposition on the east side of the spoil pile and bank erosion along the west side of the island. The treatment has not yet caused destabilization of this island as intended. **2007** Since December 2006, deposition of more than 0.5 feet, and in some areas over 1 foot, occurred on most of the island. The western bank of the island eroded more than 1.5 feet. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows deposition on the channel bed as well as the observed erosion along the western bank of the island.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: Island appeared to be inundated across the modified feature. Field crew did not ford the river.

Fall 2006 Inundation: This island had a great deal sediment (and debris) deposition as high flows easily reached the southern boundary of the project area. Most of the sediment and debris deposition was located in the northern half of the project area. For the most part the project area was still saturated and only in a small area in the southwest corner was there standing water. The vegetation in the project area is approximately 3 ft. tall and fairly sparse except in the southwest corner where it's closer to 6 ft tall and rather thick. The composition of vegetation consists of young *S. exigua*, *P. deltoides*, and *E. angustifolia*.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

SDC_3i: Island Modification (CP)

Constructed: March 2006

Treatment: SDC-3i is part of the Collaborative Program funded island destabilization project. The middle third of the island was modified to create an elevation to be inundated in support of various life stages of the silvery minnow and to test the efficacy of destabilizing an island. The modified area will be inundated at approximately 2,000 cfs.

Water Chemistry: Turbidity showed significant differences from 2006 to 2007. Turbidity significantly decreased from 535.0 to 192.0 FTU between 2006 and 2007. Depth was at 1.0 feet in 2006 and 1.6 feet in 2007. Flow was 0.9 in 2006 and 1.9 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, less than 0.16 acre of wetlands were recorded.

Vegetation: **2005** – RO5 was the dominate structure type with 0.27 acre. **2006** – CW5 was the dominate structure type with 0.27 acre. **2007** – CW5 was the dominate structure type with 0.28 acre. Dominant native vegetation replaced the non-native vegetation and increased the area by 0.01-acre from the pre-construction 2005 survey to the 2007 survey.

Fisheries: **2006** – No fisheries data collected. **2007** - Of the 145 silvery minnows caught and released, 133 were caught in the SDC Subreach. In the SDC Subreach 8 silvery minnows were caught at SDC-3i

Geomorphology: **2006 -** The middle third of this island was cut by approximately 1 foot to achieve inundation at 2,000 cfs, and the spoil was placed immediately downstream. The summer flows have not caused any appreciable erosion or deposition. The treatment has not yet caused destabilization of this island as intended. **2007** The majority of the island showed deposition of between 0.1 feet to 0.5 feet between the December 2006 survey and the November 2007 survey. An area in the lower half of the island experienced erosion up to 1 foot. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows mixed areas of erosion and deposition along the channel bed. The channel on the west side of the island generally shows deposition. The portion of the channel directly adjacent to the east bank of the island shows erosion.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: Island appeared to be inundated across the modified feature. Field crew did not ford the river.

Fall 2006 Inundation: The sediment deposition is primarily restricted to the northern part of the project area and the bar on the northwestern side of the project area. The entire project area has been inundated although there was no standing water. The vegetation is primarily herbaceous along the banks and young *S. exigua*, with a mixture of *U. pumila*, *P. deltoides*, and *E. angustifolia* on the interior. Most of the vegetation is relatively thin and about 5 ft tall, except in the northeastern corner where it's extremely think and 8 – 10 ft. tall.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

SDC_1b: Bankline Modification

Constructed: March 2006

Treatment: This bank modification was constructed on west bank of the Rio Grande north-northeast of island 4i and spanned 369 meters. The bank modification was cut with the elevation dropping 0.0009 feet per linear foot from northern to southern end. Inundation of this modification should occur at approximately 2,000 cfs.

Water Chemistry: No constituents showed significant differences. Depth was 2.9 feet in 2006 and 2.3 feet in 2007. Flow was 0.4 in 2006 and 0.5 in 2007. Water quality constituents may vary depending on time of day, temperature, and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, less than 0.1 acre of wetlands was recorded.

Vegetation: **2005** – RO/SC-CW3 at 0.14 acre and 6 (herbaceous) at 0.13 acre were the dominate structure types. **2006** – 6 (herbaceous) was the dominate structure type with 0.35 acre. **2007** – CW6 was the dominate structure type with 1.95 acres. Dominant native vegetation increased 1.81 acres from the pre-construction 2005 survey to the 2007.

Fisheries: **2006** - No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** The outside 15 feet of the bar was lowered to the 2,000 cfs inundation level, and the spoil was piled adjacent to the lowered area. The summer flows resulted in minor deposition over the upstream portion of the feature and bank erosion along the downstream half. **2007 -** The bank experienced more than 2 feet of erosion in two areas on the upstream and downstream portion of the bar. Deposition of between 0.1 feet and 0.5 feet occurred on the majority of the bar in the over bank area. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows areas of erosion on the east side of the channel bed.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: This bankline modification was inundated to the edge of the slope.

Fall 2006 Inundation: Sediment deposition at this bank modification is sparse in the northern and middle sections. However, in the southern section sediment deposition is quite significant where the width of the bank modification is between 3 – 4 feet. It appears that the modification has eroded into the river and now only a narrow bank and the slope remain. The southernmost end of the modification is still in the process of eroding away. The entire modification has been inundated and is still saturated almost to the top of the slope. Most of the vegetation is herbaceous plants along the bank line and also sparsely between the slope and the bank line. However, young (2 – 3 ft. tall) *S. exigua* occurs in a few areas in the middle section of modification.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

SDC_4i: Island Modification

Constructed: March 2006

Treatment: The upstream half of the island was modified to create terraces at different elevations to be inundated in support of various life stages of silvery minnow. The three created terraces will be inundated at approximately 1,500, 2,500, and 3,500 cfs. The embayment created downstream of the silt curtain will be inundated at low flows, including less than 500 cfs

Water Chemistry: Turbidity and conductivity showed significant differences from 2006 to 2007. Turbidity significantly decreased from 715.0 to 180.0 FTU between 2006 and 2007 while conductivity decreased from 510 to 329 µS/cm. Depth was at 1.1 feet in 2006 and 1.0 feet in 2007. Flow was 0.4 in 2006 and 1.9 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.7 acre of wetlands were recorded.

Vegetation: **2005** – RO/CW3 was the dominate structure type with 2.77 acres. **2006** – CW-RO5 was the dominate structure type with 2.77 acres. **2007** – CW-RO5 was the dominate structure type with 2.43 acres. Dominant native vegetation increased from the pre-construction 2005 survey to the 2007 survey within the area.

Fisheries: **2006** – No fisheries data collected. **2007** - Of the 145 silvery minnows caught and released, 133 were caught in the SDC Subreach. In the SDC Subreach 2 silvery minnows were caught at SDC-4i

Geomorphology: **2006 -** The upstream half of this island was modified with approximately 2 feet of cut at the upstream end tapering to very little cut toward the middle, creating terraces corresponding to levels of inundation corresponding to flows of 1,500 cfs; 2,500 cfs; and 3,500 cfs. Since construction, there has been deposition up to 1 foot. **2007** Since the December 2006 survey, the island was eroded between 0.1 feet and 0.5 feet over approximately half of the island. Comparison of the cross section elevation data from the December 2006 and November 2007 surveys shows areas of erosion on the west side of the island and deposition on the east side.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: Island appeared to be inundated across the modified feature. Field crew did not ford the river.

Fall 2006 Inundation: Sediment deposition was primarily on the outermost terrace with most occurring on the northeast side of the project area (northern extent of the embayment). Although most of the island had been inundated along the eastern side, the innermost terrace and the middle terrace on the western side were a lot less saturated and had not been recently inundated. The embayment was mostly filled in with sediment, but a small backwater channel runs along the western side up to the northern end of the embayment. Some of the northeastern section of the project area has eroded back into the river as this area receives the force of the river during high flows. This area was a part of the embayment that was filled in during construction. The vegetation on the northern tip of the project area primarily consists of 3 – 5 feet t tall *S. exigua* and *E. angustifolia*, whereas the embayment area is primarily composed of herbaceous vegetation. The rest of the island is mixed with 5 – 8 ft. tall *S. exigua*, *E. angustifolia*, *P. deltoides*, and *U. pumila*.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

SDC_2b: Bankline Modification

Constructed: March 2006

Treatment: This bank modification was constructed on east bank of the Rio Grande just east-southeast of island 4i and spanned 635 meters. The bank modification was cut with the elevation dropping 0.0009 feet per linear foot from northern to southern end. Inundation of this modification should occur at approximately 2,000 cfs.

Water Chemistry: Turbidity significantly decreased from 1000 to 104.0 FTU between 2006 and 2007. Depth was at 3.8 feet in 2006 and 1.7 feet in 2007. Flow was 0.8 in 2006 and 1.7 in 2007. Water quality constituents may vary depending on time of day and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, 0.3 acre of wetlands was recorded.

Vegetation: **2005** – RO/RO-MB-SC3 was the dominate structure type with 0.34 acre. **2006** CW5 was the dominate structure type with 0.13 acre. **2007** – CW6 at 1.47 acres and CW5 1.45 acres at were the dominate structure types. Dominant native vegetation increased 2.92 acres from the pre-construction 2005 survey to the 2007.

Fisheries: **2006** - No fisheries data collected. **2007** - No fisheries data collected.

Geomorphology: **2006 -** This site was not monitored during this phase due to lack of funding. Based on the data collected in the other SDC sites and those at the NDC subreach, it is likely that HR features at this site underwent similar morphological changes following late summer and early fall precipitation events. **2007** – Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

Summer 2006 Inundation: Partial inundation occurred along the bankline of SDC-2b. It was slightly inundated to the north of the bar and was dry to the south of the modification. A monoculture of common reed, *Phragmites australis*, dominates the southern end of SDC-2b.

Fall 2006 Inundation Moderate sediment deposition has occurred from the northern end of the modification south to the middle section. The sediment deposition appears to be a mixture of the bank eroding into the channel and the slope eroding onto the bank. The northern end of the modification has been inundated and is still saturated to the top of the slope. A few small areas of standing water also occur in this area of the modification. Herbaceous vegetation occurs along the bank line and also sparsely between the slope and the bank line. However, young (3 – 5 ft. tall) *S. exigua*, *E. angustifolia*, and *U. pumila* also occur in the northern section of modification. The middle section of the modification is adjacent to a natural channel and island. In this section the modification and natural channel were inundated and still saturated throughout. However, the vegetation is significantly taller and more dense. In this area of the modification, *S. exigua* and *E. angustifolia* occur with *Phragmites australis*, which dominates to the southern end of the modification. Sediment deposition in the southern section does not seem as apparent as in the northern section. The southern section has been inundated and standing water was evident. The vegetation at the southern end is a monoculture of *Phragmites australis*.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

SDC_3b: Bankline Modification

Constructed: March 2006

Treatment: This bank modification was constructed on west bank of the Rio Grande south of bank modification 2b and spanned 504 meters. The bank modification was cut with the elevation dropping 0.0009 feet per linear foot from northern to southern end. Inundation of this modification should occur at approximately 2,000 cfs.

Water Chemistry: No constituents showed significant differences. Depth was 2.2 feet in 2006 and 1.1 feet in 2007. Flow was 1.1 in 2006 and 0.5 in 2007. Water quality constituents may vary depending on time of day, temperature, and flow.

Wetlands: There were zero acres of wetlands prior to construction. In 2007, nearly 0.3 acre of wetlands was recorded.

Vegetation: **2005** – CW-RO-SC5 was the dominate structure type with 1.19 acres. **2006** CW5 was the dominate structure type with 0.34 acre. **2007** – CW6 at 2.66 acres at was the dominate structure type. Dominant native vegetation increased 1.47 acres from the pre-construction 2005 survey to the 2007 and non-native vegetation decreased in the original 1.19-acre area.

Fisheries: **2006 - No** fisheries data collected. **2007** - Of the 145 silvery minnows caught and released, 133 were caught in the SDC Subreach. In the SDC Subreach 34 silvery minnows were caught at SDC-3b upstream and 89 at SDC-3b downstream.

Geomorphology: **2006 -** This site was not monitored during this phase due to lack of funding. Based on the data collected in the other SDC sites and those at the NDC subreach, it is likely that HR features at this site underwent similar morphological changes following late summer and early fall precipitation events. **2007** – Geomorphology studies began in December 2007 and concluded in January 2008.

Spring Runoff 2006: The site had no observed inundation during 2006 runoff.

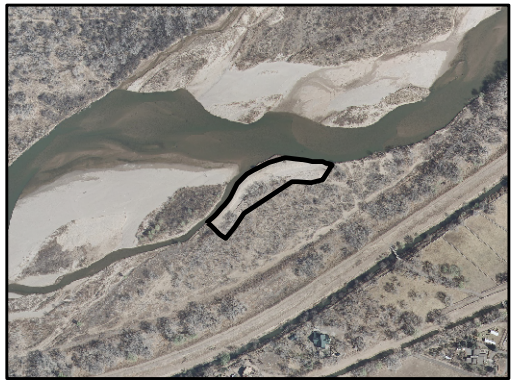
Summer 2006 Inundation: Partial inundation occurred along the bankline of SDC-3b.

Fall 2006 Inundation Sediment deposition is little to moderate throughout this bank modification. Only within the middle section was there an area where the bank had begun to erode into the river. The entire modification has been inundated and is still saturated almost to the top of the slope. Standing water was prevalent in small areas all along the length of the modification. Most of the vegetation is herbaceous plants along the bank line and also sparsely between the slope and the bank line. Patches of young (2 – 3 ft. tall) *S. exigua* occur in a few areas throughout the modification.

Spring 2007 Inundation: The site was inundated for almost a three month period from mid-March until mid-June.

2005 – Pre-construction (summer); 2006 (fall); and 2007 (fall)

APPENDIX D
DETAILED MAPS FROM GEOMORPHIC SURVEYS



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

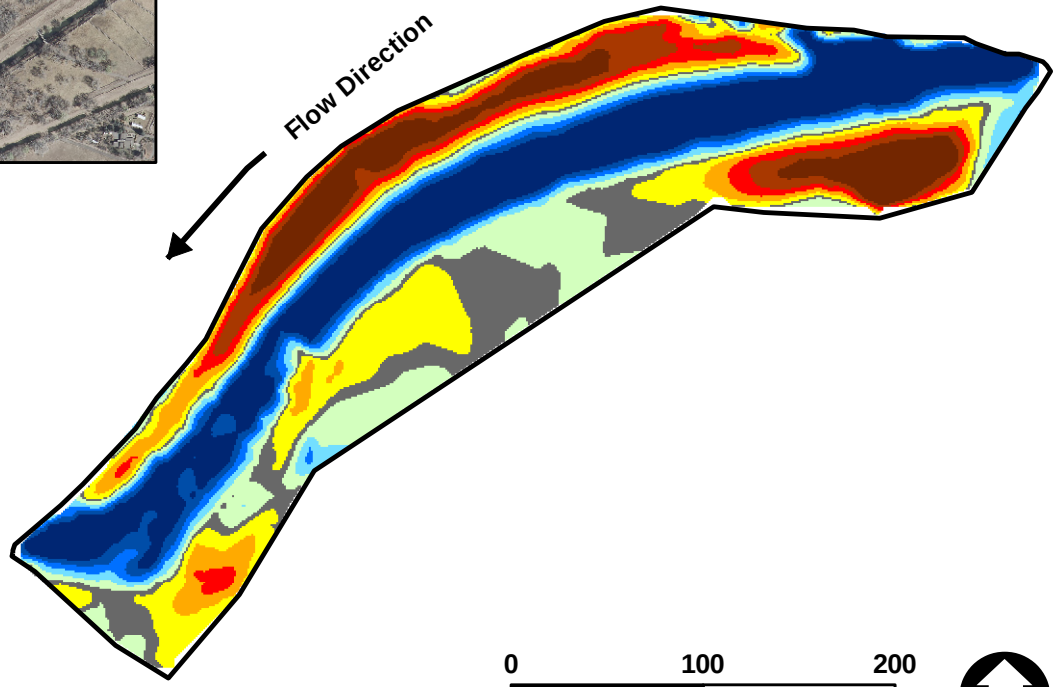
NDC 1b & 1ch

1529800E

Flow Direction

Design Flow = 400 cfs
Design Depth = 0 feet

1531000N



Treatment Boundary

0 100 200
Feet

Change in Elevation (feet)

Fill
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Cut
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Mussetter Engineering Inc.
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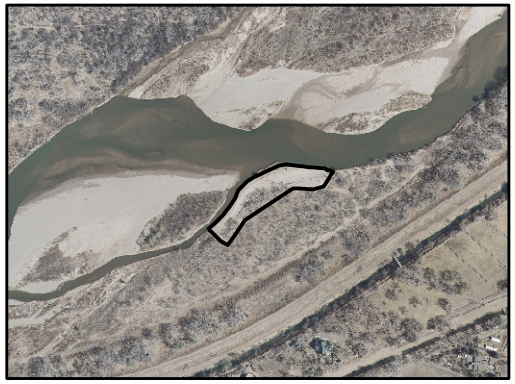
Fort Collins, Colorado 80525

Comparison of Original Surface (Sept. 2005) and As-Built (Feb. 2006) Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

NDC 1b & 1ch



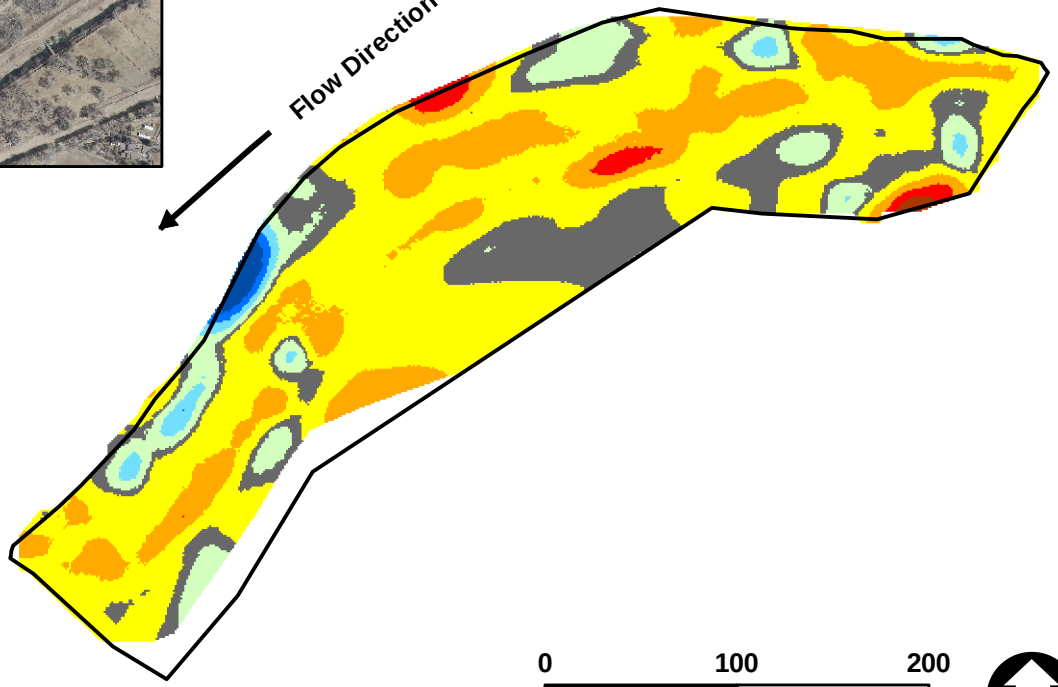
Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 400 cfs
Design Depth = 0 feet
Days of Inundation = 260*

1529800E

1531000N

Flow Direction



Treatment Boundary

0 100 200
Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

*Number of days that the design flow was equaled or exceeded based on mean daily flow between survey dates 03/01/06 to 12/10/06.

Mussetter Engineering Inc.
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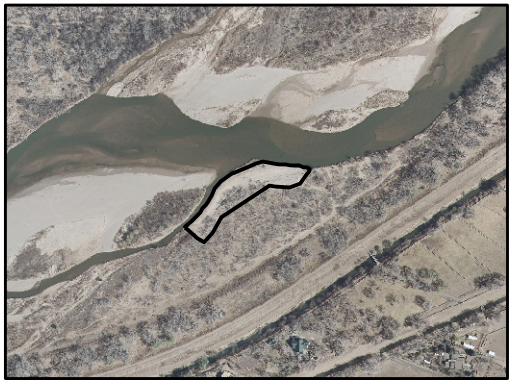
Comparison of As-Built (February 2006) and December 2006 Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

NDC 1b & 1ch



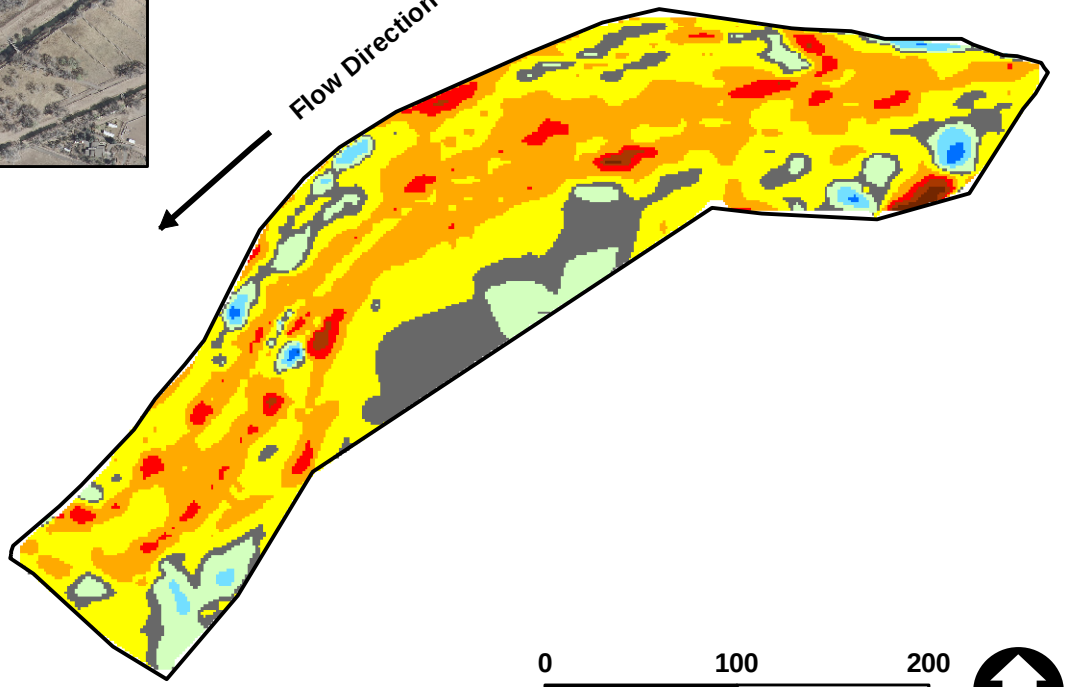
Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 400 cfs
Design Depth = 0 feet
Days of Inundation = 269*

1529800E

1531000N

Flow Direction



Treatment Boundary

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 12/14/06 to 10/28/07.

0 100 200
Feet

N

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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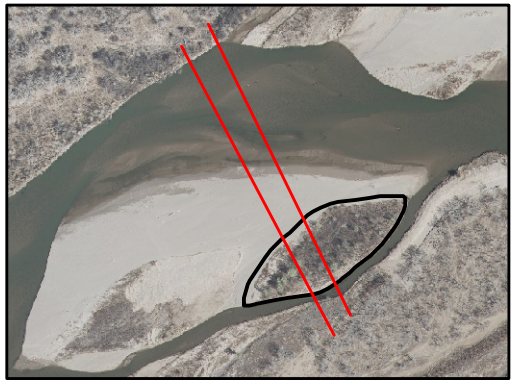
Fort Collins, Colorado 80525

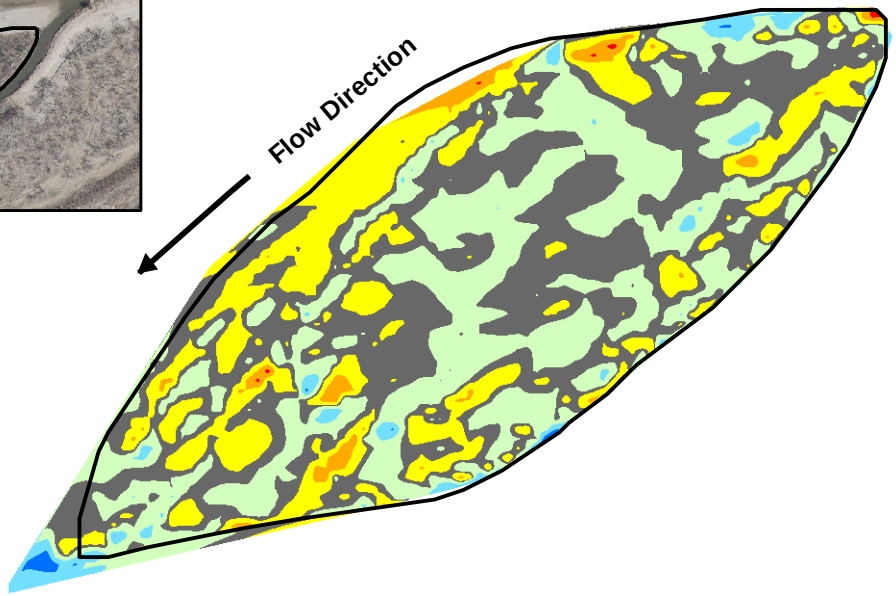
Comparison of December 2006 and November 2007 Surveys

Date: 12/03/2007
MEI Project #07-28 Rio Grande Monitoring

NDC Control Island



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs



Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Control Island Boundary

Mesohabitat Cross Sections

0 100 200

Feet

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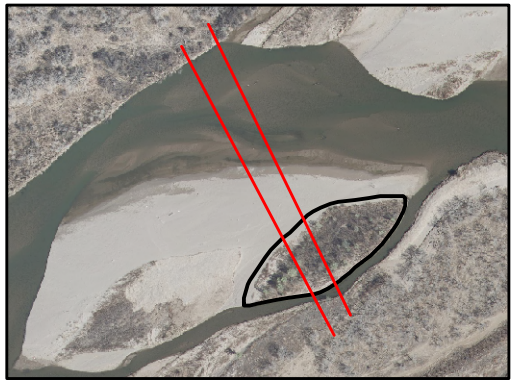
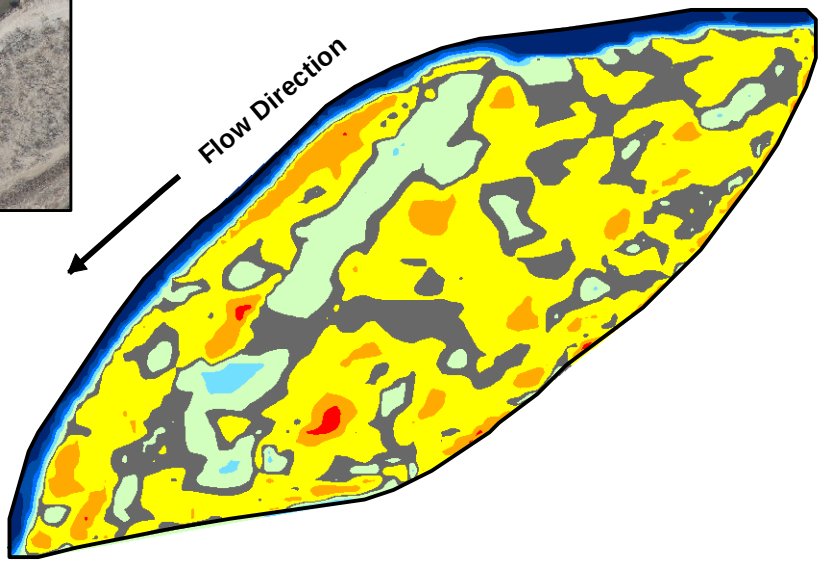
Natural Changes - Comparison of September 2005 and December 2006 Surveys

Date: December 3, 2007
MEI Project #07-28 Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

NDC Control Island



Control Island Boundary

Mesohabitat Cross Sections

0 100 200

Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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Natural Changes - Comparison of December 2006 and November 2007 Surveys

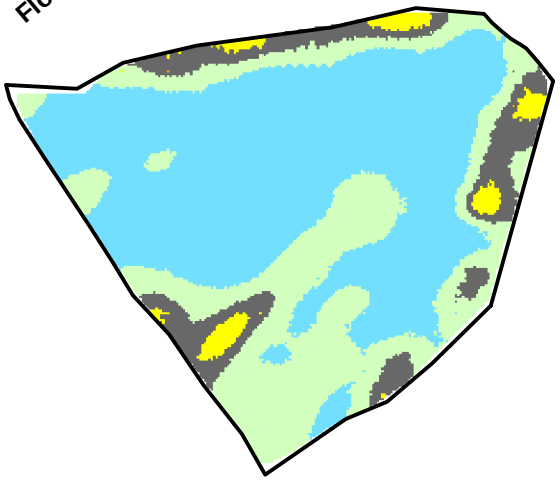
Date: December 3, 2007
MEI Project #07-28 Rio Grande Monitoring

NDC 2i

1529100E

Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Flow Direction



Design Flow = 3000 cfs
Design Depth = 0 feet

Change in Elevation (feet)

Fill
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Cut
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

1530800N

Treatment Boundary

Mesohabitat Cross Sections

0 50 100

Feet

N

Mussetter Engineering Inc.
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Fort Collins, Colorado 80525

Comparison of Original Surface (Sept. 2005) and As-Built (Feb. 2006) Surveys

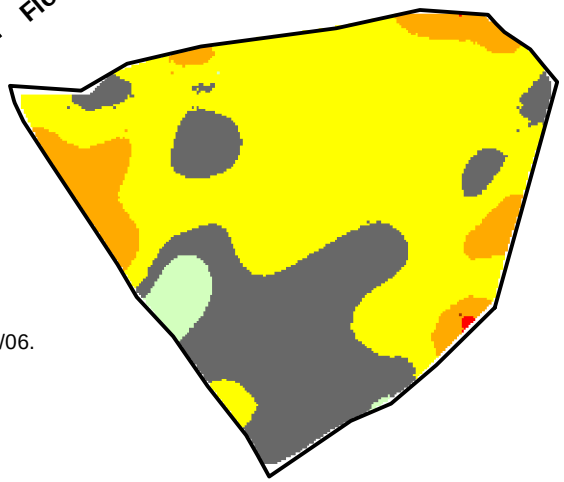
Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

NDC 2i

Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

1529100E

Flow Direction



Design Flow = 3000 cfs
Design Depth = 0 feet
Days of Inundation = 0*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 03/01/06 to 12/10/06.

1530800N

Treatment Boundary
Mesohabitat cross sections

0 50 100
Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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Comparison of As-Built (Feb. 2006) and December 2006 Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

NDC 2i

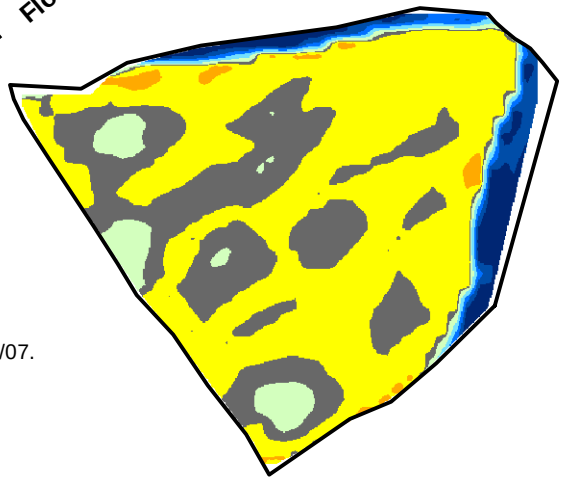
Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 3000 cfs
Design Depth = 0 feet
Days of Inundation = 10*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 12/14/06 to 10/28/07.

1529100E

Flow Direction



1530800N

Treatment Boundary

Mesohabitat Cross Sections

0 50 100
Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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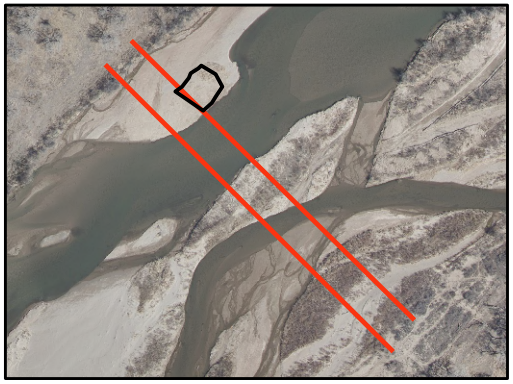
Comparison of December 2006 and November 2007 Surveys

Date: 12/03/2007
MEI Project #07-28 Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 2000 cfs
Design Depth = 0 feet

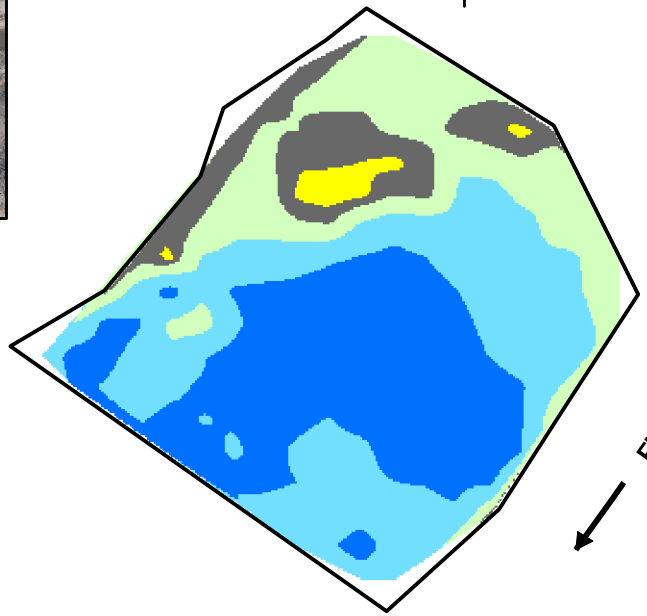
Treatment Boundary

Mesohabitat Cross Sections

1529600N

NDC 4i

1524400E



0 30 60

Feet

Change in Elevation (feet)

Fill
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Cut
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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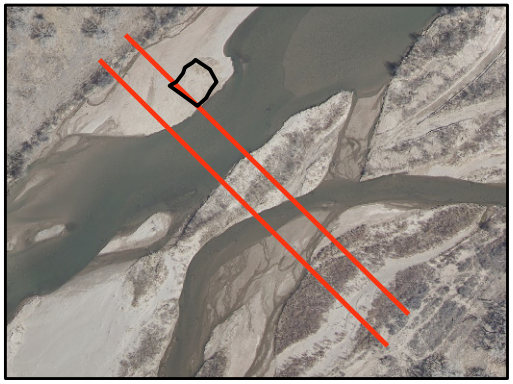
Comparison of Original Surface (Sept. 2005) and As-Built (Feb. 2006) Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

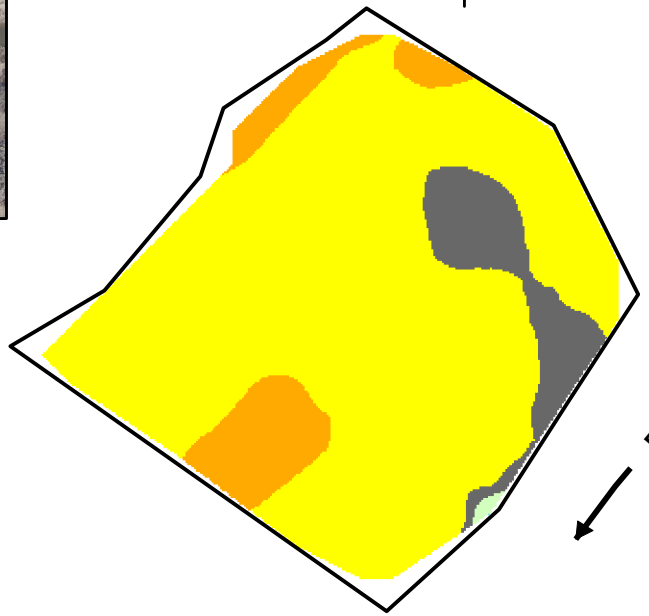


Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 2000 cfs
Design Depth = 0 feet
Days of Inundation = 1*

NDC 4i

1524400E



Treatment Boundary

Mesohabitat cross sections

1529600N

0 30 60

Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 03/01/06 to 12/10/06.

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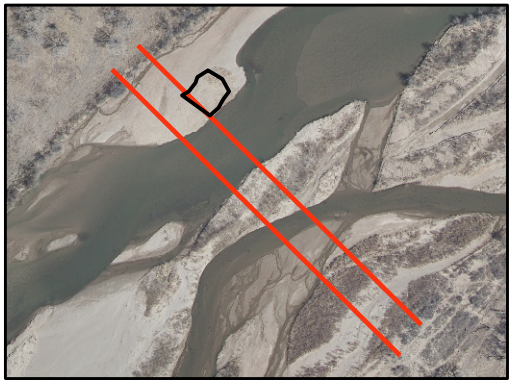
Comparison of As-Built (Feb. 2006) and December 2006 Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

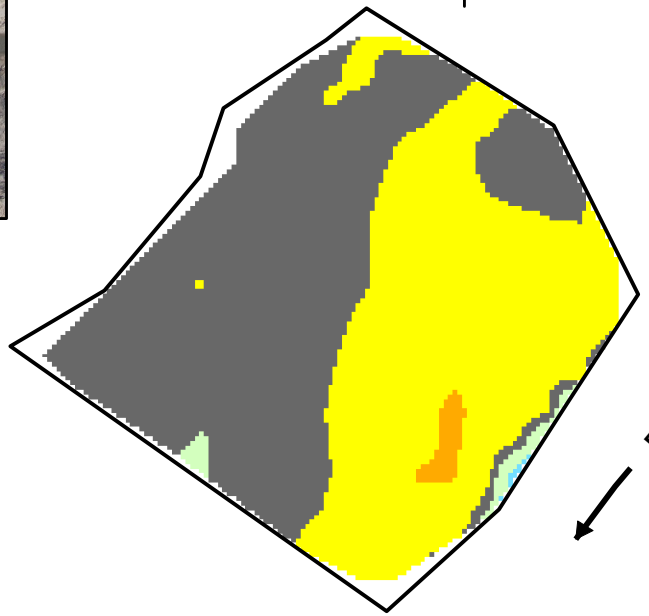


Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 2000 cfs
Design Depth = 0 feet
Days of Inundation = 41*

NDC 4i

1524400E



Treatment Boundary

Mesohabitat Cross Sections

1529600N

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 12/14/06 to 10/28/07.

0 30 60
Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5
- 0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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Fort Collins, Colorado 80525

Comparison of December 2006 and November 2007 Surveys

Date: 12/03/2007
MEI Project #07-28 Rio Grande Monitoring

Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 2000 cfs
Design Depth = 0 feet
Days of Inundation = 1*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 03/23/06 to 12/10/06.

1463000N

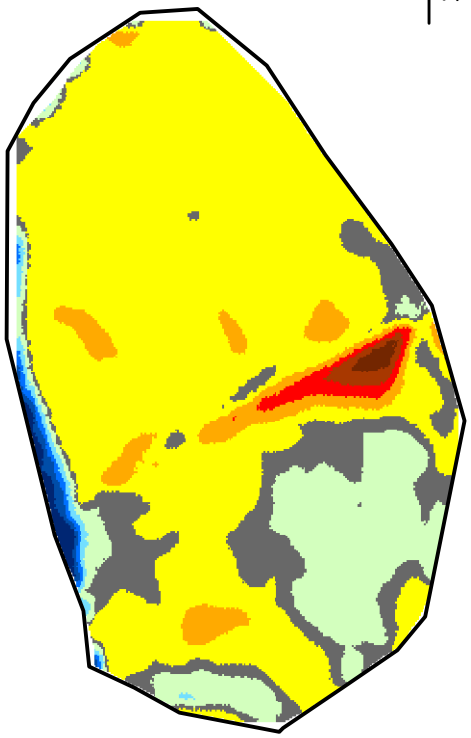
Treatment Boundary

Mesohabitat Cross Sections

SDC 2i

1514000E

Flow Direction



0 100 200

Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Mussetter Engineering Inc.
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Fort Collins, Colorado 80525

Comparison of As-Built (March 2006) and December 2006 Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 2000 cfs
Design Depth = 0 feet
Days of Inundation = 1*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 03/23/06 to 12/10/06.

1463000N

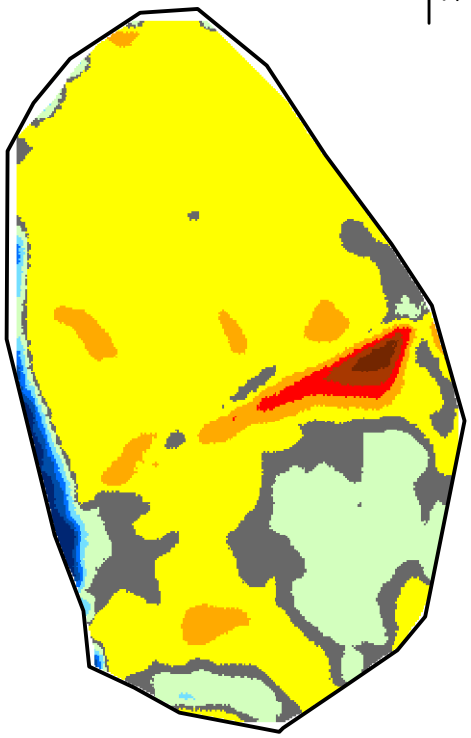
Treatment Boundary

Mesohabitat Cross Sections

SDC 2i

1514000E

Flow Direction



0 100 200
Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Mussetter Engineering Inc.
1730 South College Ave. Suite 100
Fort Collins, Colorado 80525

Comparison of As-Built and December 2006 Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 2000 cfs
Design Depth = 0 feet
Days of Inundation = 41*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 12/14/06 to 10/28/07.

SDC 2i

1514000E

Flow Direction

1463000N

Treatment Boundary

Mesohabitat Cross Sections

0 100 200

Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5
- 0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Mussetter Engineering Inc.
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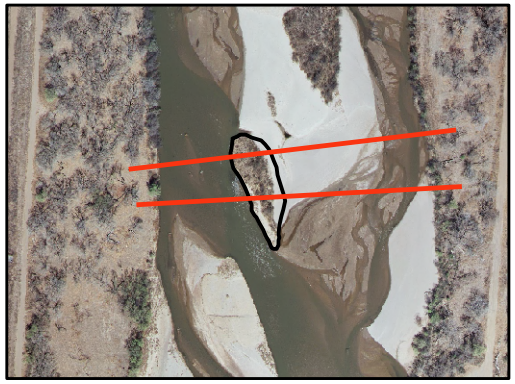
Fort Collins, Colorado 80525

Comparison of December 2006 and November 2007 Surveys

Date: 12/03/2007
MEI Project #07-28 Rio Grande Monitoring

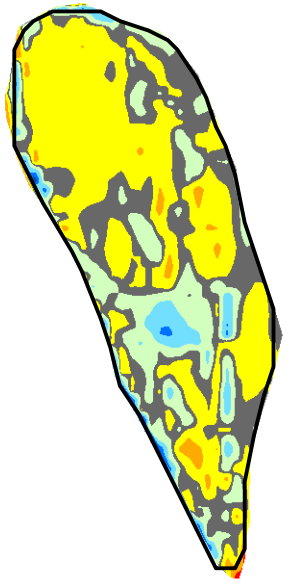
SDC Control Island

1514150E



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

1462500N



Flow Direction

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Treatment Boundary

Mesohabitat Cross Sections

0 100 200

Feet

N

Mussetter Engineering Inc.
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Fort Collins, Colorado 80525

Natural Changes - Comparison of September 2005 and December 2006 Surveys

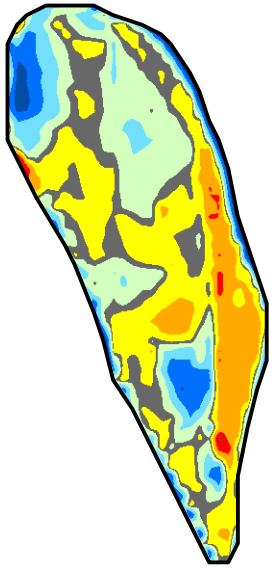
Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

SDC - Control Island

1514150E

Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

1462500N



Flow Direction

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Treatment Boundary

Mesohabitat Cross Sections

0 100 200

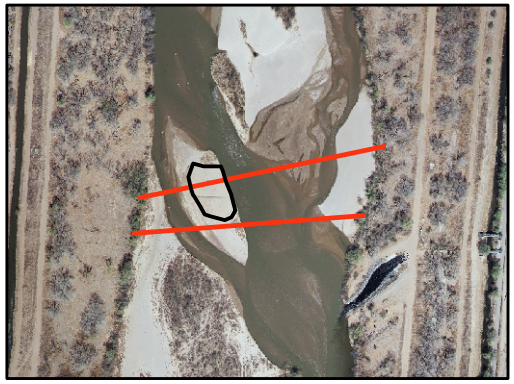
Feet

N

Mussetter Engineering Inc.
1730 South College Ave. Suite 100
Fort Collins, Colorado 80525

Natural Changes - Comparison of December 2006 and November 2007 Surveys

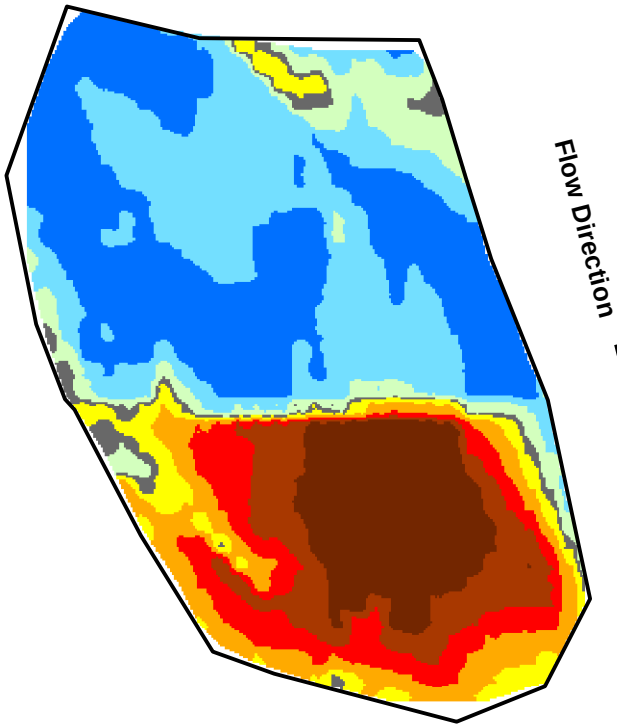
Date: December 3, 2007
MEI Project #07-28 Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

SDC 3i

1513900E



1462200N

Design Flow = 2000 cfs
Design Depth = 0 feet

Treatment Boundary
Mesohabitat Cross Sections

0 50 100
Feet

Change in Elevation (feet)

Fill
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

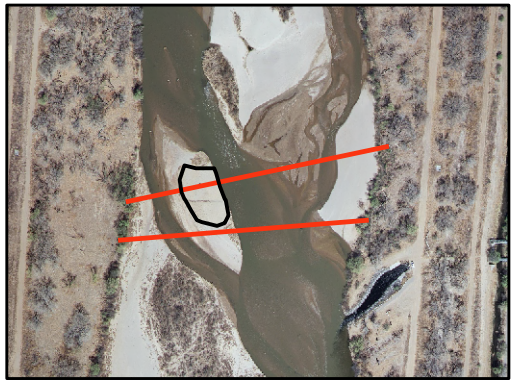
0

Cut
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Mussetter Engineering Inc.
1730 South College Ave. Suite 100
Fort Collins, Colorado 80525

Comparison of Original Surface (Sept. 2005) and As-Built (March 2006)

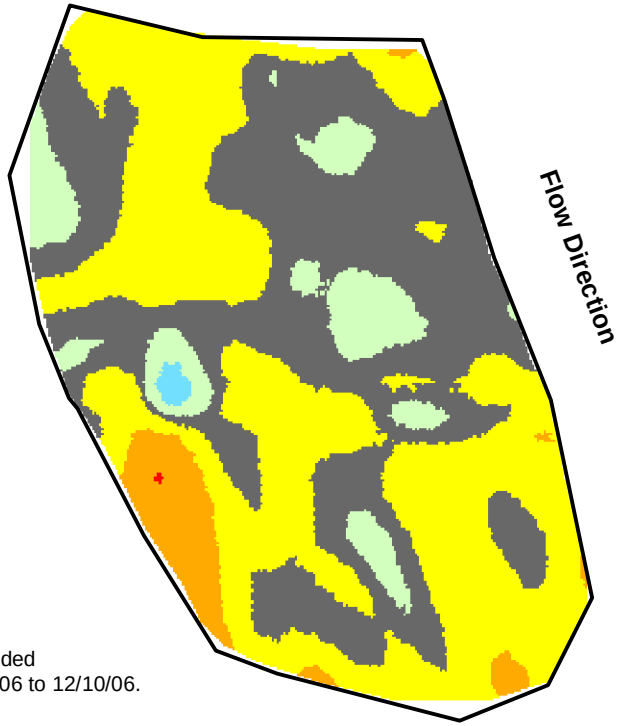
Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

SDC 3i

1513900E



1462200N

Design Flow = 2000 cfs
Design Depth = 0 feet
Days of Inundation = 1*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 03/23/06 to 12/10/06.

Treatment Boundary

Mesohabitat Cross Sections

0 50 100
Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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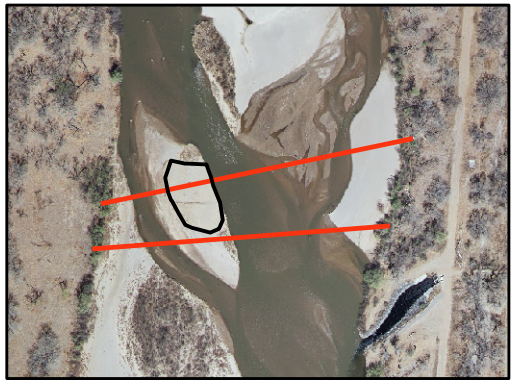
Comparison of As-Built (March 2006) and December 2006 Surveys

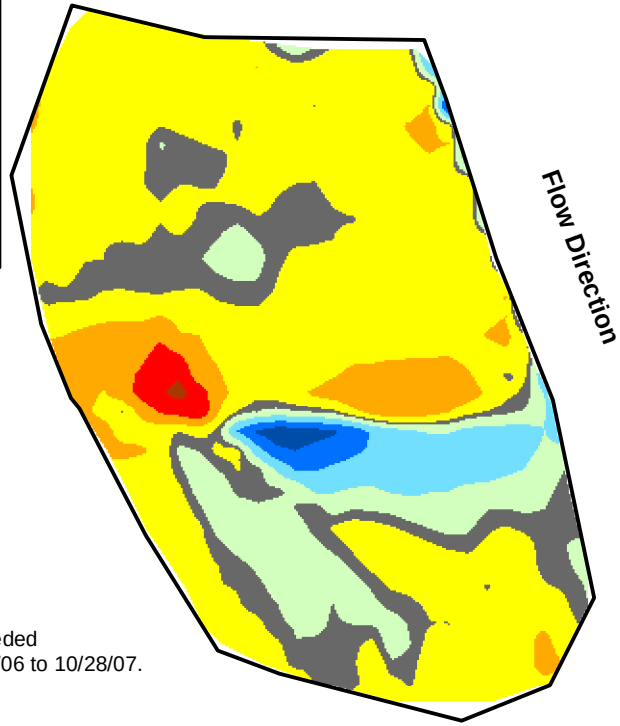
Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

SDC 3i

1513900E



1462200N

Design Flow = 2000 cfs
Design Depth = 0 feet
Days of Inundation = 41*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 12/14/06 to 10/28/07.

Treatment Boundary

Mesohabitat Cross Sections

0 50 100
Feet

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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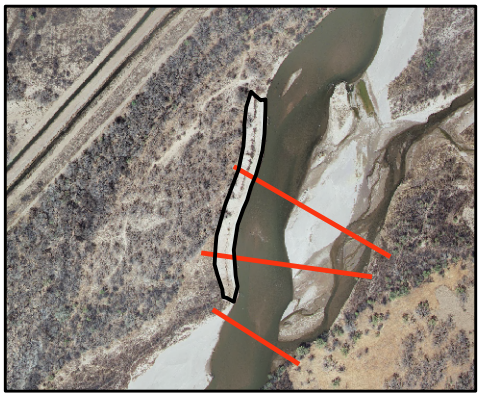
Comparison of December 2006 and November 2007 Surveys

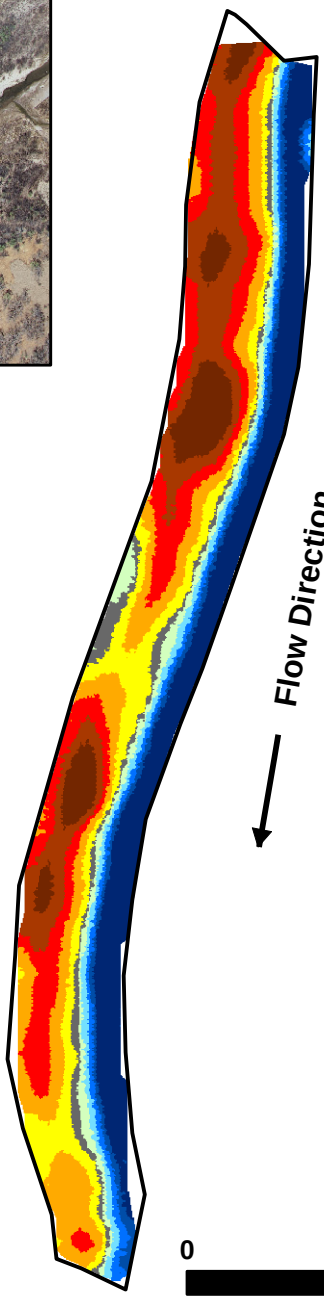
Date: 12/03/2007
MEI Project #07-28 Rio Grande Monitoring

SDC 1b



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 1500 cfs
Design Depth = 0 feet



Treatment Boundary
Mesohabitat Cross Sections

0 100 200
Feet

Change in Elevation (feet)

Fill
> 2
1.5 - 2
1 - 1.5
0.5 - 1
0.1 - 0.5

Cut
0
0.1 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
> 2

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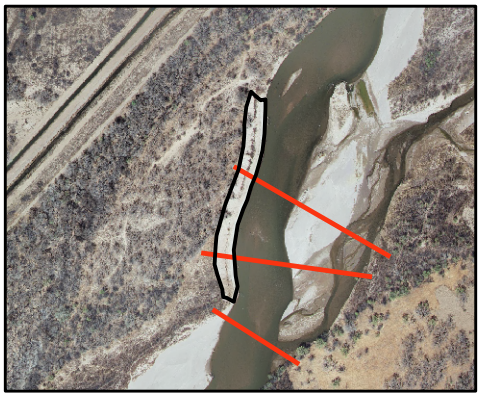
Comparison of Original Surface (September 2005) and As-Built (March 2006)

Date: 03/14/2007
MEI Project #06-22
Rio Grande Monitoring

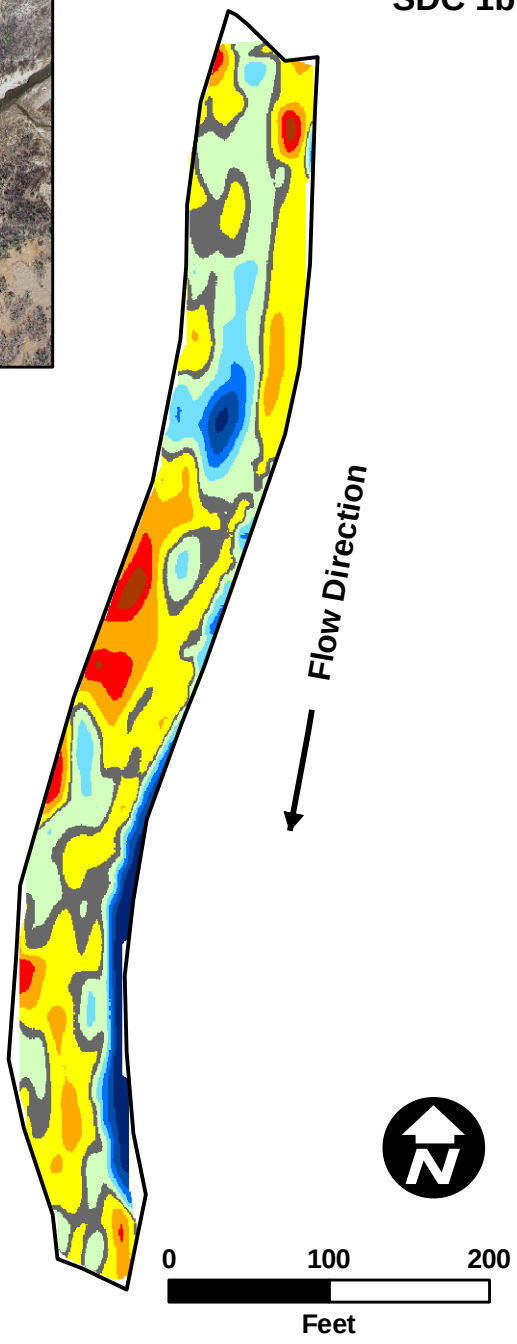
SDC 1b



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 1500 cfs
Design Depth = 0 feet
Days of Inundation = 7*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 03/01/06 to 12/10/06.



Treatment Boundary

Mesohabitat Cross Sections

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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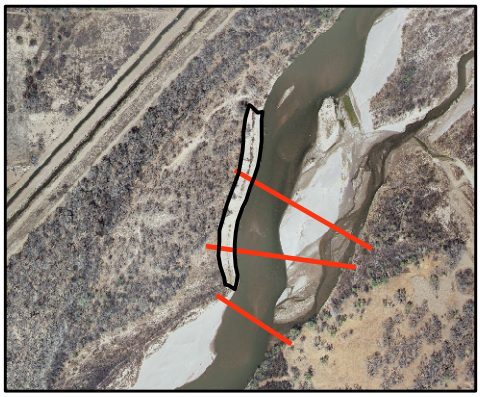
Comparison of As-Built (March 2006) and December 2006 Surveys

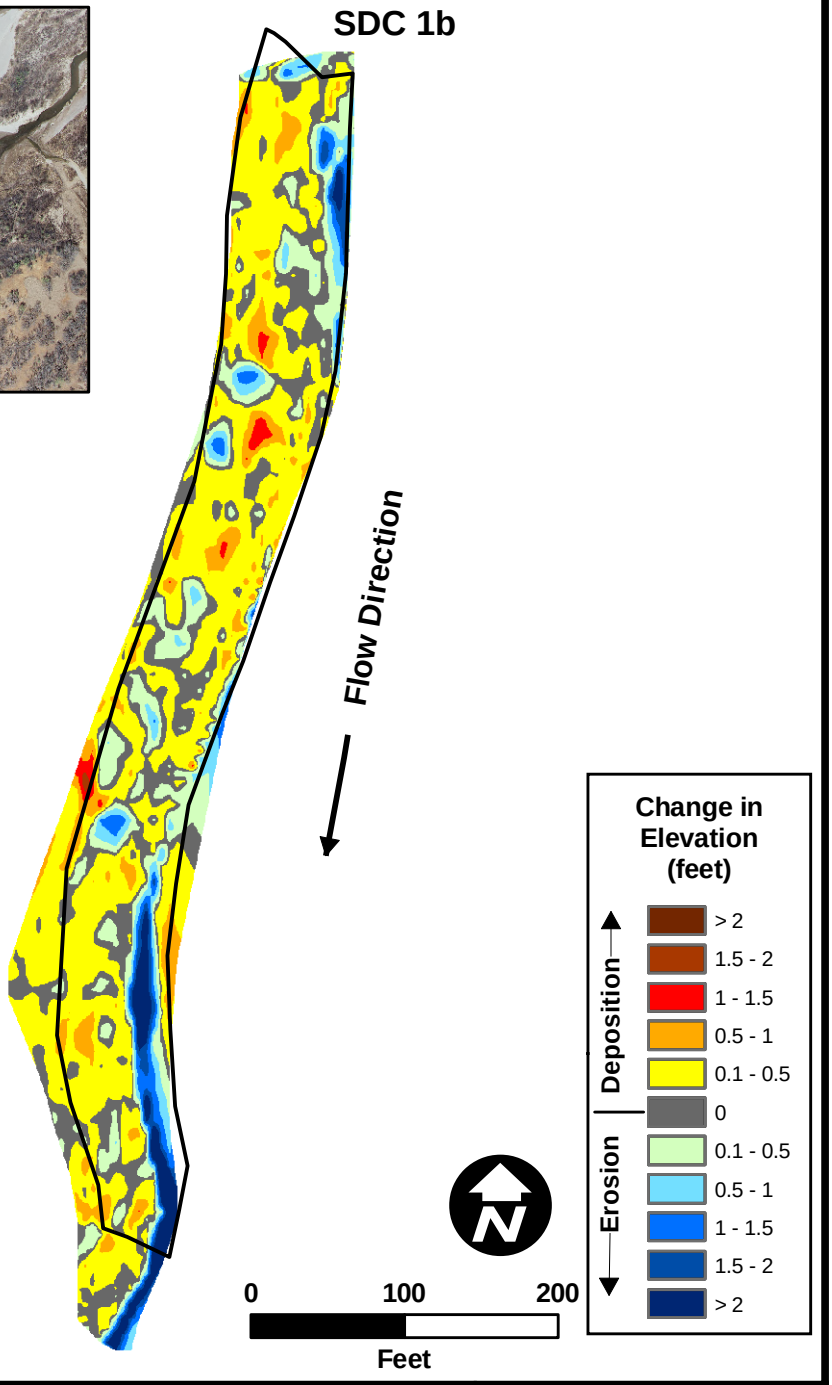
Date: 03/14/2007
MEI Project #06-22
Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Design Flow = 1500 cfs
Design Depth = 0 feet
Days of Inundation = 62*

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 12/14/06 to 10/28/07.



Treatment Boundary
Mesohabitat Cross Sections

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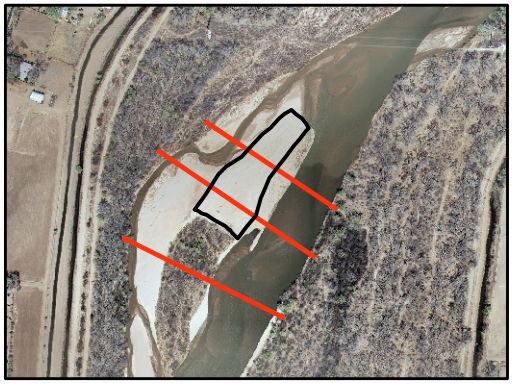
Comparison of December 2006 and November 2007 Surveys

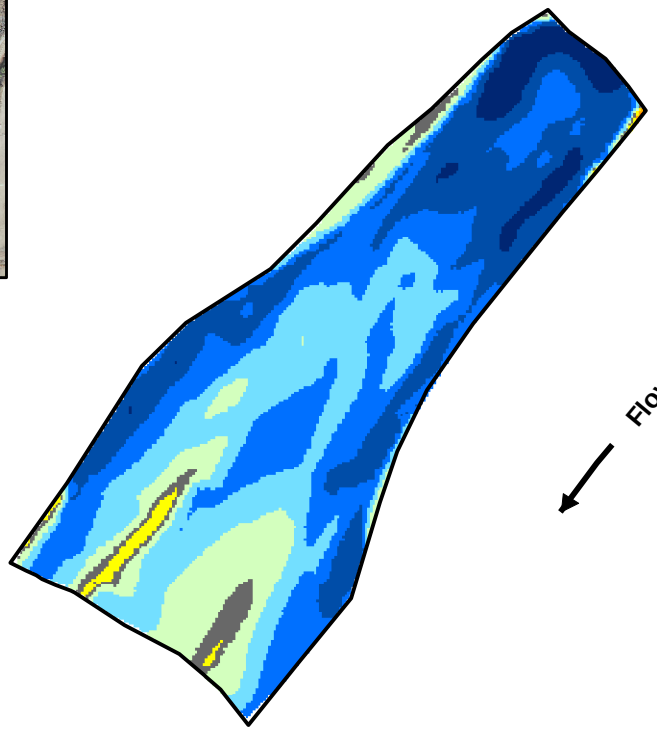
Date: 12/03/2007
MEI Project #07-28
Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

SDC 4i

1510000E



1456500N

Design Flow = 1500, 2500, and 3500 cfs
Design Depth = 0 feet

0 150 300
Feet

Change in Elevation (feet)

Fill
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Cut
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

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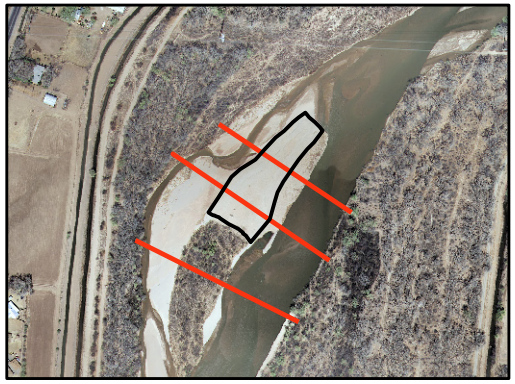
Comparison of Original Surface (July 2005) and As-Built (March 2006) Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring



Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

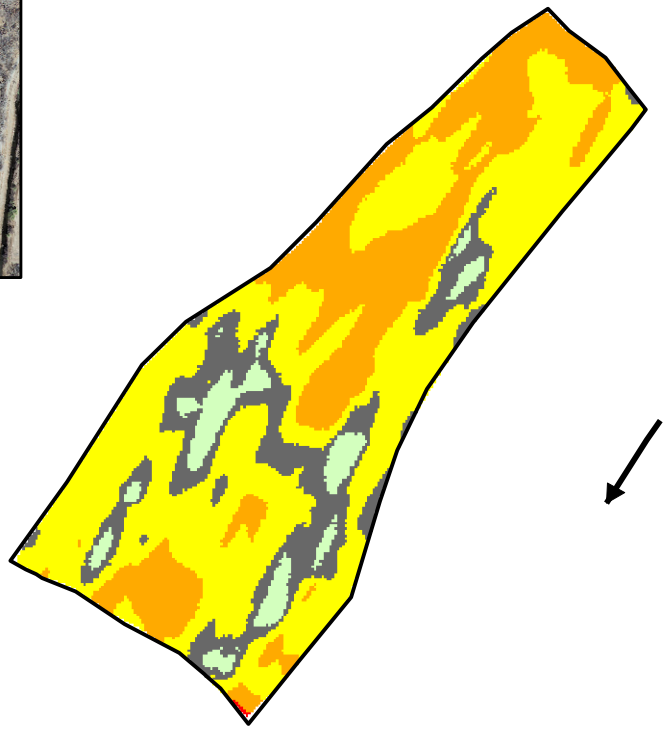
Treatment Boundary

Mesohabitat Cross Sections

1466500N

SDC 4i

1510000E



Flow Direction

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Design Flow = 1500, 2500, and 3500 cfs
Design Depth = 0 feet
Days of Inundation = 7 (1500 cfs), 0 (2500 cfs), 0 (3500 cfs)

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 03/23/06 to 12/10/06.

0 150 300
Feet

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Comparison of As-Built (March 2006) and December 2006 Surveys

Date: 03/14/2007
MEI Project #06-22 Rio Grande Monitoring

SDC 4i

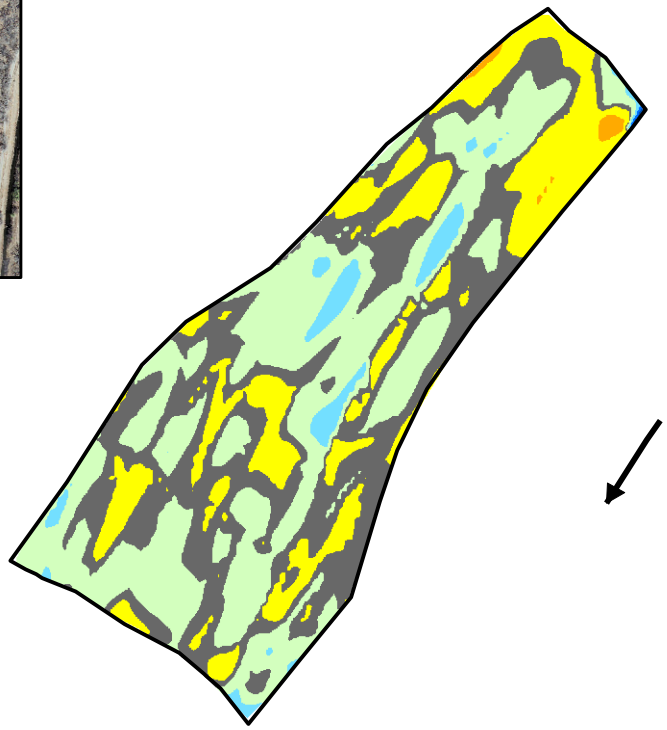
Aerial photo date: 04/07/2006
Flow approx. = 421 cfs

Treatment Boundary

Mesohabitat Cross Sections

1466500N

1510000E



Flow Direction

Change in Elevation (feet)

Deposition
- > 2
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0.1 - 0.5

0

Erosion
- 0.1 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Design Flow = 1500, 2500, and 3500 cfs
Design Depth = 0 feet
Days of Inundation = 62 (1500 cfs), 20 (2500 cfs), 3 (3500 cfs)

*Number of days the design flow was equaled or exceeded based on mean daily flow between survey dates 12/14/06 to 10/28/07.

0 150 300

Feet

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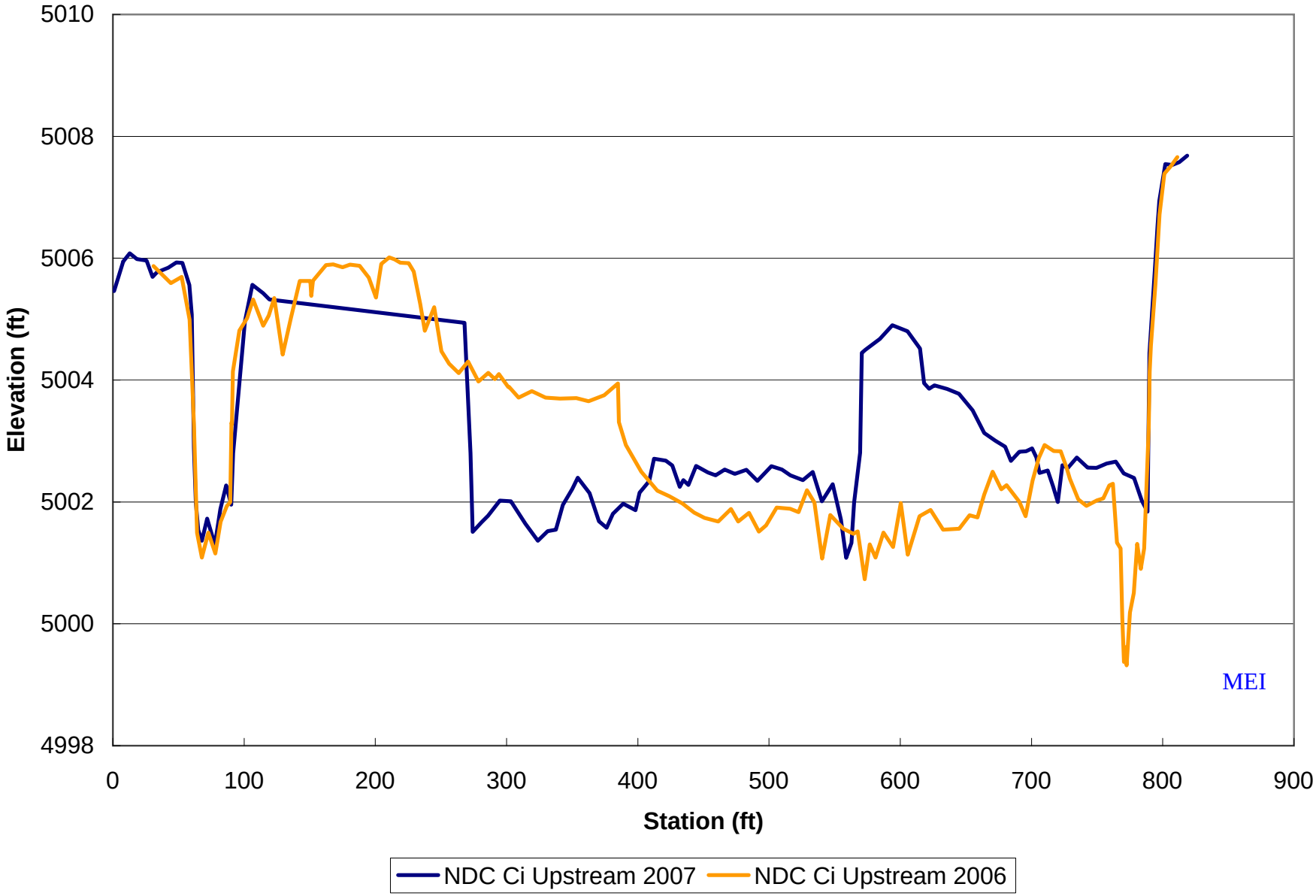
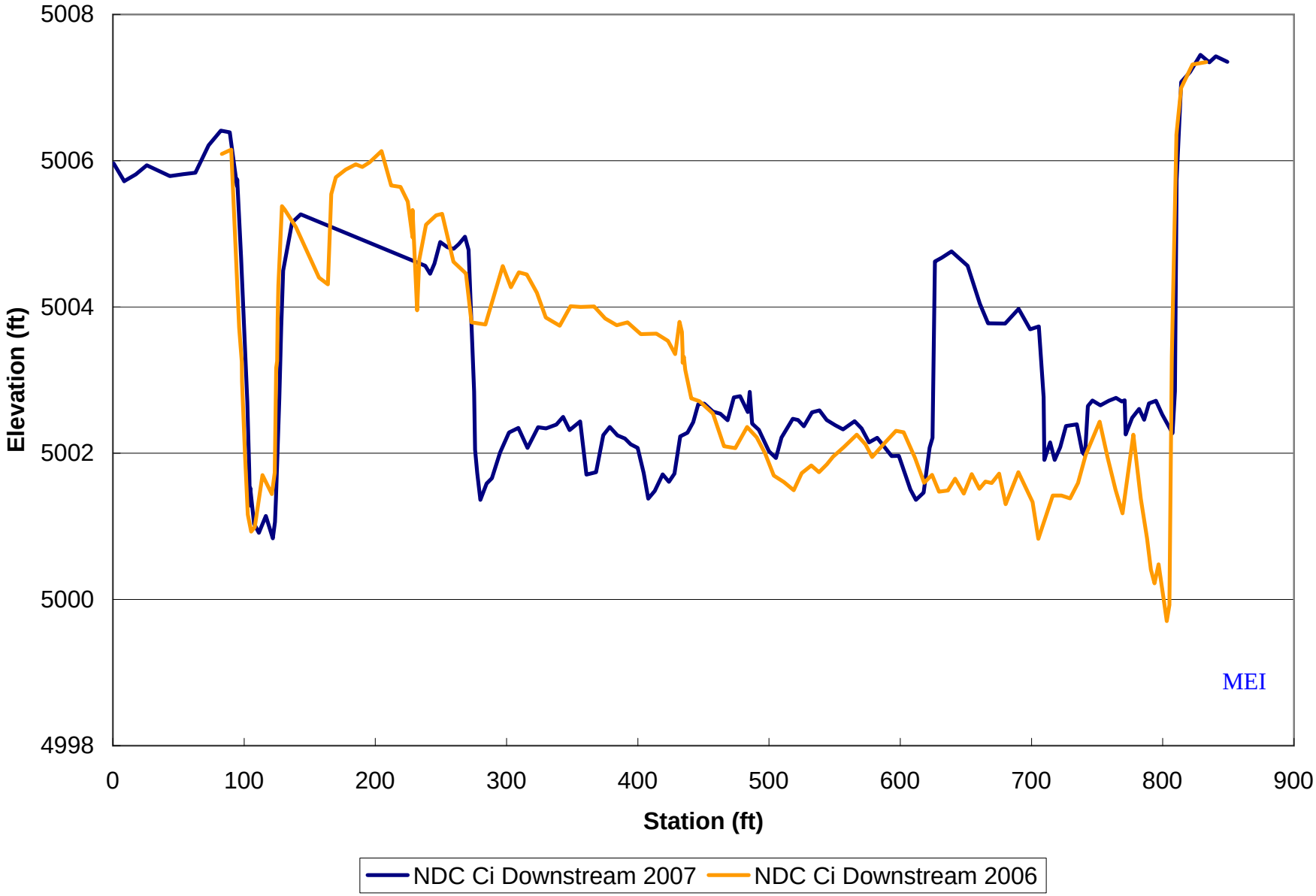
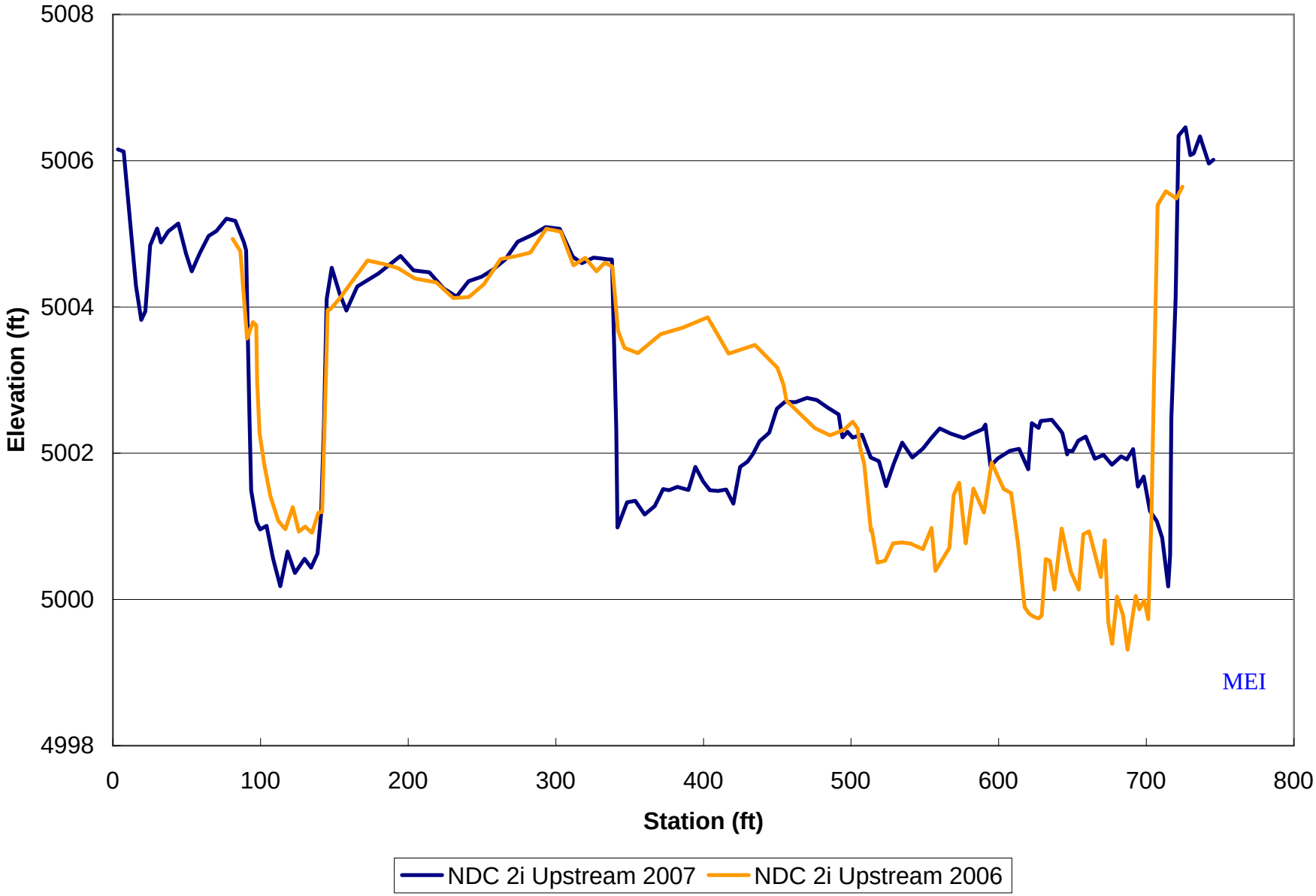
Comparison of December 2006 and November 2007 Surveys

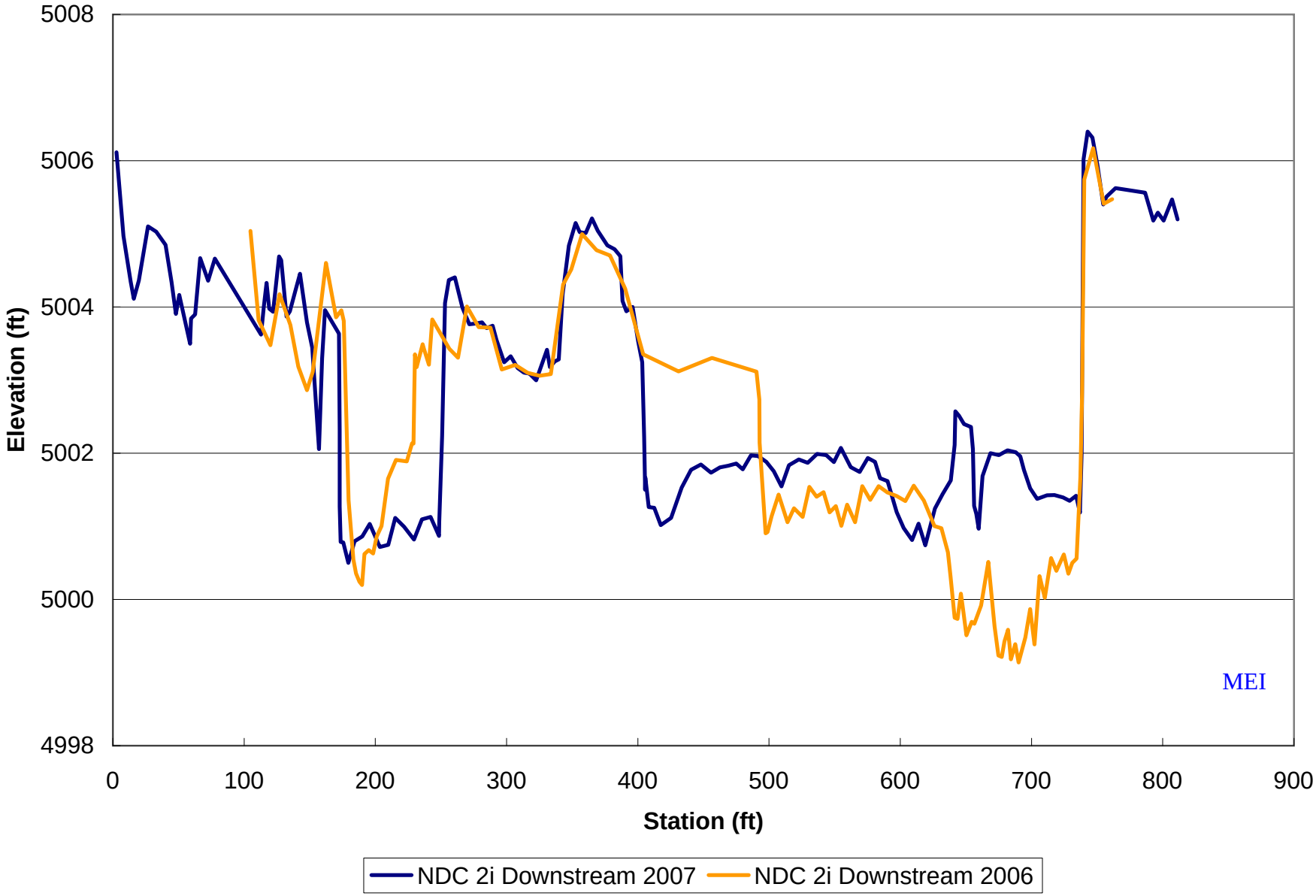
Date: 12/03/2007
MEI Project #07-28 Rio Grande Monitoring

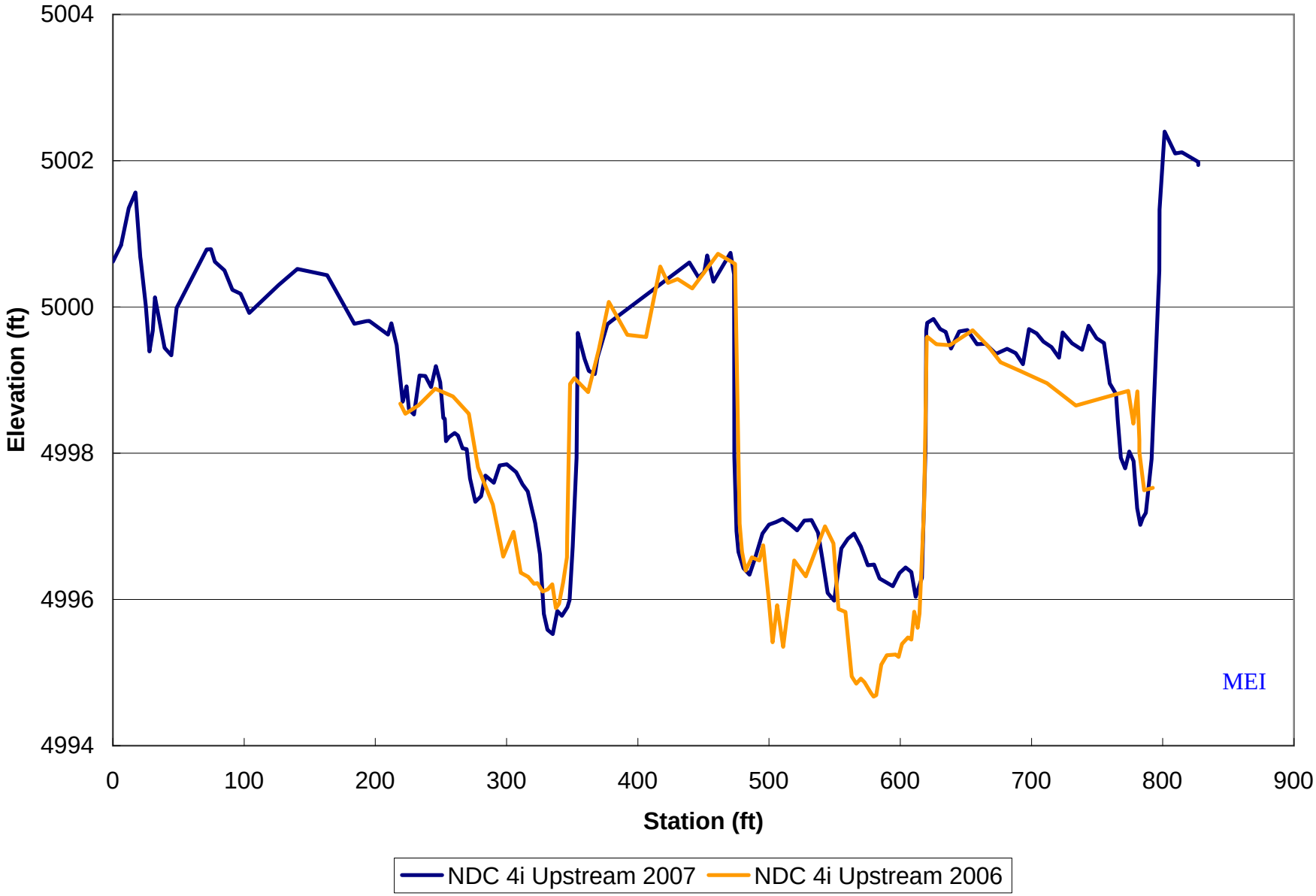
APPENDIX E
MESOHABITAT XS DATA AND PLOT COMPARISON

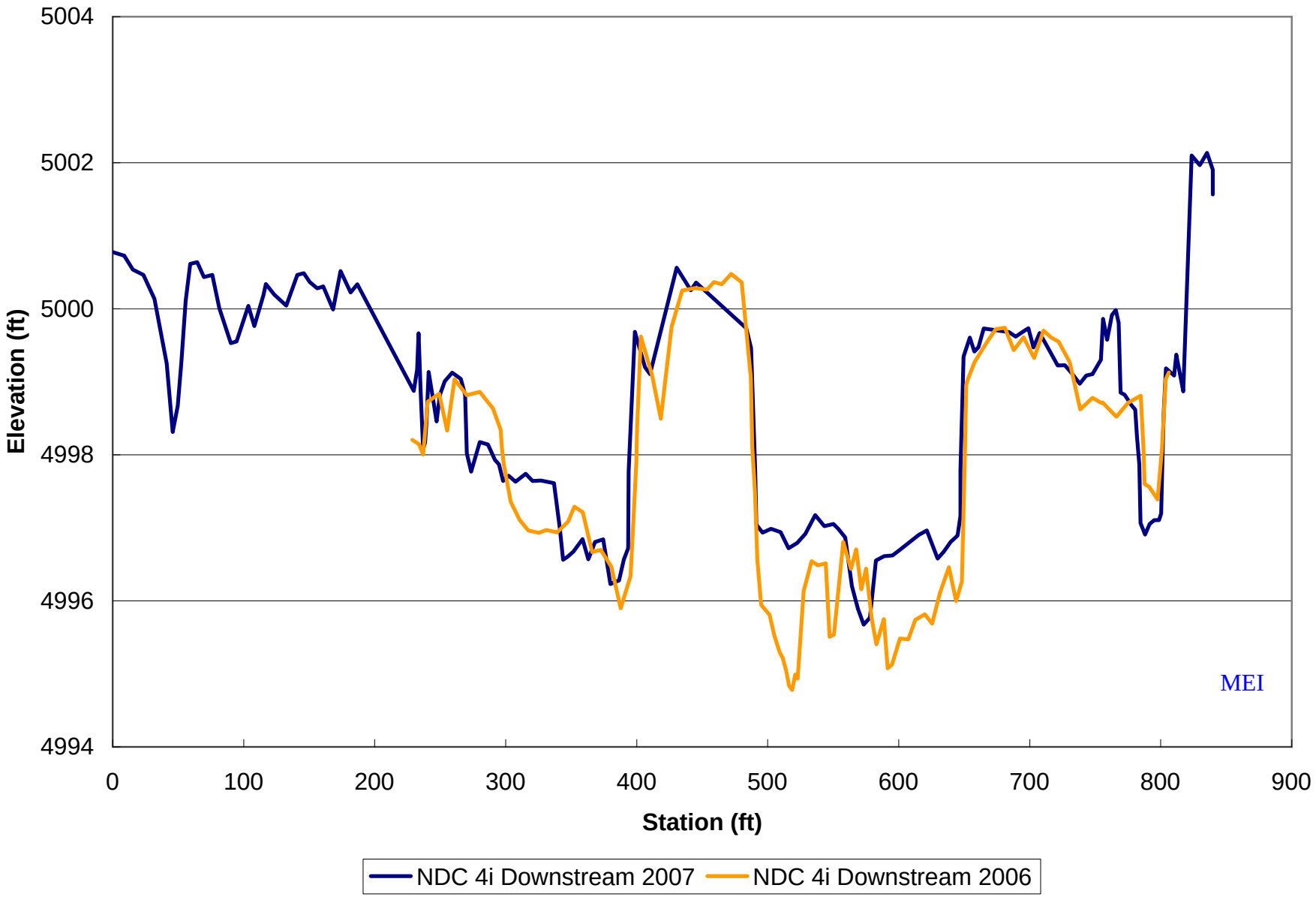

5010
5008
5006
5004
5002
5000
4998
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
NDC Ci Upstream 2007
NDC Ci Upstream 2006

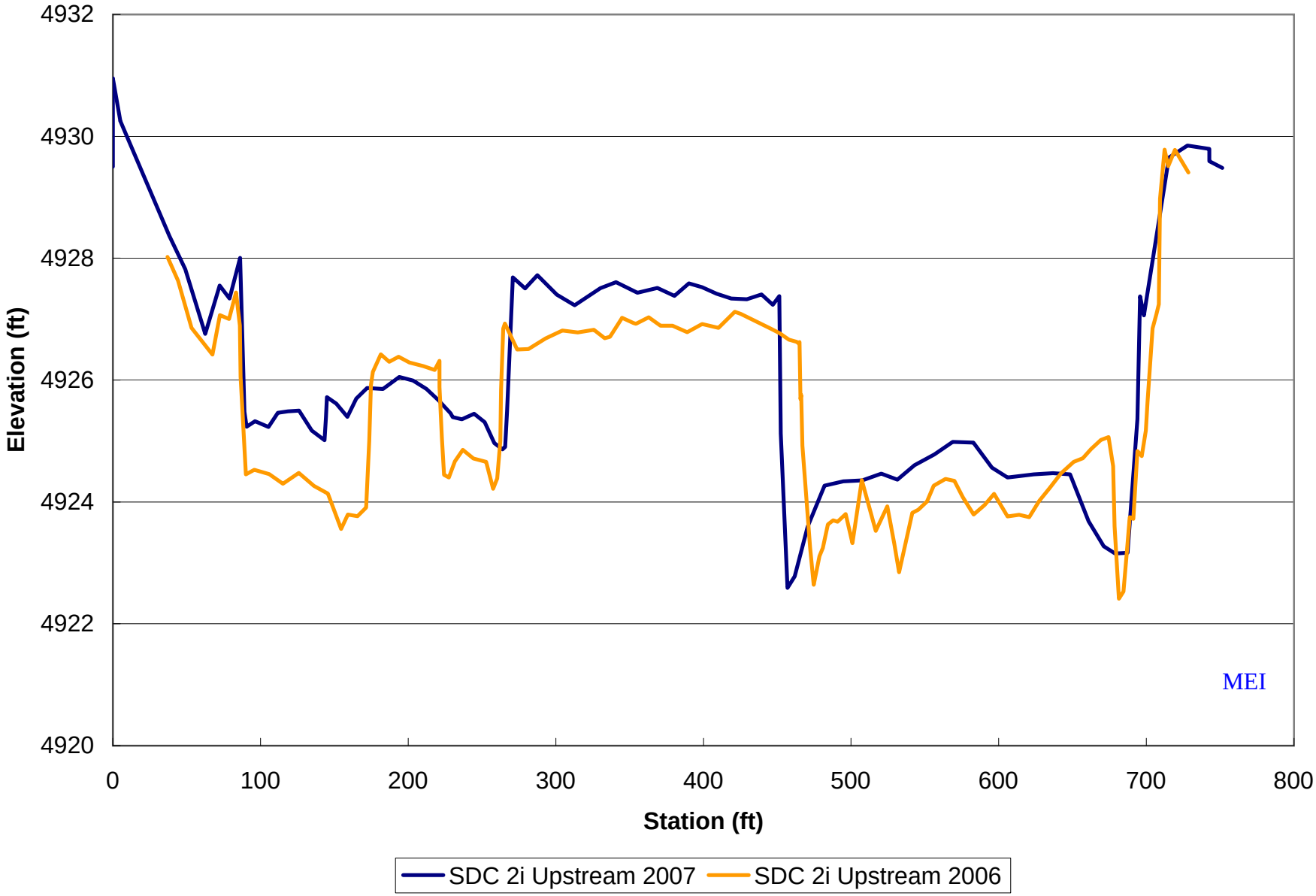

5008
5006
5004
5002
5000
4998
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
NDC Ci Downstream 2007
NDC Ci Downstream 2006

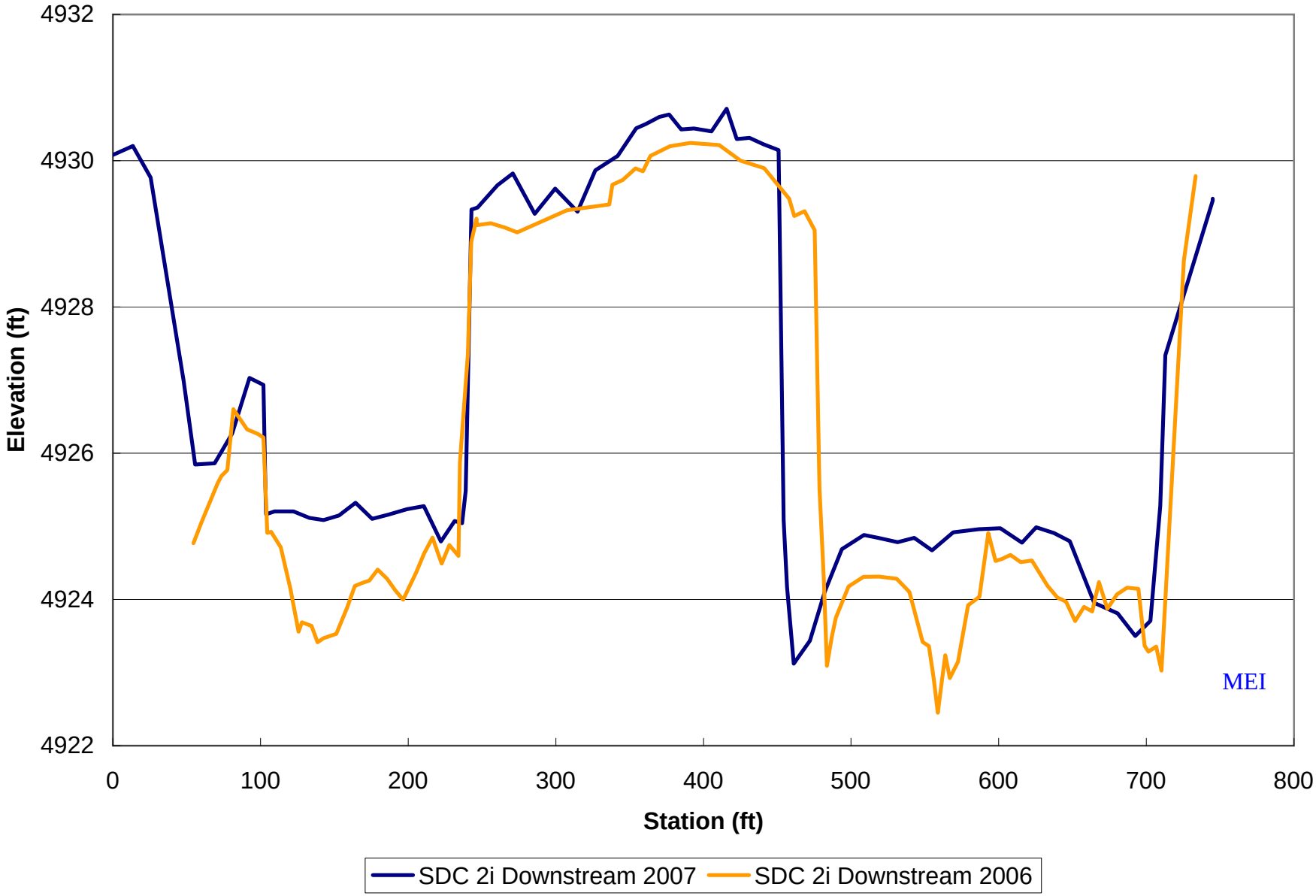

5008
5006
5004
5002
5000
4998
Elevation (ft)
0
100
200
300
400
500
600
700
800
Station (ft)
MEI
NDC 2i Upstream 2007
NDC 2i Upstream 2006

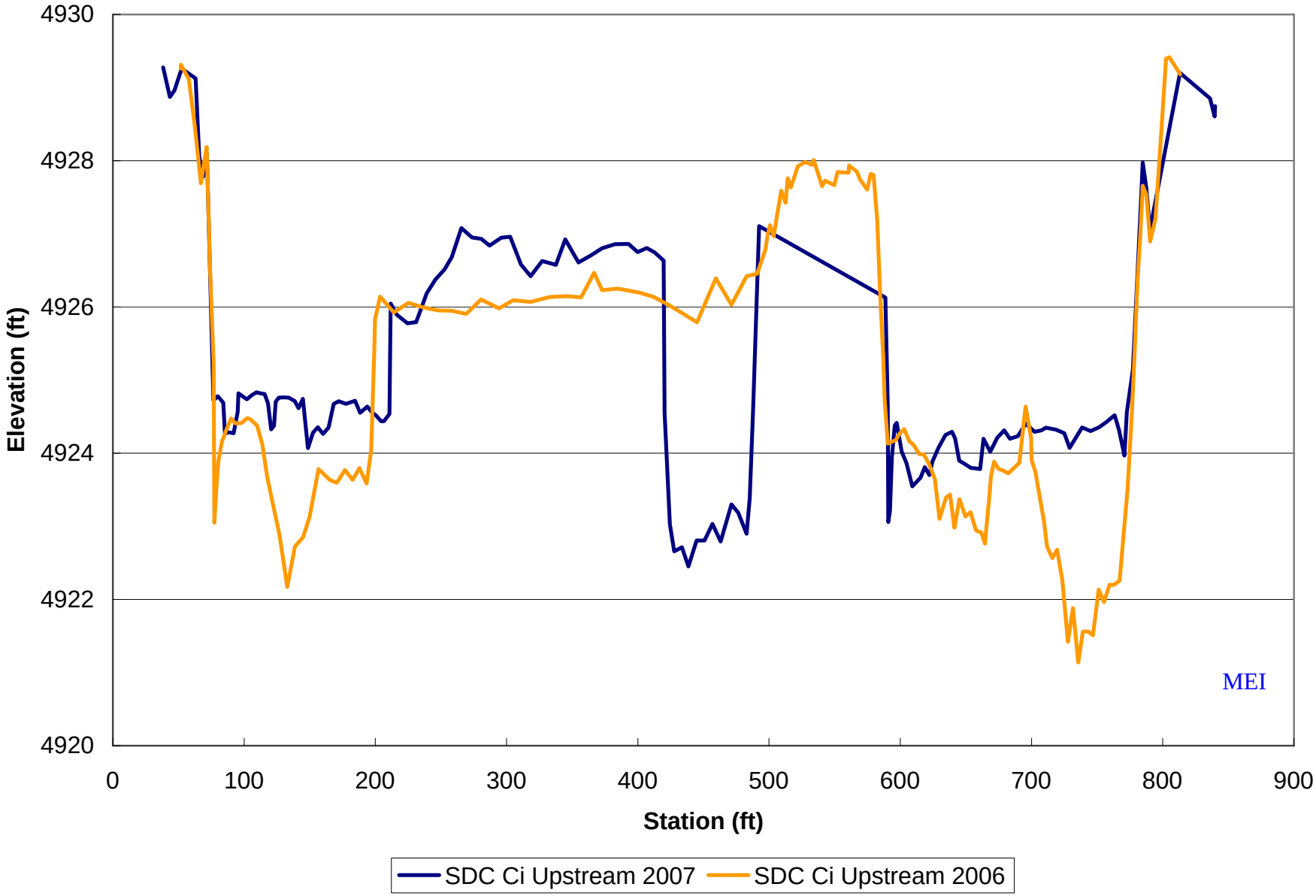

5008
5006
5004
5002
5000
4998
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
NDC 2i Downstream 2007
NDC 2i Downstream 2006

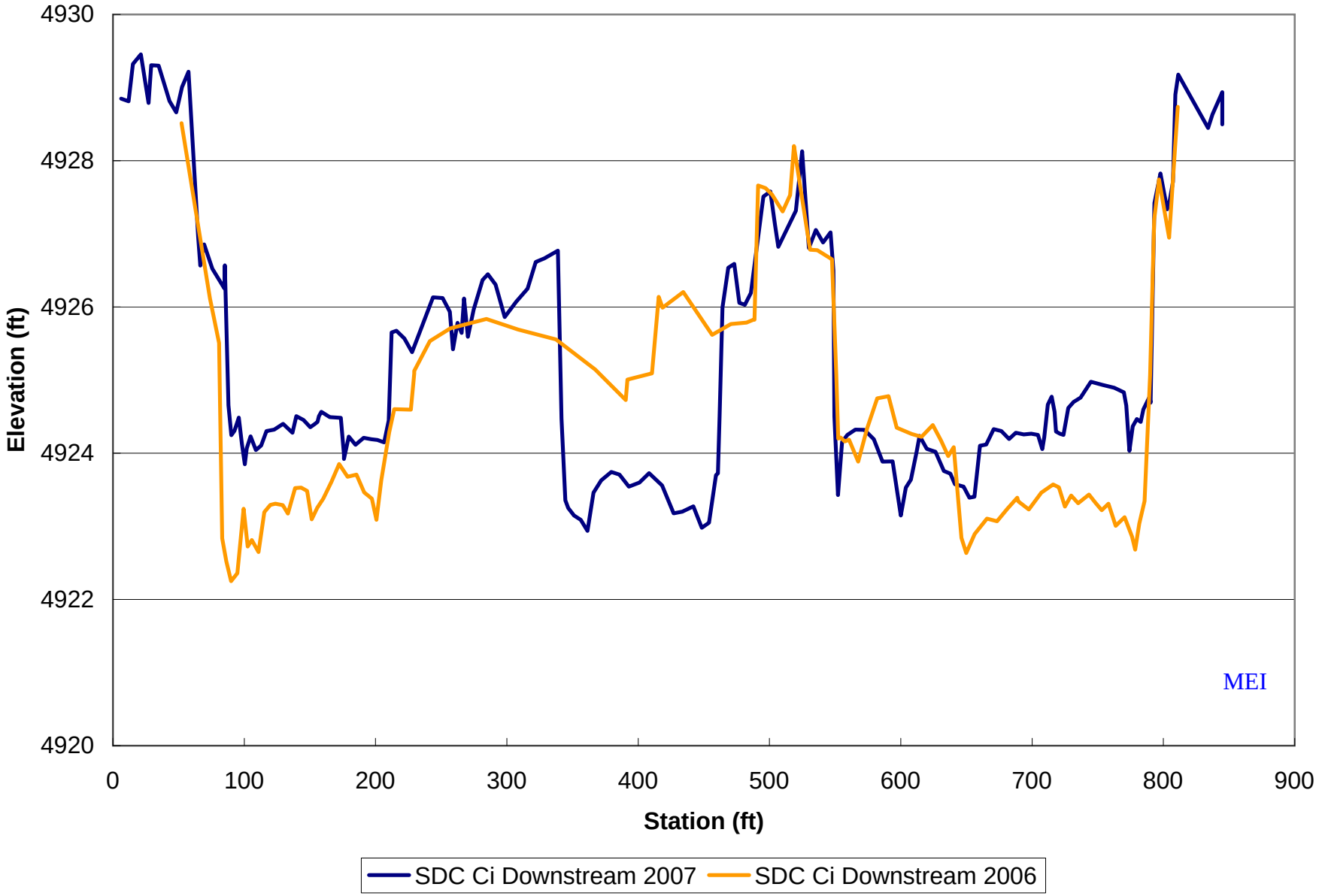

5004
5002
5000
4998
4996
4994
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
NDC 4i Upstream 2007
NDC 4i Upstream 2006

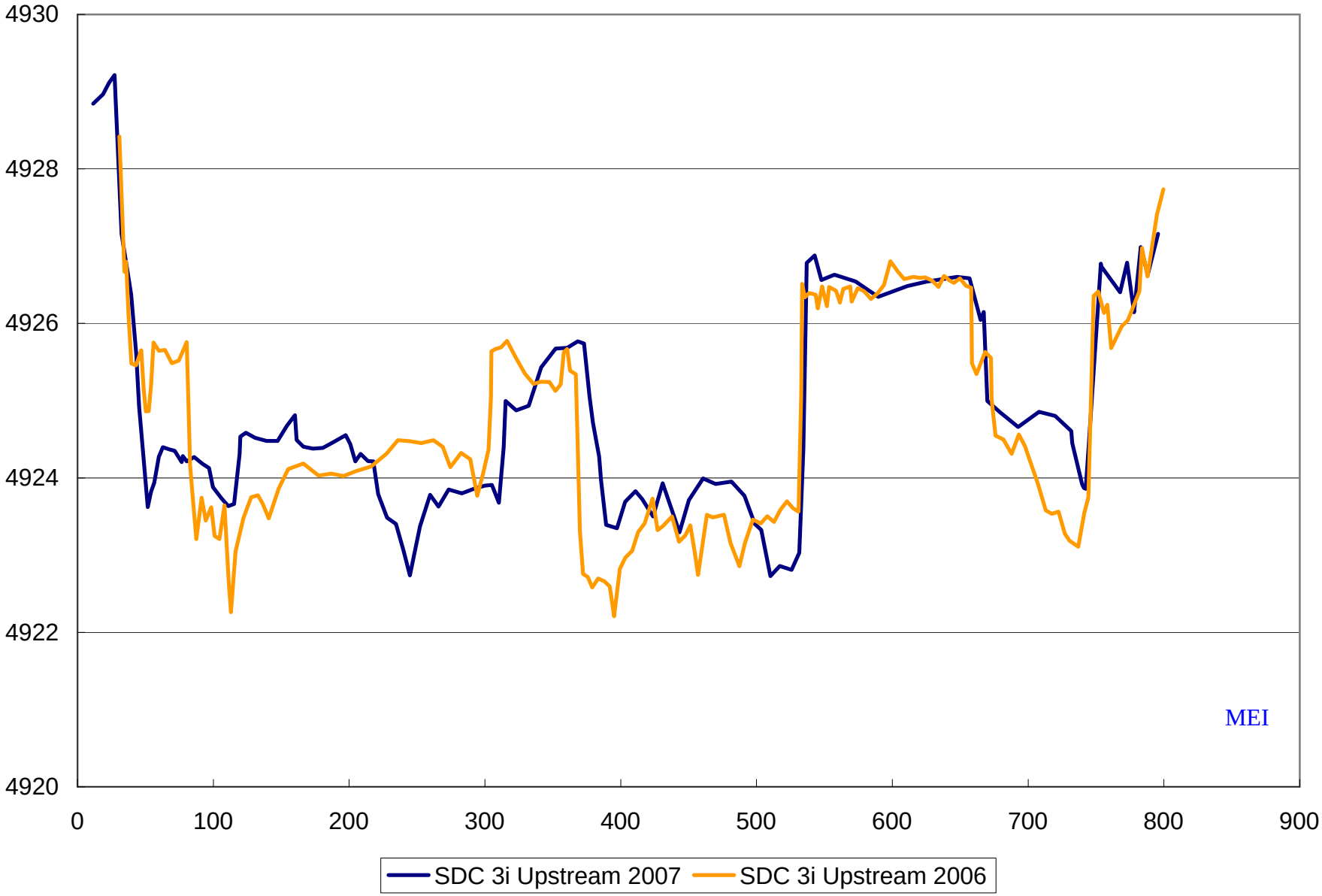

5004
5002
5000
4998
4996
4994
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
NDC 4i Downstream 2007
NDC 4i Downstream 2006


4932
4930
4928
4926
4924
4922
4920
Elevation (ft)
0
100
200
300
400
500
600
700
800
Station (ft)
MEI
SDC 2i Upstream 2007
SDC 2i Upstream 2006


4932
4930
4928
4926
4924
4922
Elevation (ft)
0
100
200
300
400
500
600
700
800
Station (ft)
MEI
SDC 2i Downstream 2007
SDC 2i Downstream 2006


4930
4928
4926
4924
4922
4920
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
SDC Ci Upstream 2007
SDC Ci Upstream 2006


4930
4928
4926
4924
4922
4920
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
SDC Ci Downstream 2007
SDC Ci Downstream 2006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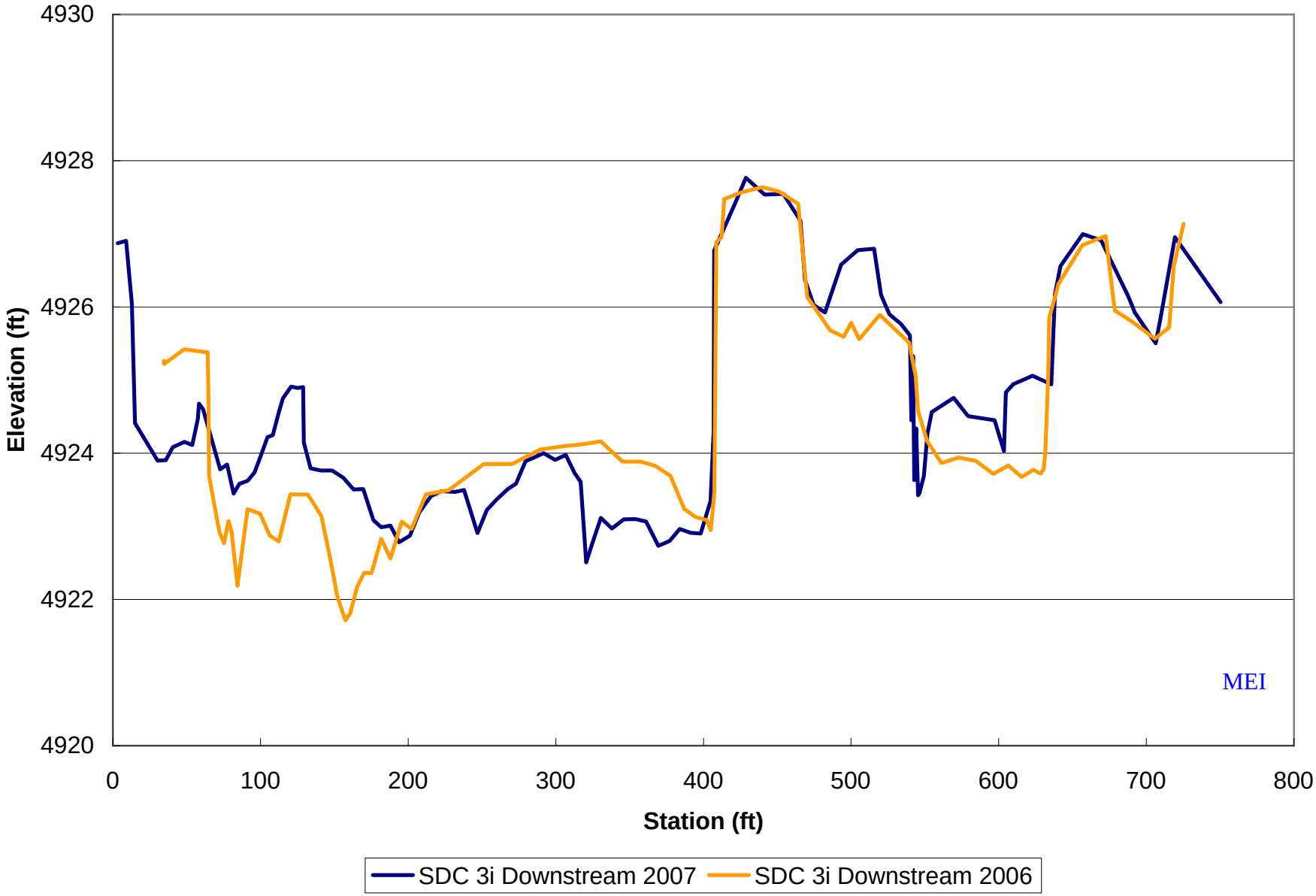
4928
4926
4924
4922
4920
0
100
200
300
400
500
600
700
800
900
MEI
SDC 3i Upstream 2007
SDC 3i Upstream 2006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4928
4926
4924
4922
4920
Elevation (ft)
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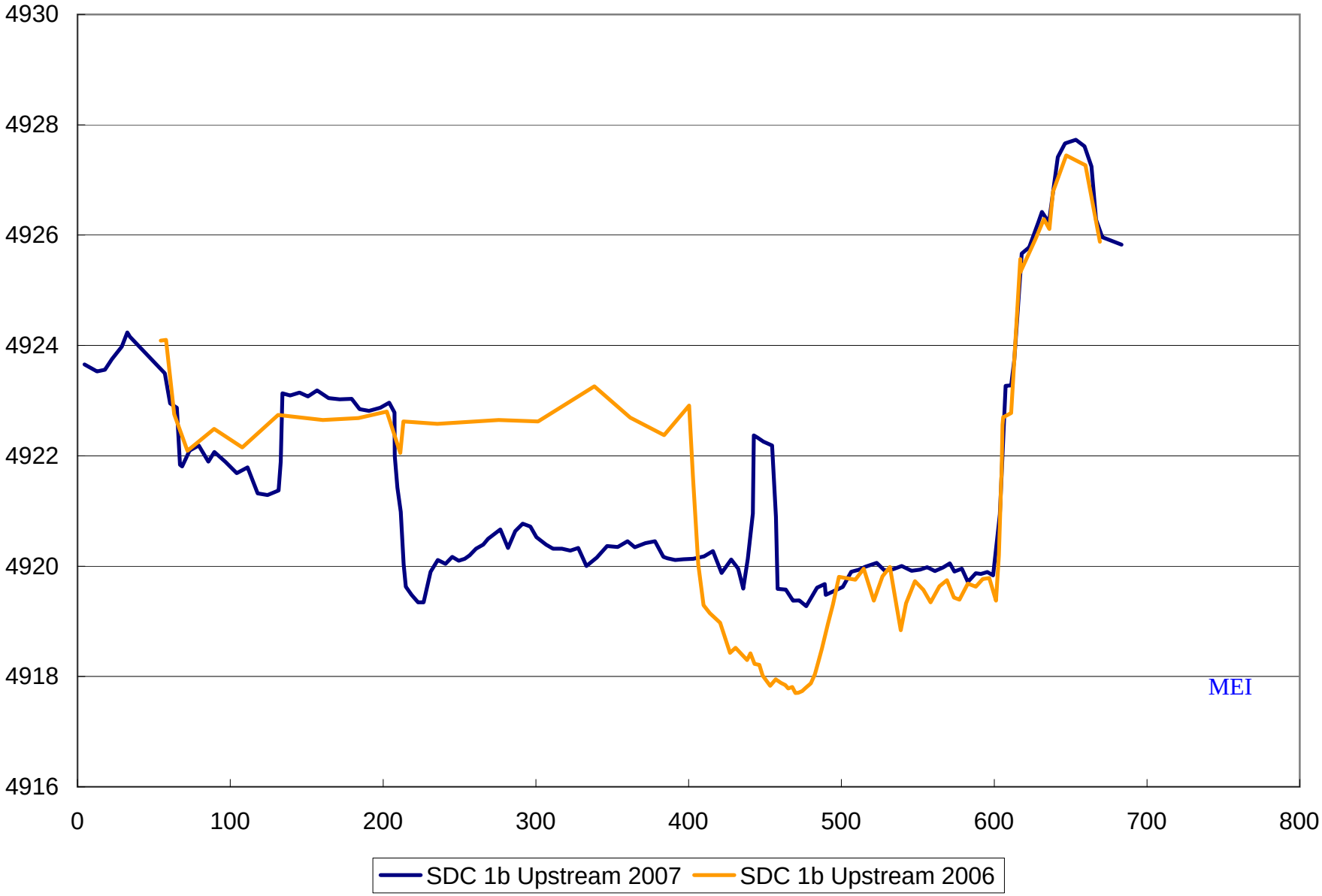
200
300
400
500
600
700
800
Station (ft)
MEI
SDC 3i Downstream 2007
SDC 3i Downstream 2006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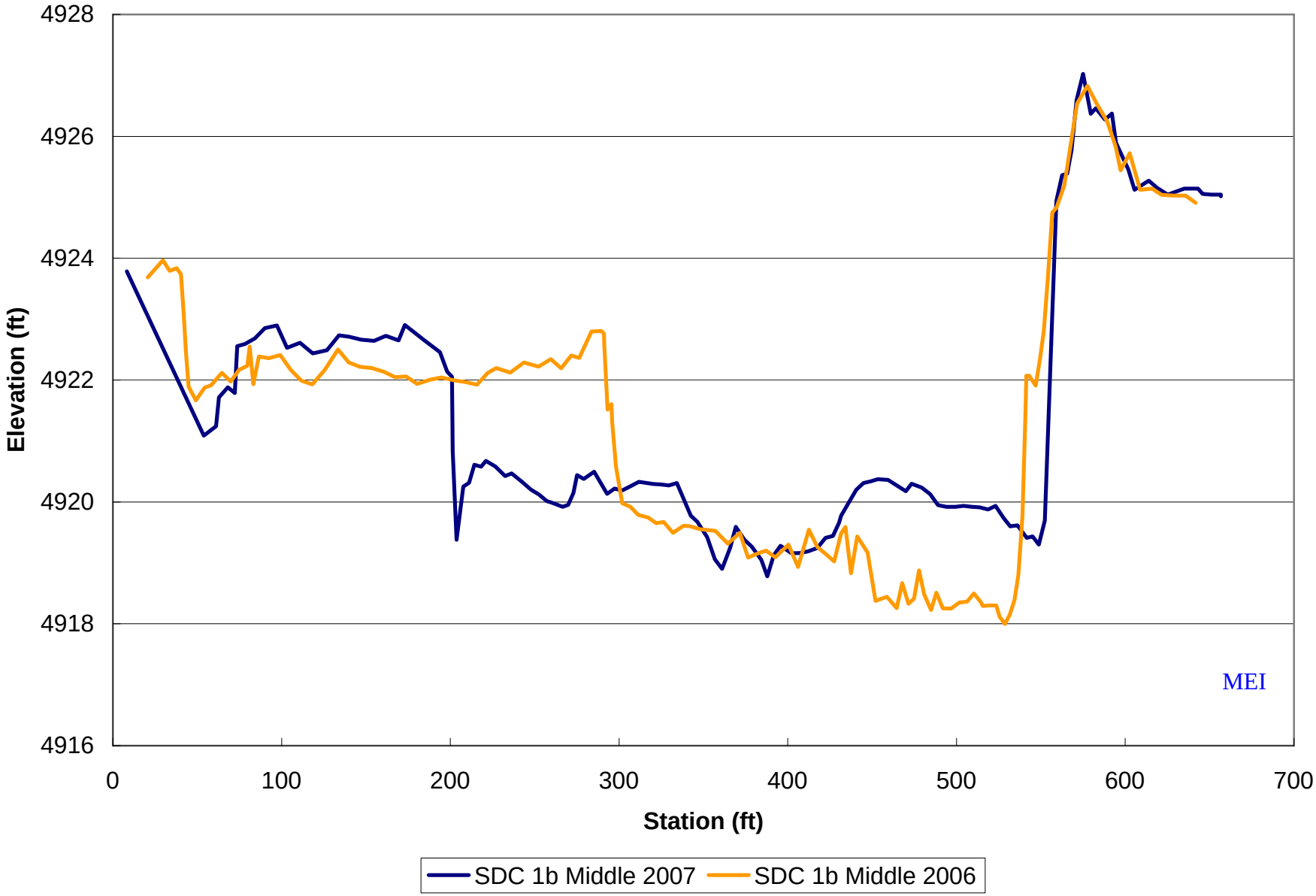
600
700
800
MEI
SDC 1b Upstream 2007
SDC 1b Upstream 2006


4928
4926
4924
4922
4920
4918
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Elevation (ft)
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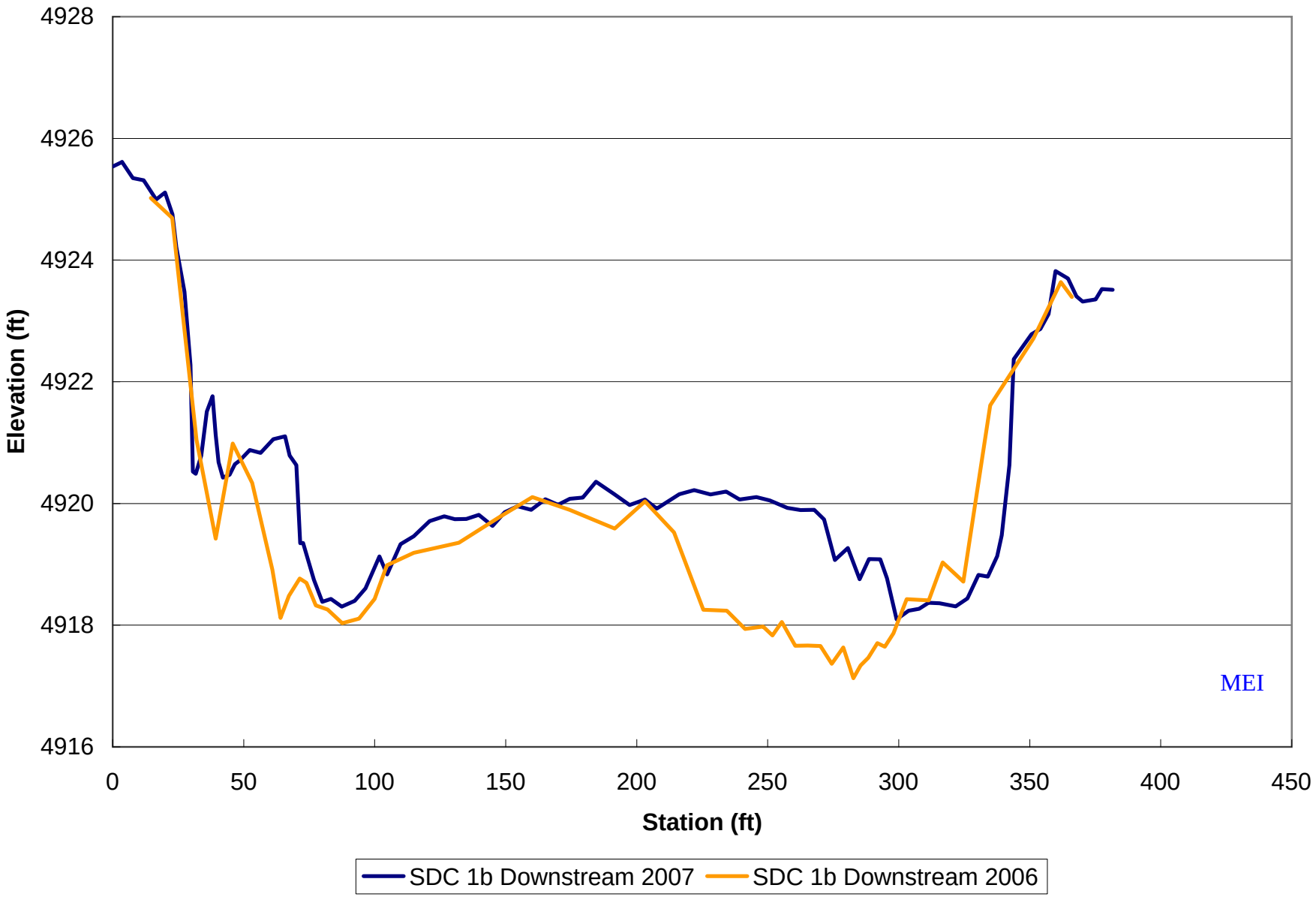
100
200
300
400
500
600
700
Station (ft)
MEI
SDC 1b Middle 2007
SDC 1b Middle 2006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4916
Elevation (ft)
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50
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150
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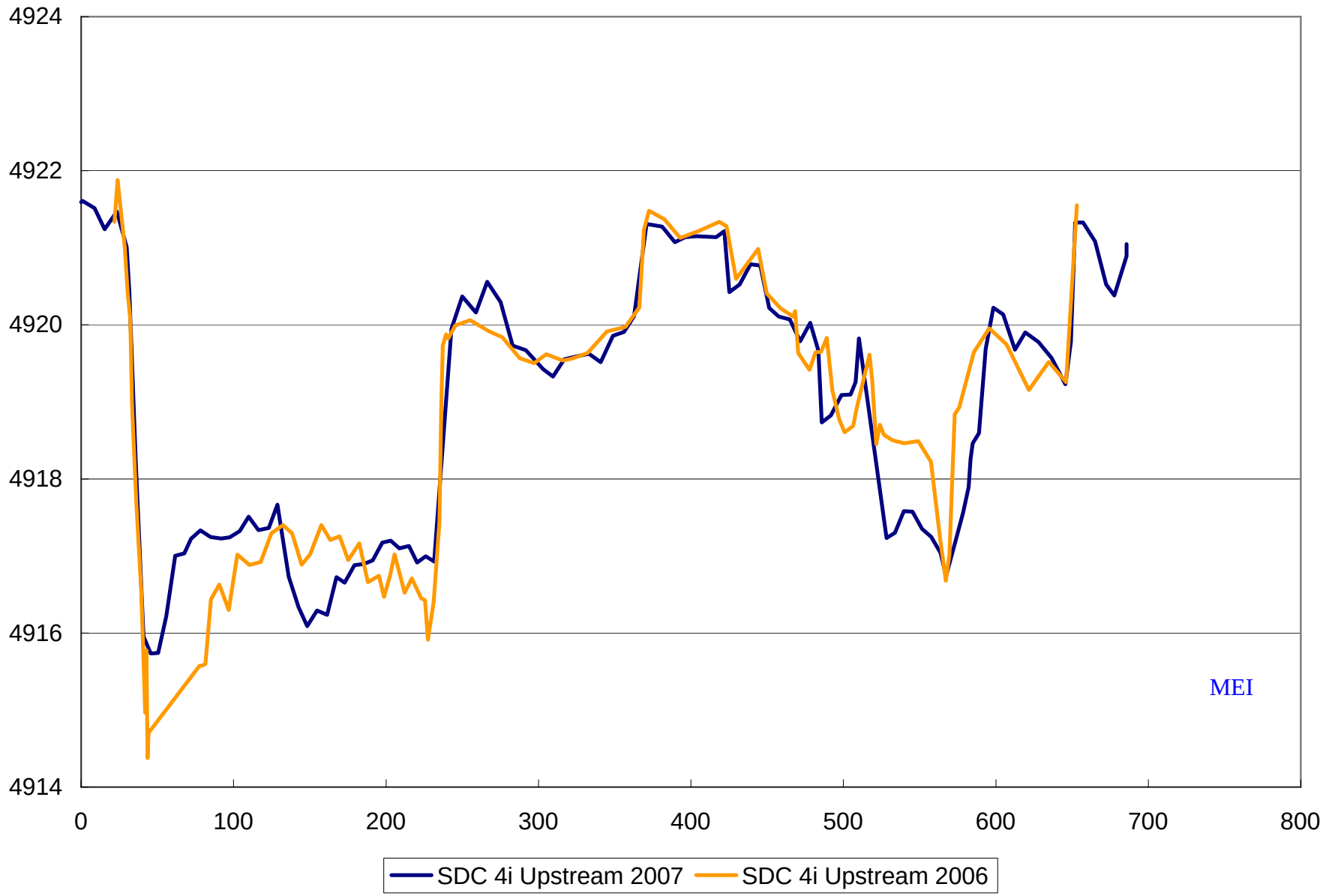
450
Station (ft)
MEI
SDC 1b Downstream 2007
SDC 1b Downstream 2006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4920
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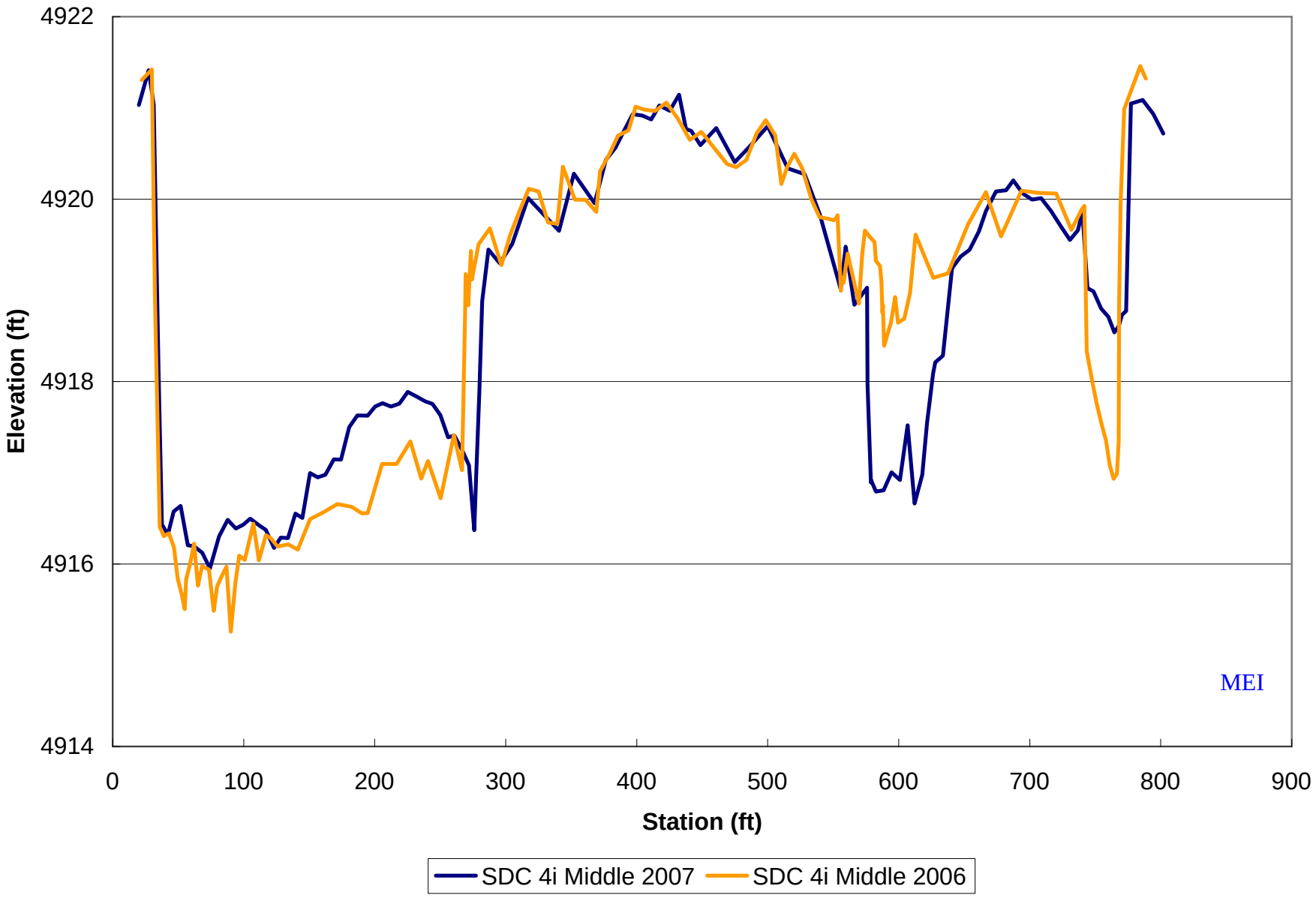
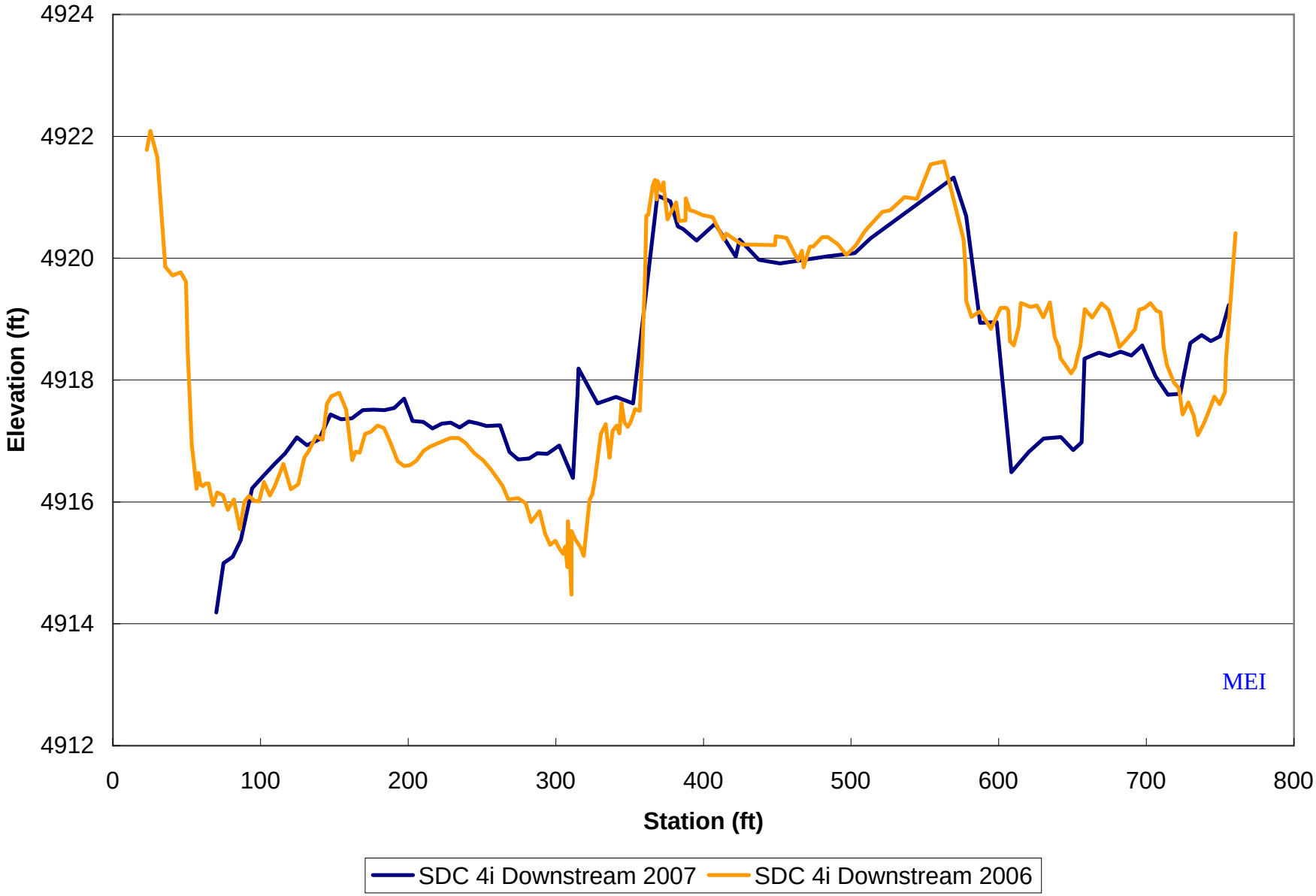
4914
0
100
200
300
400
500
600
700
800
MEI
SDC 4i Upstream 2007
SDC 4i Upstream 2006


4922
4920
4918
4916
4914
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
Station (ft)
MEI
SDC 4i Middle 2007
SDC 4i Middle 2006


4924
4922
4920
4918
4916
4914
4912
Elevation (ft)
0
100
200
300
400
500
600
700
800
Station (ft)
MEI
SDC 4i Downstream 2007
SDC 4i Downstream 2006

APPENDIX F
2007 WETLAND DELINEATION MAPS

Figure F.1. NDC 1b and NDC 1ch wetlands.

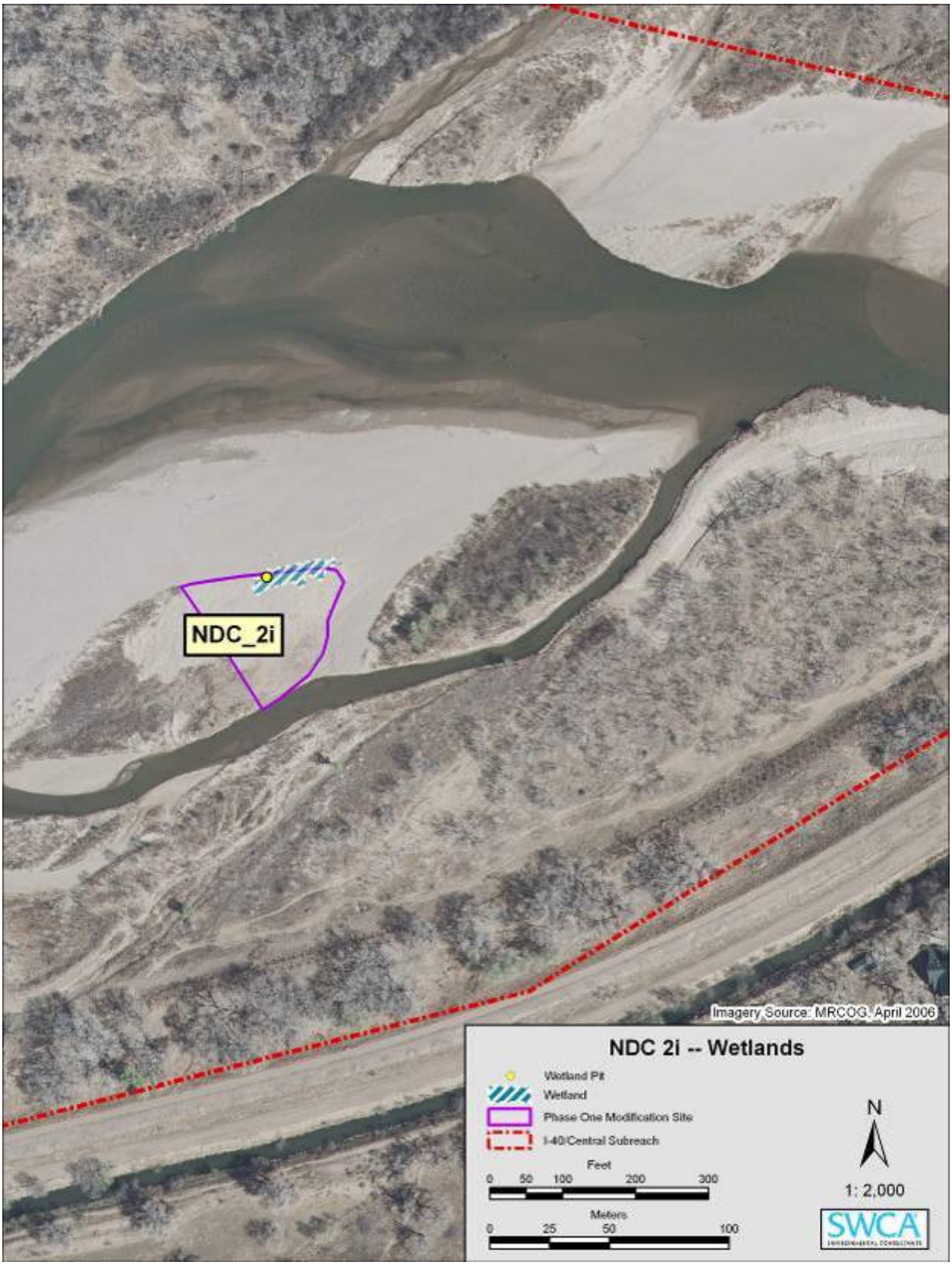


Figure F.2. NDC 2i wetlands.

Figure F.3. NDC 3i wetlands.

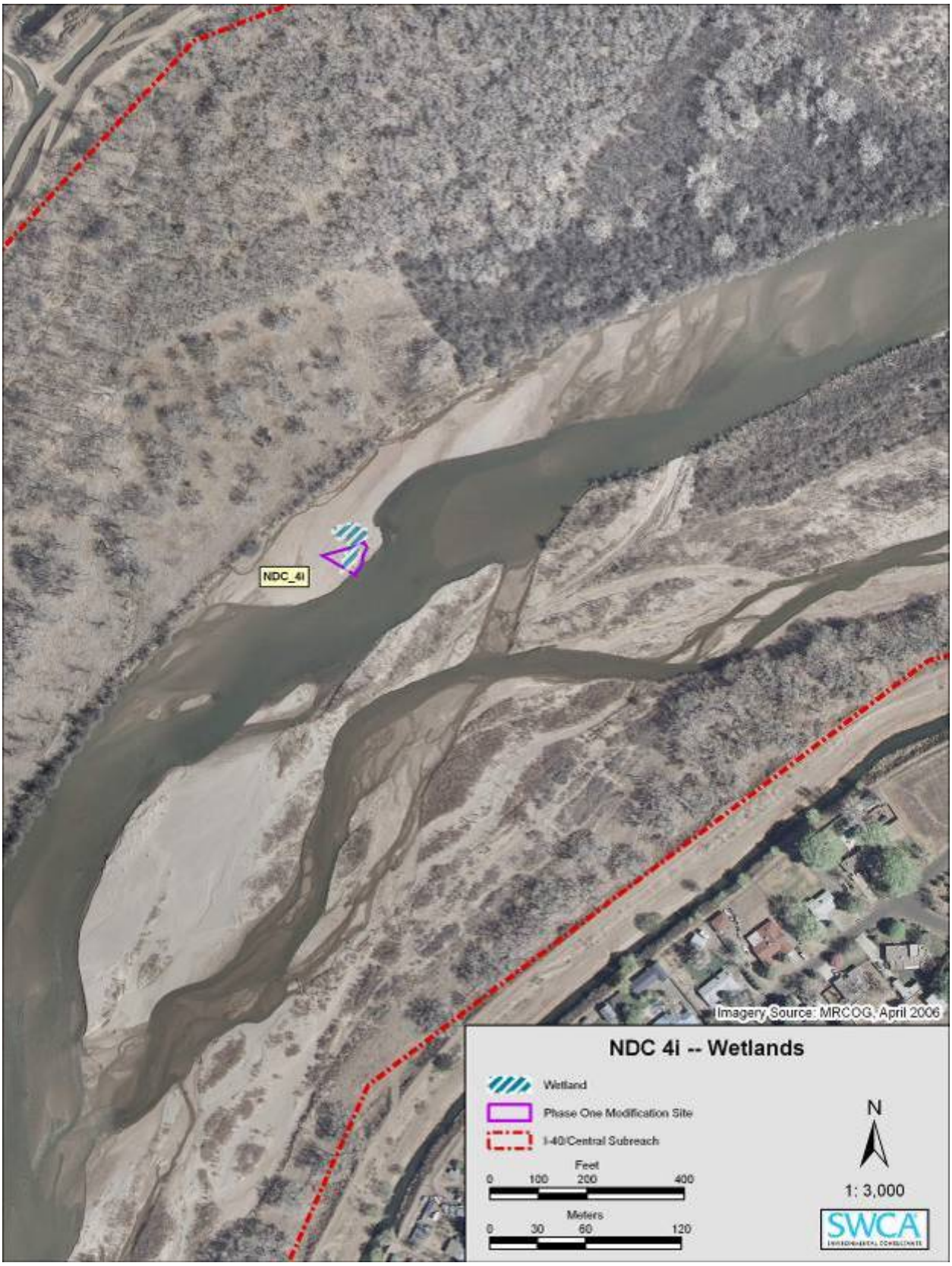


Figure F.4. NDC 4i wetlands.

Figure F.5. NDC 2ch and 3ch wetlands.

Figure F.6. NDC 5i wetlands.

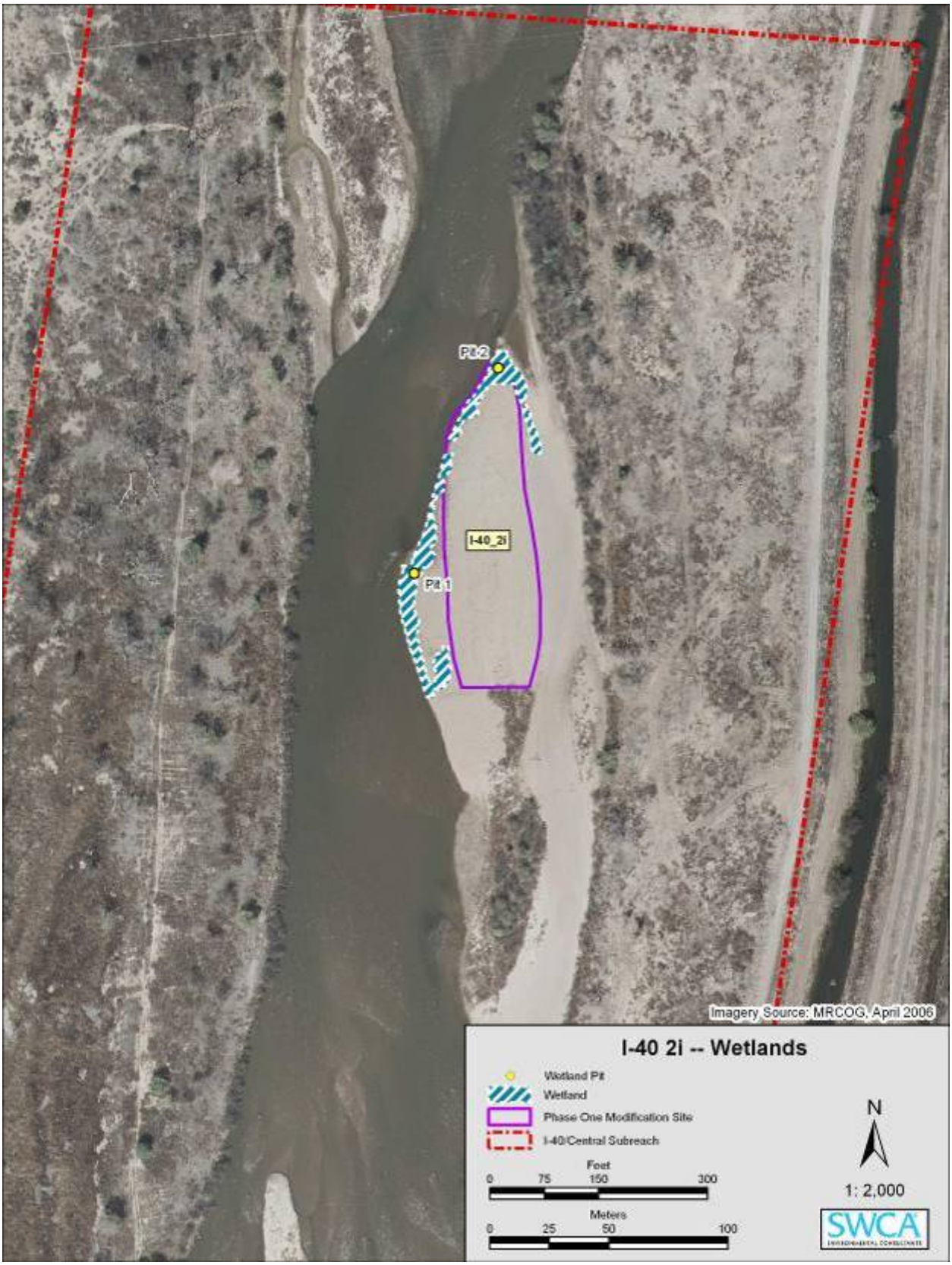


Figure F.7. I-40 2i wetlands.

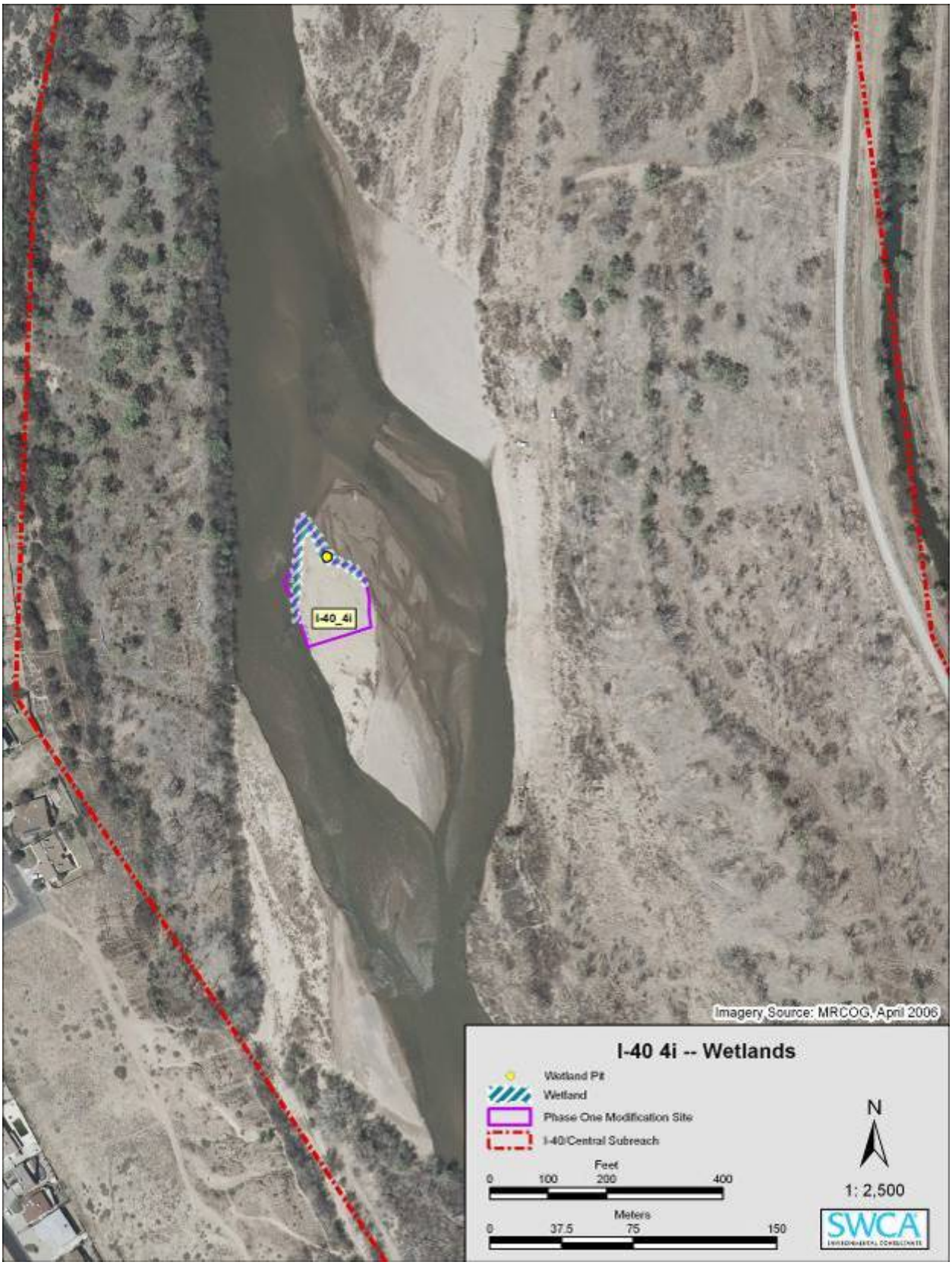


Figure F.8. I-40 4i wetlands.

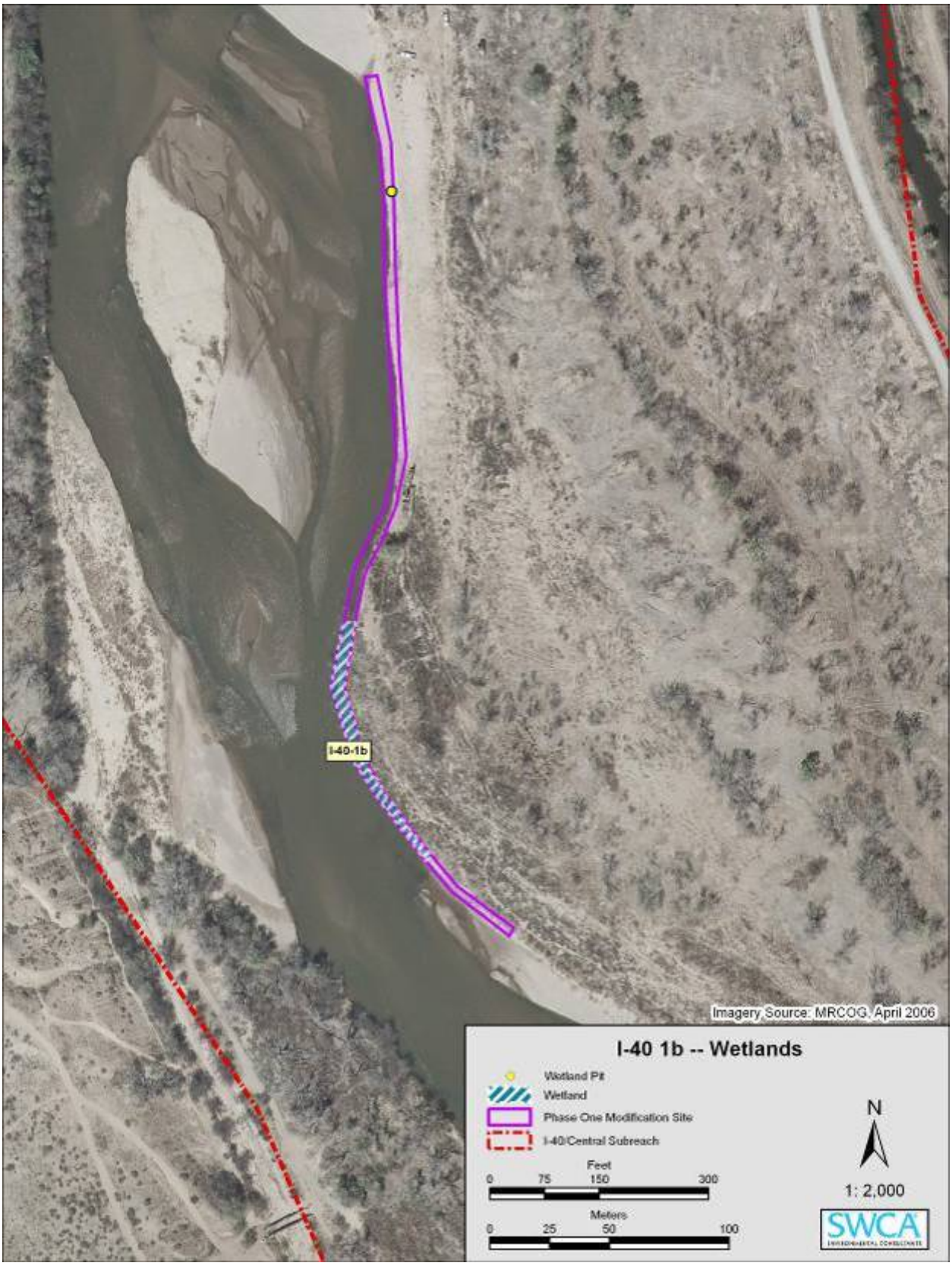


Figure F.9. I-40 1b wetlands.

Figure F.10. I-40 1ch wetlands.

Figure F.11. I-40 3b wetlands.

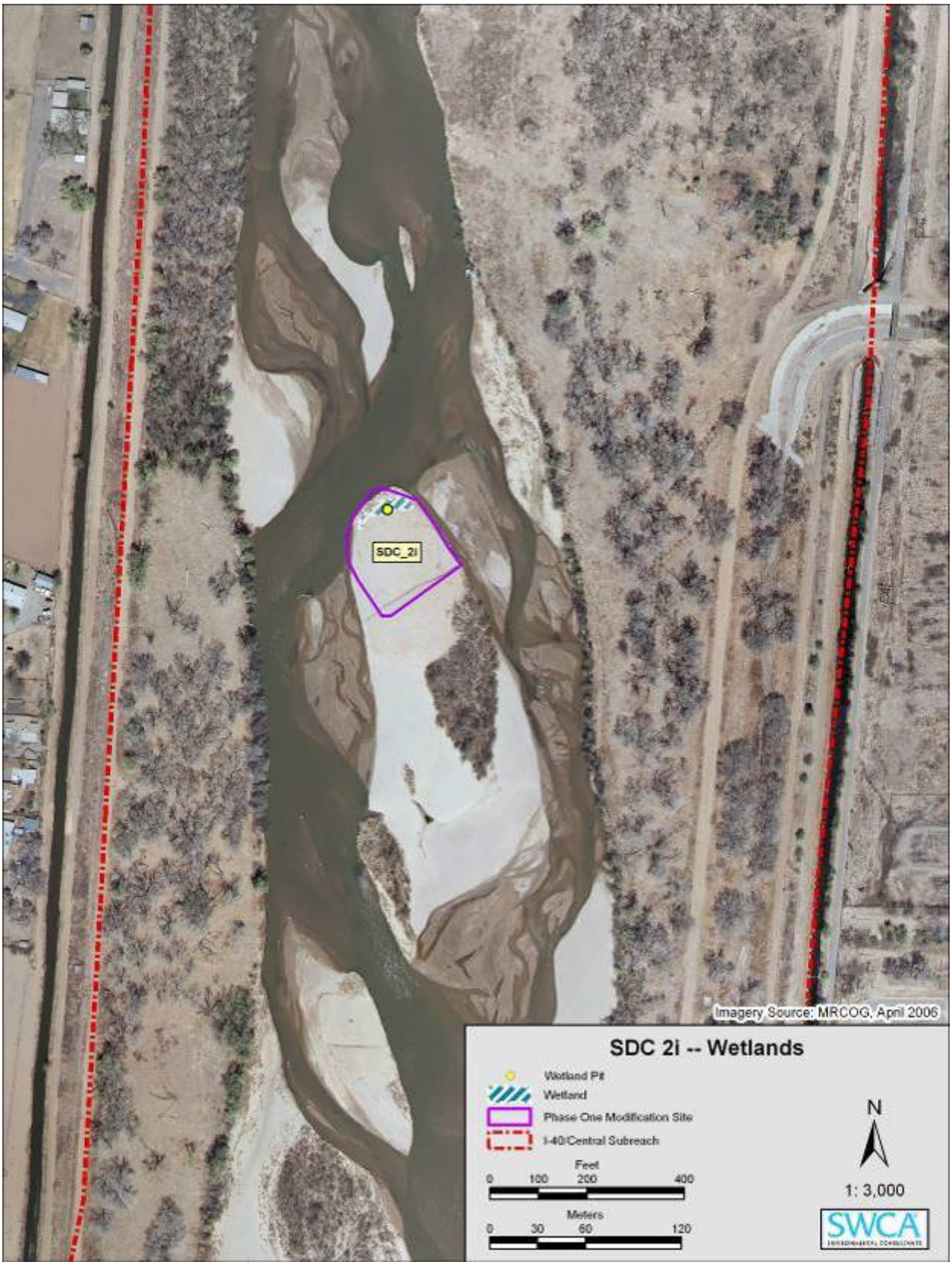


Figure F.12. SDC 2i wetlands.

Figure F.13. SDC 3i wetlands.

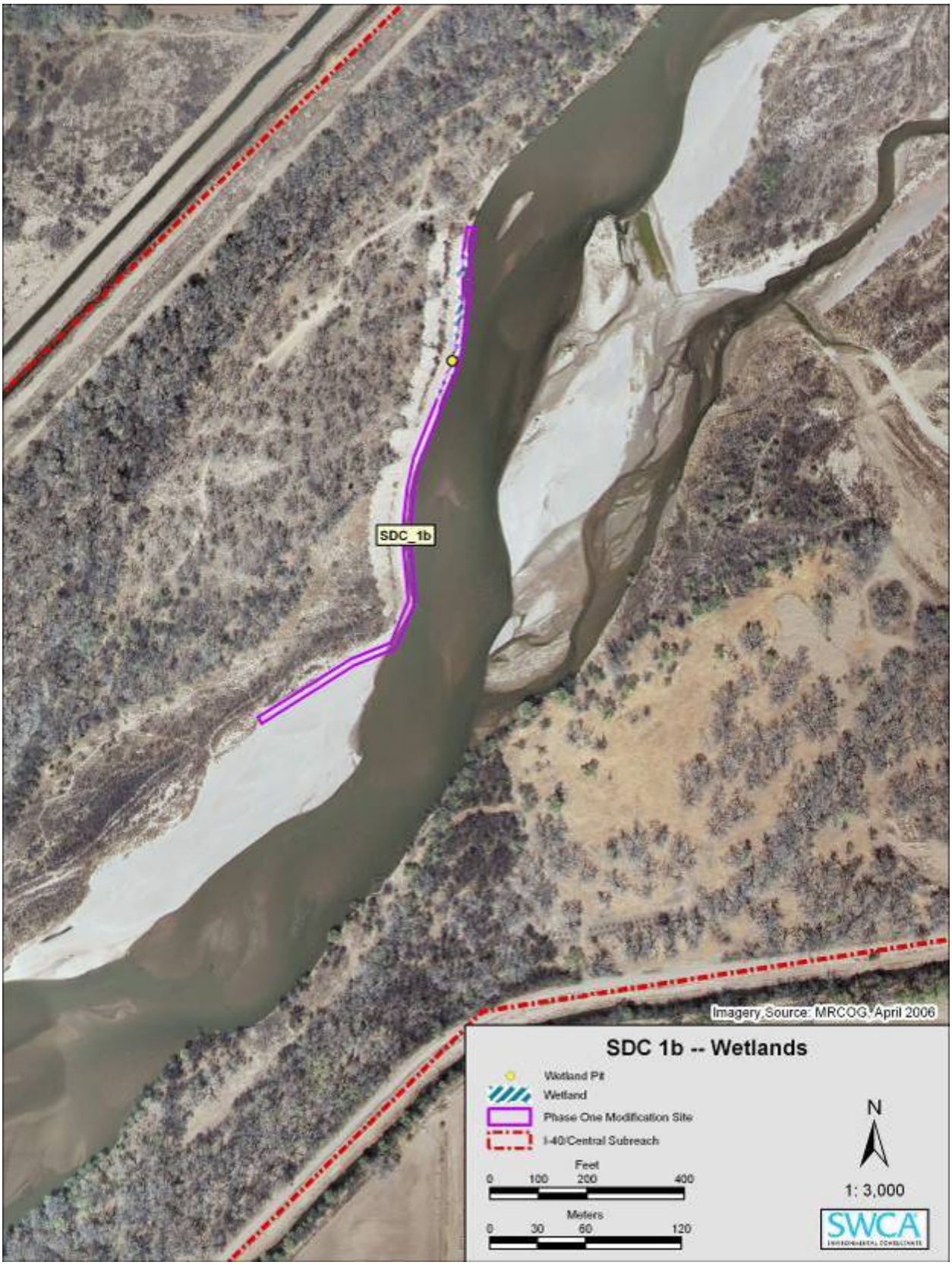


Figure F.14. SDC 1b wetlands.

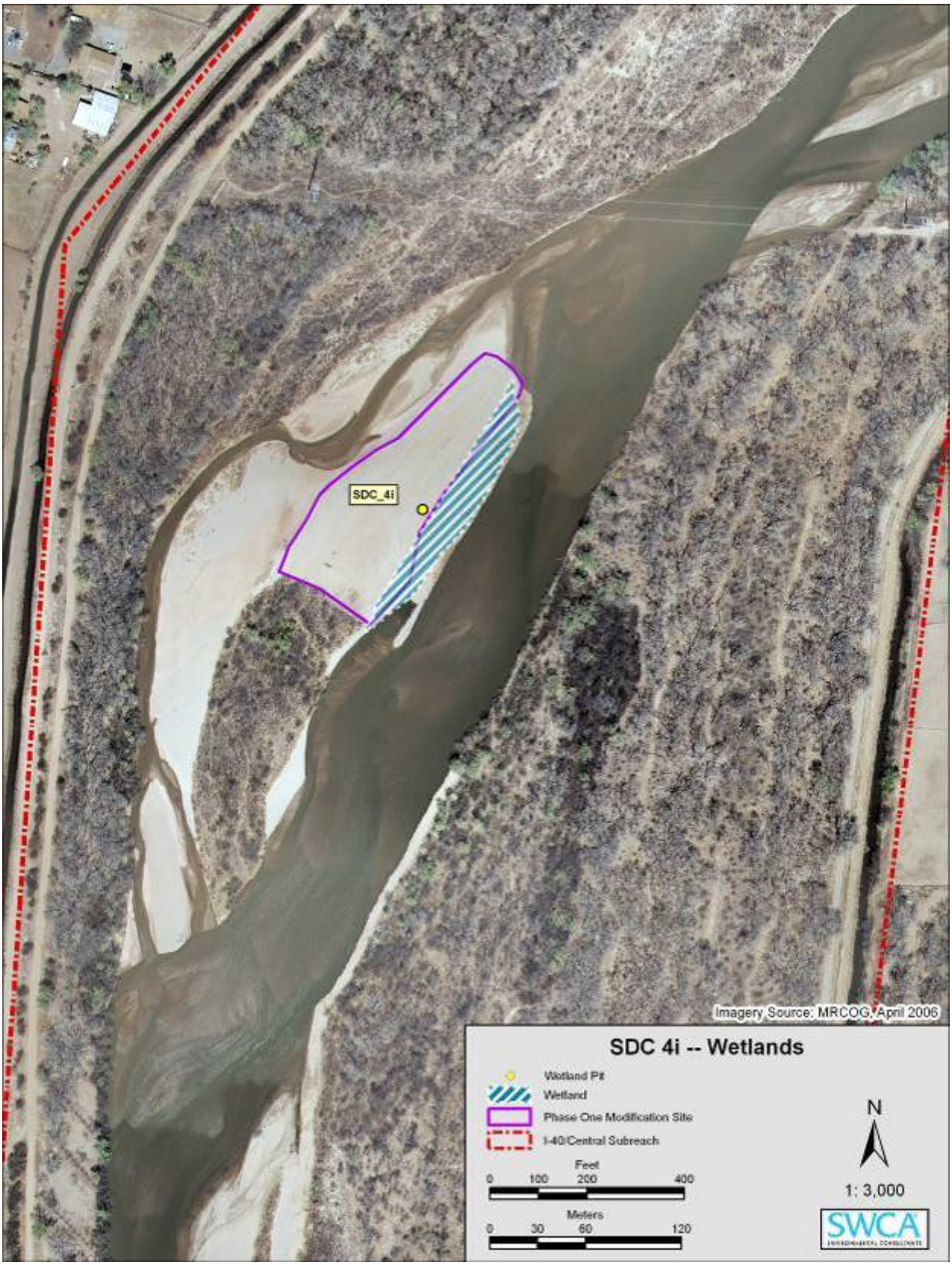


Figure F.15. SDC 4i wetlands.

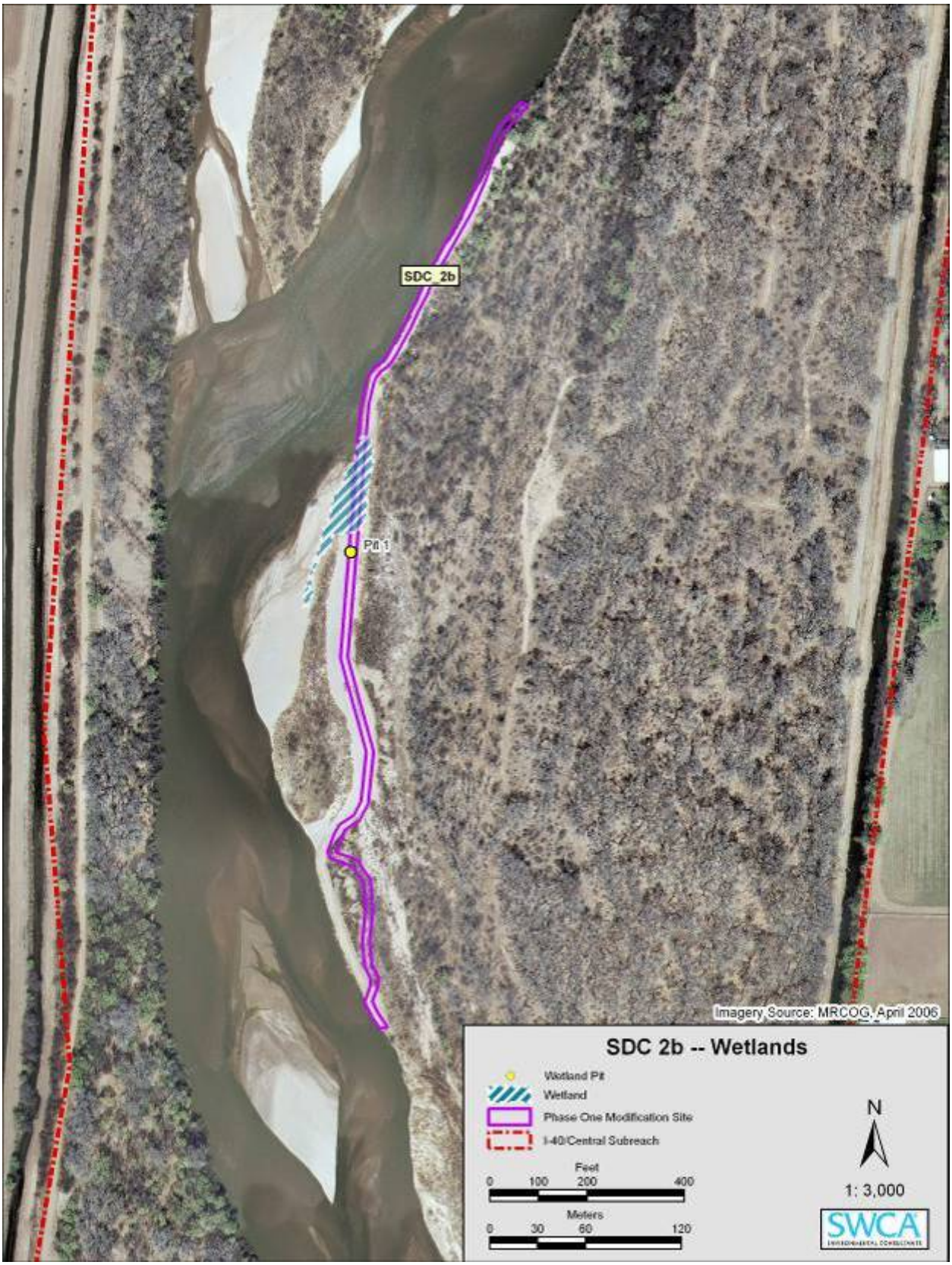


Figure F.16. SDC 2b wetlands.

Figure F.17. SDC 3b wetlands.