DRAFT
GEOTECHNICAL EVALUATION

SHERMAN ISLAND – TWO FISH RELEASE SITES
RECLAMATION DISTRICT 341
SACRAMENTO COUNTY, CALIFORNIA

Project No. 789.04
March 13, 2014

Prepared by

Hultgren – Tillis Engineers

A California Corporation
Specializing in Geotechnical Engineering

Hultgren-Tillis Engineers

March 13, 2014
Project No. 789.04

Reclamation District 341
c/o Wagner & Bonsignore
2151 River Plaza Drive, Suite 100
Sacramento, California 95833-4133

Attention: Mr. Henry Matsunaga

Draft
Geotechnical Evaluation
Sherman Island – Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Dear Mr. Matsunaga:

We performed a geotechnical evaluation for the two New Salvaged Fish Release Sites on Sherman Island in Sacramento County, California located at approximately Reclamation District 341 (District) Stations 707 and 733. Our geotechnical services were performed in accordance with the Service Agreement with Wagner & Bonsignore dated June 25, 2012 and our proposals dated June 25, 2013 and November 18, 2013. The results of the evaluation are presented in the attached report.

It was a pleasure working with you on this project. If you have any questions, please call.

Sincerely,

Hultgren – Tillis Engineers

DRAFT

W. Rick Chen
Geotechnical Engineer

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Geotechnical Engineer

WMC:RKT:lm:la

2 copies submitted

cc: Reclamation District 341 (2 copies)

File No. 78904R01 Sherman Island Two Fish Release Sites Draft.docx

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I. INTRODUCTION

This report presents the results of our geotechnical evaluation for the two New Salvaged Fish Release Sites for Reclamation District 341 (District) on Sherman Island in Sacramento County, California. The California Department of Water Resources (DWR) plans to construct two salvaged fish release facilities on the northwest side of Sherman Island along the Sacramento River: the Little Baja Site (at approximately District Station 707) and the Manzo Ranch Site (at approximately District Station 733). Each salvaged fish release site will require widening the existing crest to at least 50 feet and raising the crest. The levee crest will be paved with asphalt concrete and a fish release system will be constructed on the waterside slope. The fish release system will consist of a fish discharge pipe extending down the waterside slopes into the water, a water intake pipe, and an equipment platform (approximately 20 feet wide by 12 feet long). The pipes and platform will be supported by pile foundations which will be designed by DWR. The platform will extend over the waterside slope. The levee between the fish release sites and the county road will be realigned as part of this project. Our evaluation for the levee improvements and the county road realignment between the two fish release sites are presented in a separate report.

Sherman Island and the surrounding areas are shown on the Vicinity Map, Plate 1. The two fish release sites and locations of borings and cone penetration test soundings (CPT) are shown on the Site Plans, Plates 2 and 3. The elevations in this report are referenced to the North American Vertical Datum of 1988 (NAVD88). However, some of the published data (Geologic map and previous boring and drill logs) were recorded using the National Geographic Vertical Datum of 1929 (NGVD29). A correction of +2.4 feet is used to convert from NGVD29 to NAVD88 elevations for this project by the design team.

Our scope of services was outlined in our proposals dated June 25, 2013 and November 18, 2013. Our scope of services is for design of improvements for the fish release sites. The results of our geotechnical evaluation are presented in this report.

II. EXISTING DATA

DWR collected subsurface data in 2013 for the two salvaged fish release sites and presented the data in the Project Geology Report 80-10-39 dated January 2014.

The approximate boring and CPT locations are presented on the Site Plans, Plates 2 and 3. The logs of borings and CPT's, the laboratory testing results, and the 1950's DWR drill logs are presented in our report, titled "Geotechnical Investigation Report, Sherman Island – Stations 700 to 850, Sacramento County, California", dated March 10, 2014, and in DWR's Project Geology Report 80-10-39.

III. SITE CONDITIONS

A. Geology

The United States Geological Survey (USGS) has published geologic maps for the Sacramento-San Joaquin Delta (Atwater 1982). The Atwater geologic map that includes Sherman Island and the geologic descriptions of the map (geology) units are presented on Plate 4. The geology map shows that Sherman Island is covered by peat and mud (Qpm), except one relatively small area (between approximately Stations 755 and 805) along the Sacramento River where hydraulic fill (Qds) blankets the surface.

The present configuration of the Sacramento-San Joaquin River Delta began to form after the last ice age, about 10,000 years ago. During the ice age, sea levels were 200 to 300 feet below present levels. Sea levels rose rapidly for several thousand years then the rate of sea level rise slowed. As sea levels rose, the Delta was inundated. The sea level rise was slow enough to allow for the accretion of marsh vegetation and formation of a widespread peat marsh (mapped as Qpm).

The peat continued to accumulate as sea levels rose. The marsh formation was halted upon reclamation of land in the late 1800's and early 1900's within the Delta.

The reclamation of the Delta allowed the peat materials to dry. The process of drying an organic material such as the peat causes it to oxidize and deplete. The ground surface within Sherman Island has subsided since the island was reclaimed predominately due to soil oxidation and disappearance of the peat. Oxidation continues to occur throughout the Delta.

B. Surface Conditions

1. Little Baja Site (Station 707)

The topographic survey data indicates that the crest centerline varies from Elevation 12.9 feet to Elevation 14.9 feet. The levee crest width ranges from 28 feet to 30 feet. The levee crest is covered with aggregate base. The island interior near the levee varies from about Elevation -7 feet to Elevation -10 feet. The landside slope is inclined at about 3H:1V (horizontal to vertical) to 4H:1V. The landside levee slope and toe are covered by vegetation that consists of grass and brush.

The waterside slope is inclined at 3H:1V. Based on the bathymetric data, the mudline near the waterside slope is at approximately Elevation -30 feet. The upper portion of most of the waterside slope is not covered by riprap.

2. Manzo Ranch Site (Station 733)

The topographic survey data indicates that the crest centerline varies from Elevation 12.1 feet to Elevation 14.1 feet. The levee crest width ranges from 16 feet to 20 feet. The levee crest is covered with aggregate base.

The island interior near the levee is at Elevation -10 feet to Elevation -11 feet. The landside slope is inclined at 3H:1V to 4H:1V. The landside levee slope and toe are covered by vegetation that consists of grass and brush.

The waterside slope is inclined at 3H:1V. The mudline near the waterside slope is at approximately Elevation -25 feet. The upper portion of most of the waterside slope is not covered by riprap.

C. Subsurface Conditions

The island is below sea level and groundwater levels within the island are artificially controlled by evapo-transpiration and pumping. Conditions are expected to vary across the site with time, and depend on several factors including changes in moisture content resulting from seasonal precipitation, irrigation practices, and tides.

The typical daily tidal range at Sherman Island varies from about Elevation 2 feet to Elevation 6 feet. Extreme low tides are near Elevation 1 foot and extreme high tides are near Elevation 7 feet. The 100-year base flood level used by the District and the design team is Elevation 9.8 feet.

1. Little Baja Site

The levee consists of fill over marsh deposits. The crest is covered with aggregate base. Beneath the aggregate base is a heterogeneous mixture of fill consisting predominately of silty sand. The consistency of the silty sand fill ranges from very loose to loose. The fill thickness ranges from 15 to 20 feet at the boring and CPT locations.

The fill is underlain by marsh deposits. The marsh deposits consist predominately of weak and compressible peat and organic silt and clay. The base of the marsh deposits ranges from approximately Elevation -53 feet to Elevation -61 feet. Our interpretation of the elevation of the base of marsh deposits beneath the levee is presented on Plate 5.

The material beneath the marsh deposits varies with several locations underlain by sand to the depths explored and with other locations underlain by variable zones of silt and sand. The consistency of the sand is variable and ranges from loose to dense. The loosest sand is typically located directly below the marsh soils. The geologic sections at the Little Baja site (from the DWR Project Geology Report) are presented on Plates 6 through 8.

2. Manzo Ranch Site

The levee consists of fill over marsh deposits. The crest is covered with aggregate base. Beneath the aggregate base is a heterogeneous mixture of fill consisting of sand, silt, and clay. The consistency of the sand fill ranges from very loose to very dense. The consistency of the silt and clay fill ranges from medium stiff to stiff. The fill thickness ranges from 19 to 23 feet at the boring and CPT locations.

The fill is underlain by marsh deposits. The marsh deposits consist predominately of weak and compressible peat and organic silt and clay. The base of the marsh deposits ranges from approximately Elevation -44 feet to Elevation -47 feet.

The material beneath the marsh deposits is similar to the Little Baja Site, including variable zones of silt and sand. The consistency of the sand is variable and ranges from loose to dense. The geologic sections at the Manzo Ranch site (from the DWR Project Geology Report) are presented on Plates 9 through 11.

IV. DISCUSSION AND CONCLUSIONS

A. General

The significant geotechnical considerations for this project are the presence of marsh soils below the levee, short term stability of the levee during fill placement, and settlement and lateral deformation of the levee. These issues and other considerations for design and construction of the project are discussed below.

This report is limited to the evaluation of levee improvements needed to construct the wider crest at the two sites. Our recommendations for construction of other levee improvements and the seepage analysis parameters and results are presented in our report titled "Geotechnical Investigation Report, Sherman Island - Stations 700 to 850, Sacramento County, California", dated March 10, 2014.

The levee on Sherman Island is founded on weak marsh deposits consisting predominately of peat and organic soil. Up to 15 feet of fill is required to construct the 50-foot wide crests. To avoid overstressing the underlying marsh deposits, we conclude that the fish release sites will need broad landside berms to buttress the sites and will need to be constructed in stages. The levee will deform and settle as is typical of Delta levees. The stage construction method has been used successfully on Sherman Island and other Delta projects. The levee will need to be monitored and there is still some risk of extensive movement occurring during fill placement.

DWR will need to consider the effects of settlement and deformation on the design of the improvements. The pile supported structures will not settle appreciably. DWR should make accommodations for settlement for structures spanning from the levee to the pile supported structures. Flexible couplings should be included for utilities. Other maintenance activities may include releveling of gates and raising of the levee. DWR plans to install foundation and utilities within the levee crest. The improvements should not be placed within the theoretical levee section and will be subject to approval by the Central Valley Flood Protection Board.

The initial design includes providing camber for settlement. The intent is to provide a provision to accommodate settlement so the levee will continue to meet the minimum PL 84-99 criteria.

B. Slope Stability and Settlement

Slope stability and seepage analysis for the levee is presented in our March 10, 2014 report. The slope stability analysis in this report is limited to an undrained analysis for purposes of evaluating the stages of fill needed for the wider crest at the fish release sites. The levee is underlain by a thick deposit of marsh soils. Levees that are constructed too quick can exceed the strength capacity of weak foundation materials (marsh soils). The levee should be constructed in stages. The foundation materials will gain strength as the soil consolidates allowing subsequent stages of fill to be placed. Our analysis included placing stages of fill up to 4 feet thick with a minimum waiting period between stages of 4 months. The number of stages required will depend on the thickness of fill needed to achieve grade and the magnitude of settlement that occurs during and after filling. For purposes of this report, we have shown four stages of filling. The typical design configurations, including four stages of fill placement, are presented on Plates 12 through 15.

The stage analysis used undrained shear strengths for the marsh soils presented on Plate 16 and parameters on Plates 12 through 21 for the remaining soil layer. We used Spencer's Method of Analysis and computer program SLOPE/W for the analysis of consolidation. For ground settlement we used computer program CONSOL. The properties used for the settlement analysis are presented in Table 1. The results of the analysis are presented on Plates 17 through 21 and in Tables 2 through 4.

The stability analysis and settlement were performed together as an iterative process. The time for complete consolidation and strength gain is too long to meet the construction schedule. The second and subsequent stages for fill need to be placed while consolidation continues. We used the pore pressure dissipation and estimate of effect stress from CONSOL to estimate the undrained shear strength for each stage.

The analysis was performed for the Manzo Ranch site with conclusions used by us for both sites.

Table 1: Properties of Marsh Soils for Settlement Analysis

Properties	Peat	Silt
Unit Weight (pcf)	70	100
Initial Void Ratio, e_0	5	2
Compression Index, C_c	3	0.7
Recompression Index, C_r	0.3	0.07
Coefficient of Consolidation, C_v (ft^2/year)	80 to 150	40

Table 2: Factors of Safety for Landside Slopes – Rehabilitated Levee

Site	Existing Levee	Rehabilitated Levee – End of Construction			
	Undrained Strength*	Undrained Strength			
		Stage 1	Stage 2	Stage 3	Stage 4
Manzo Ranch	1.42	1.46	1.45	1.48	1.39

Table 3: Factors of Safety for Waterside Slopes – Rehabilitated Levee

Site	Existing Levee	Rehabilitated Levee – End of Construction			
	Undrained Strength*	Undrained Strength			
		Stage 1	Stage 2	Stage 3	Stage 4
Manzo Ranch	1.43	1.42	1.42	1.42	1.36

Our settlement models assumed double drainage. Our estimate of settlement is based on the fill thicknesses (Stages 1 through 4) shown in Table 4. The analysis indicated that the levee crest will settle 1.3 feet for the first year. The analysis indicated that the levee crest will settle another 1 foot (a total settlement of 2.2 feet) one year after placement of the Stage 4 fill, and 2 feet (a total settlement of 3.2 feet) four years after placement of the Stage 4 fill.

The time rate of settlement will vary depending on the inherent variability of the marsh soils, permeabilities of soils, and drainage paths. Under the new fill loading, the levee may settle to design crest elevation earlier than our estimates. Additional fill may need to be placed to maintain the design crest elevation.

Table 4: Settlement Estimate – Primary Consolidation without Creep

Time after Stage 1 Fill Placement (year)	New Levee Centerline		New Landside Hinge Point	
	Settlement (feet)	Total Fill Thickness (feet)	Settlement (feet)	Total Fill Thickness (feet)
0 (Stage 1)	0	0	0	4
0.33 (Stage 2)	0	2	0.4	8
0.67 (Stage 3)	0.1	6	0.8	12
1 (Stage 4)	0.5	8	1.3	16
2	1.0	8	2.2	16
5	1.4	8	3.2	16
10	1.6	8	3.4	16

C. Seismic Hazards and Performance

1. Seismic Hazards

The predominant seismic hazard for this site is strong groundshaking resulting from earthquakes. The fish release facilities should be designed to accommodate such groundshaking in accordance with existing codes. No known active faults pass through the site and we conclude that the risk of fault rupture is low. A site-specific response analysis was performed by DWR to evaluate ground motions and develop spectra for design of the facilities. Methodology and results of the analysis are presented in DWR's Project Geology Report 80-10-39 dated January 2014.

2. Soil Liquefaction

Soil liquefaction is a phenomenon in which a loose- to medium-dense saturated granular soil undergoes reduction of internal strength as a result of increased pore water pressure generated by shear strains within the soil mass. This behavior is most commonly induced by strong groundshaking associated with earthquakes.

For Delta levees, the two soil zones most susceptible to liquefaction are the levee fill (where the fill consists of sand) and the upper portion of the foundation sand below the marsh deposits. The levee fill at the two fish release sites contains predominately very loose to very dense sand with zones of very dense sand above groundwater tables. We analyzed the liquefaction potential using the method described in Idriss and Boulanger (2008

and 2010) which includes procedures for liquefaction triggering. Our analysis indicates that the levee fill will liquefy and that liquefaction will occur within the upper five feet (or less) of the foundation sand under the design earthquake. Other Delta studies have concluded that large deformation may occur if the levee fill liquefies.

V. RECOMMENDATIONS

A. Levee Configuration

The levee at the Fish Release Sites should be constructed in accordance with the details provided on Plates 12 through 15. The existing inclinometer should be checked during and after episodes of filling. Additional inclinometers should be considered near the waterside slopes. The levee crest, slope, and toe area should be inspected daily during construction to check for signs of deformation and cracking.

B. Earthwork

1. Site Preparation

The footprint of the levee and toe berm fill should be cleared and grubbed of surface and subsurface deleterious matter including trees, grasses, other vegetation, and debris designated for removal. The site should be stripped to sufficient depth to remove vegetation and soil containing roots. Tree roots greater than 1-inch in diameter should be removed. Stripped and grubbed materials should be removed from the site and should not be used as fill.

2. Compaction

Surfaces exposed by stripping or excavation should be scarified to a depth of at least 8-inches except where peat is exposed. Scarification is not required where peat exists at the ground surface. The scarified soil should be moisture conditioned to at least optimum moisture content and compacted to at least 90 percent relative compaction. ASTM D1557 should be used to establish the reference values for computing optimum moisture content and relative compaction.

Fill should be placed in lifts 8-inches or less in loose thickness and moisture conditioned to at least optimum moisture content. Moisture conditioning should be performed prior to compaction. Each lift should be methodically compacted to at least 90 percent relative compaction. Material that fails to meet the moisture or compaction criteria should be loosened by ripping or scarifying, moisture conditioned, and then recompacted. Fill should be placed on horizontal surfaces. The fill should be benched into the existing landside levee slope to allow recompaction of some of the existing soil. The horizontal bench width into the existing slopes should not exceed 5 feet.

In pavement areas subject to vehicle traffic, the upper 6-inches of subgrade should be compacted to at least 95 percent relative compaction and rolled to provide a smooth, non-yielding surface. Subgrade soils should be proof-rolled before placing aggregate base. Proof-rolling should be performed with the heaviest available rubber-tired construction equipment and should be observed by the geotechnical engineer. Soft or pumping areas should be aerated or excavated and recompacted.

Aggregate base should be placed in thin lifts no greater than 8-inches in loose thickness and in a manner that avoids segregation, moisture conditioned as necessary, and compacted to at least 95 percent relative compaction.

3. Slopes

Fill slopes should be inclined at 4H:1V or flatter except as noted. Fill slopes should be constructed fat and trimmed back to expose well-compacted fill. Finished slopes and toe berms should be trackwalked perpendicular to the slope face with a bulldozer after completion. The slopes should be hydroseeded to promote vegetation.

REFERENCES

REFERENCES

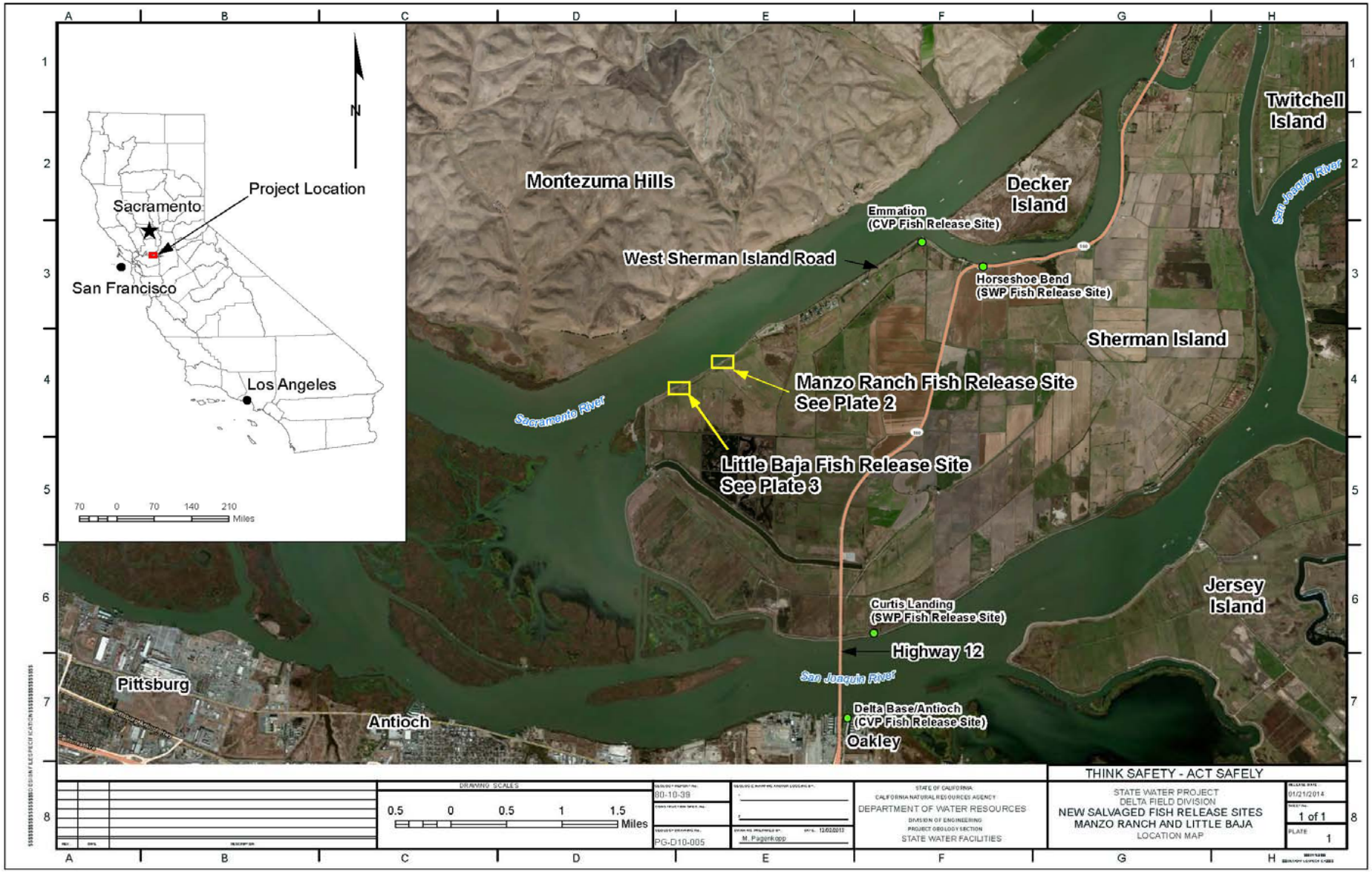
Atwater, Brian F. 1982. United Stated Department of the Interior Geological Survey, Geologic Maps of the Sacramento-San Joaquin Delta, California.

California Department of Water Resources. 2014. Sherman Island New Salvaged Fish Release Sites Exploration Geology Report, Project Geology Report 80-10-39, January 2014.

California Department of Water Resources. 2011. Guidance Document for Geotechnical Analyses, Draft Revision 9, January 24, 2011.

California Department of Water Resources. 1958. Salinity Control Barrier Investigation, Primary Subsurface Exploration on Sherman Island, Plan and Profile of Borings, September 1955 to August 1958. Prepared for State of California, Department of Water Resources, Division of Resources Planning.

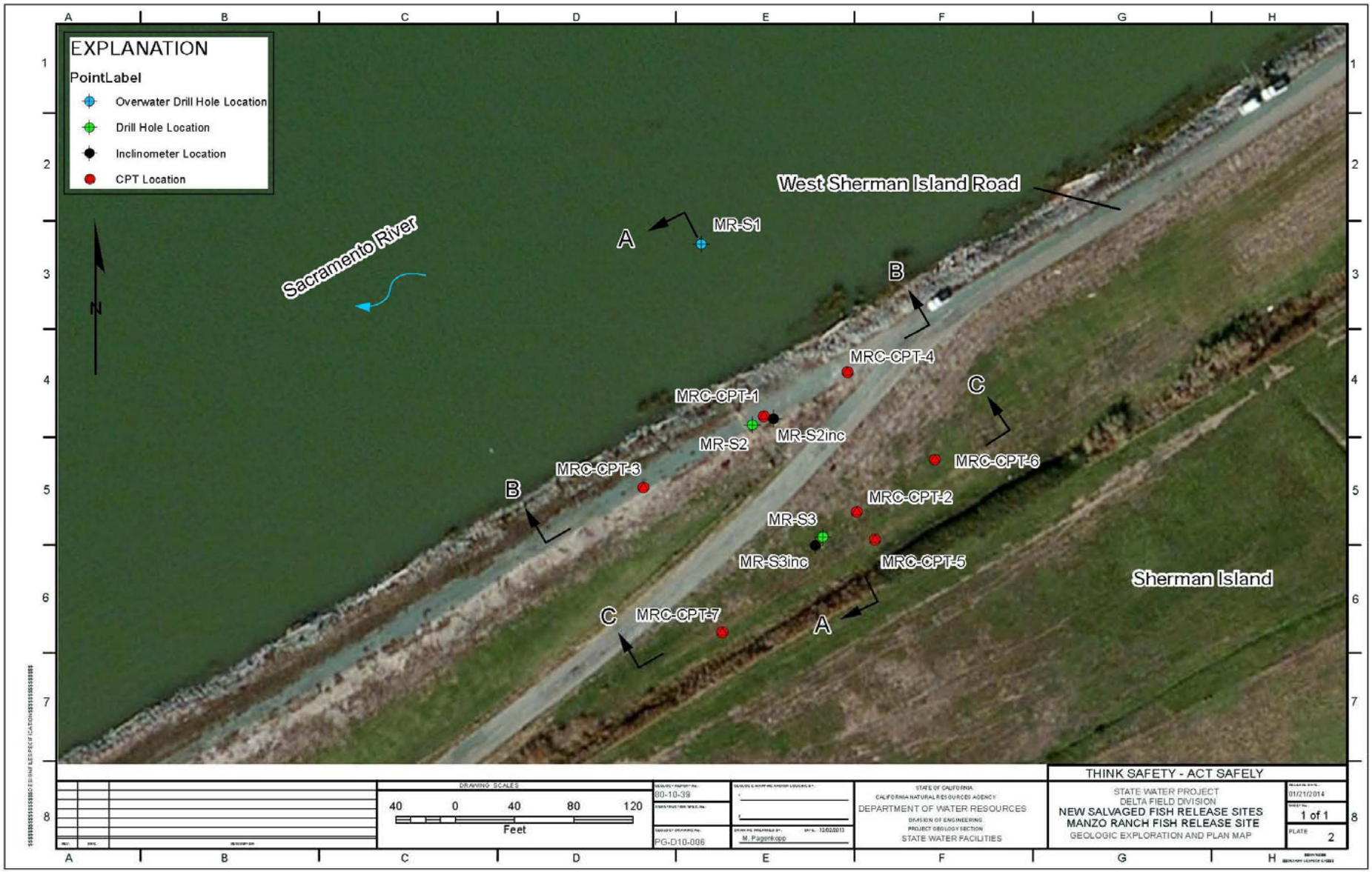
PLATES



Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Vicinity Map

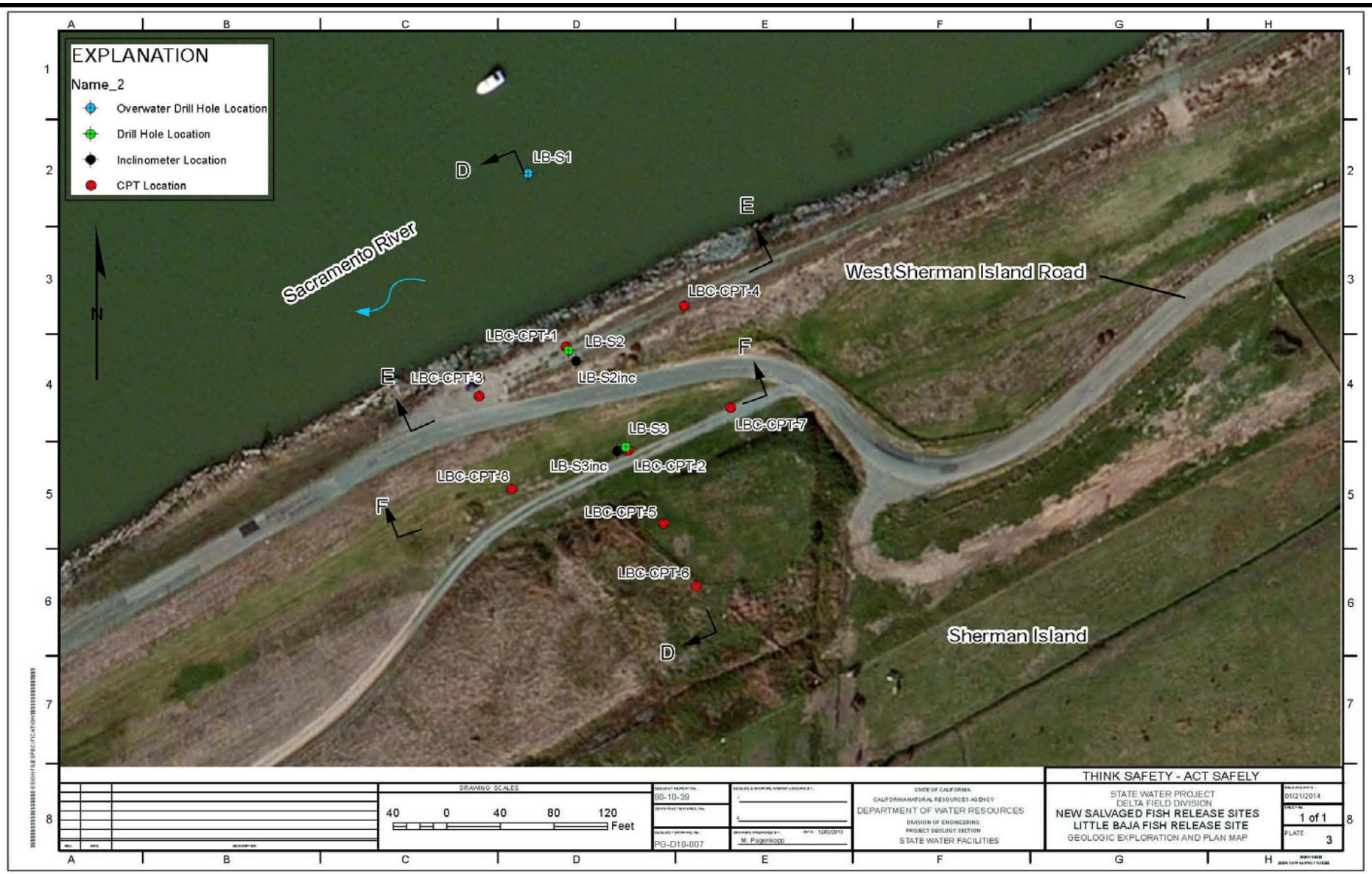
Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 1



Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Site Plan - Manzo Ranch Site

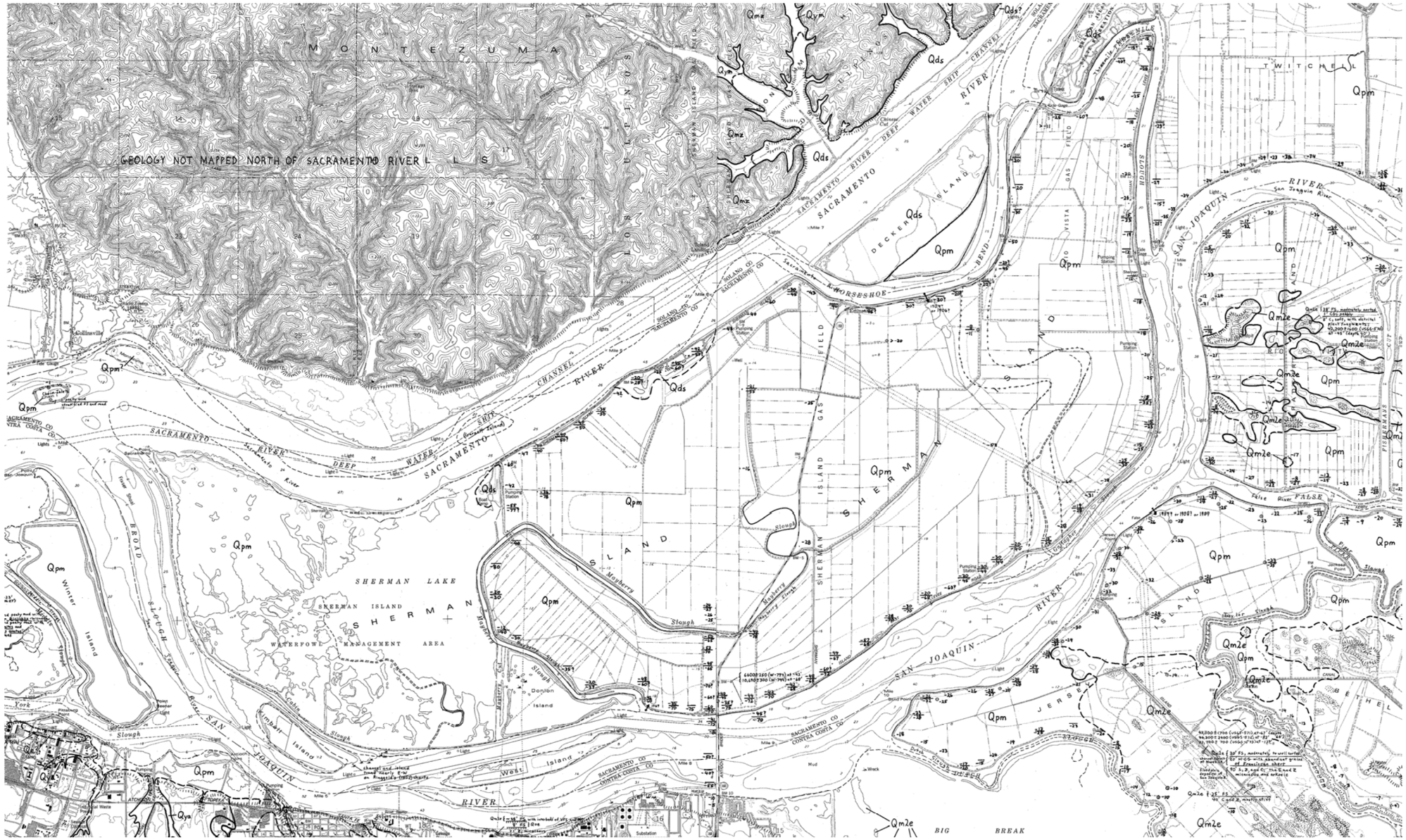
Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 2



Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Site Plan - Little Baja Site

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 3



Qds: Hydraulic-dredge soils (Holocene; post-1900)
Qpm: Peat and mud of tidal wetlands and waterways (Holocene)
Qm2e: Eolian deposits of upper member of Modesto Formation (Upper Pleistocene)
Qym: Younger alluvium of Montezuma Hills and vicinity (Holocene)
Qya: Youngest alluvium of Antioch and vicinity (Holocene)
Qmz: Montezuma Formation (Pleistocene)

Source: Map by Brian F. Atwater 1982.

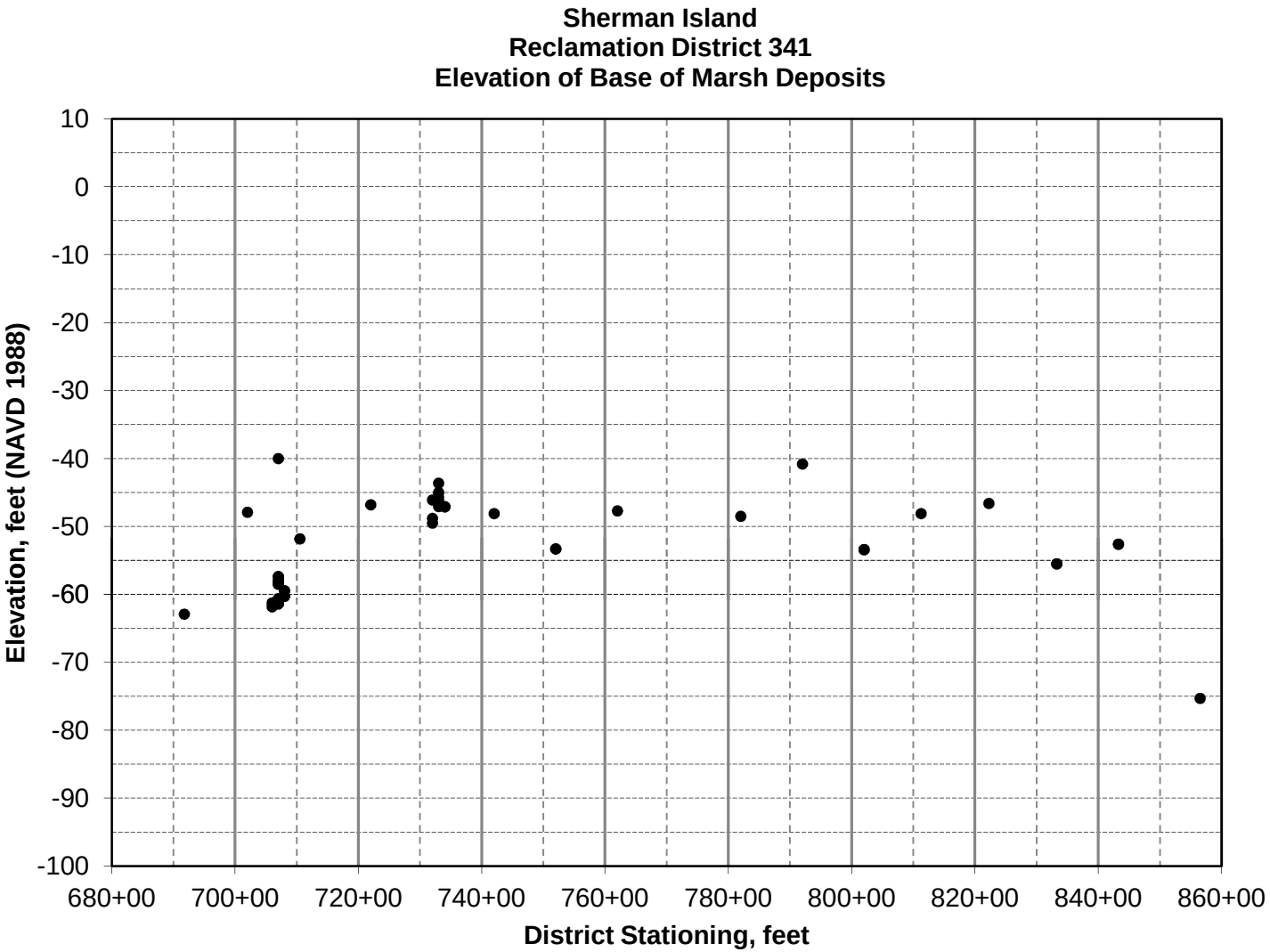
Not to Scale

Elevations at base of soft deposits
-11: Basal deposits peat or peaty mud
-16: Basal deposits mud
(-1): Soft deposits missing; firm or stiff deposits at ground surface at indicated elevation

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

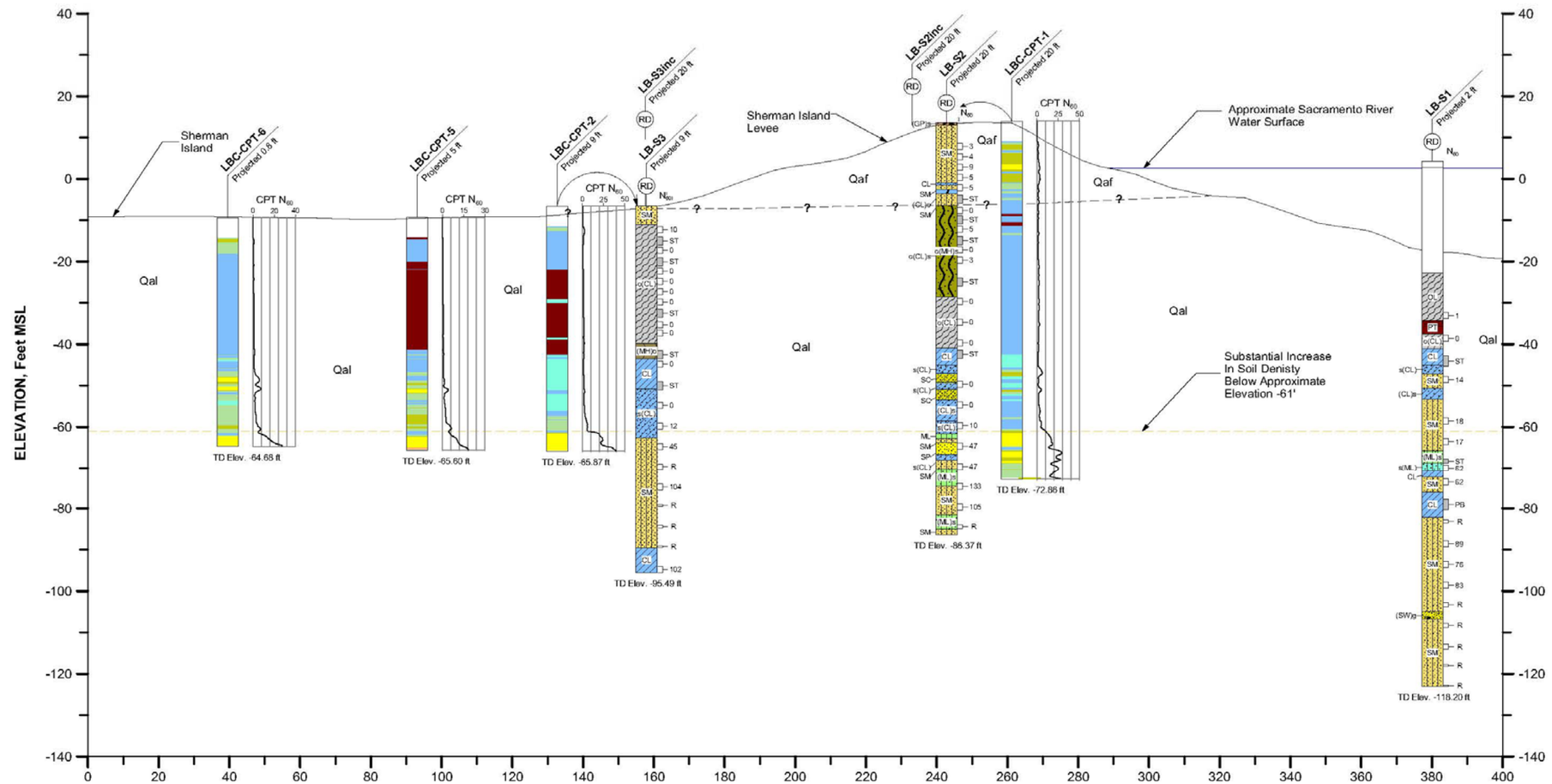
Geologic Map

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 4



● Base of Marsh Deposits

Sherman Island - Two Fish Release Sites Reclamation District 341 Sacramento County, California	**Base of Marsh Deposits**	
Hultgren - Tillis Engineers	Project No. 789.06	Plate No. 5



Notes:
1) See Plate 3 for geologic section and exploration locations.
2) See Plate 10 for explanation of graphic logs.

DRAWING SCALES
Vertical Scale 25.00 ft/in.
Horizontal Scale 30.00 ft/in.

GEOLOGY REPORT No. 80-10-39
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No. PG-D10-011
GEOLOGIC MAPPING AND/OR LOGGING BY: 1 D. Perry 2 N. Hightower
DRAWING PREPARED BY: M. Pagenkopp DATE: 12/05/2013

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

THINK SAFETY - ACT SAFELY

STATE WATER PROJECT
DELTA FIELD DIVISION
NEW SALVAGED FISH RELEASE SITES
LITTLE BAJA FISH RELEASE SITE
GEOLOGIC SECTION D - D

RELEASE DATE: 01/21/2014
SHEET No. 1 of 1
PLATE 7

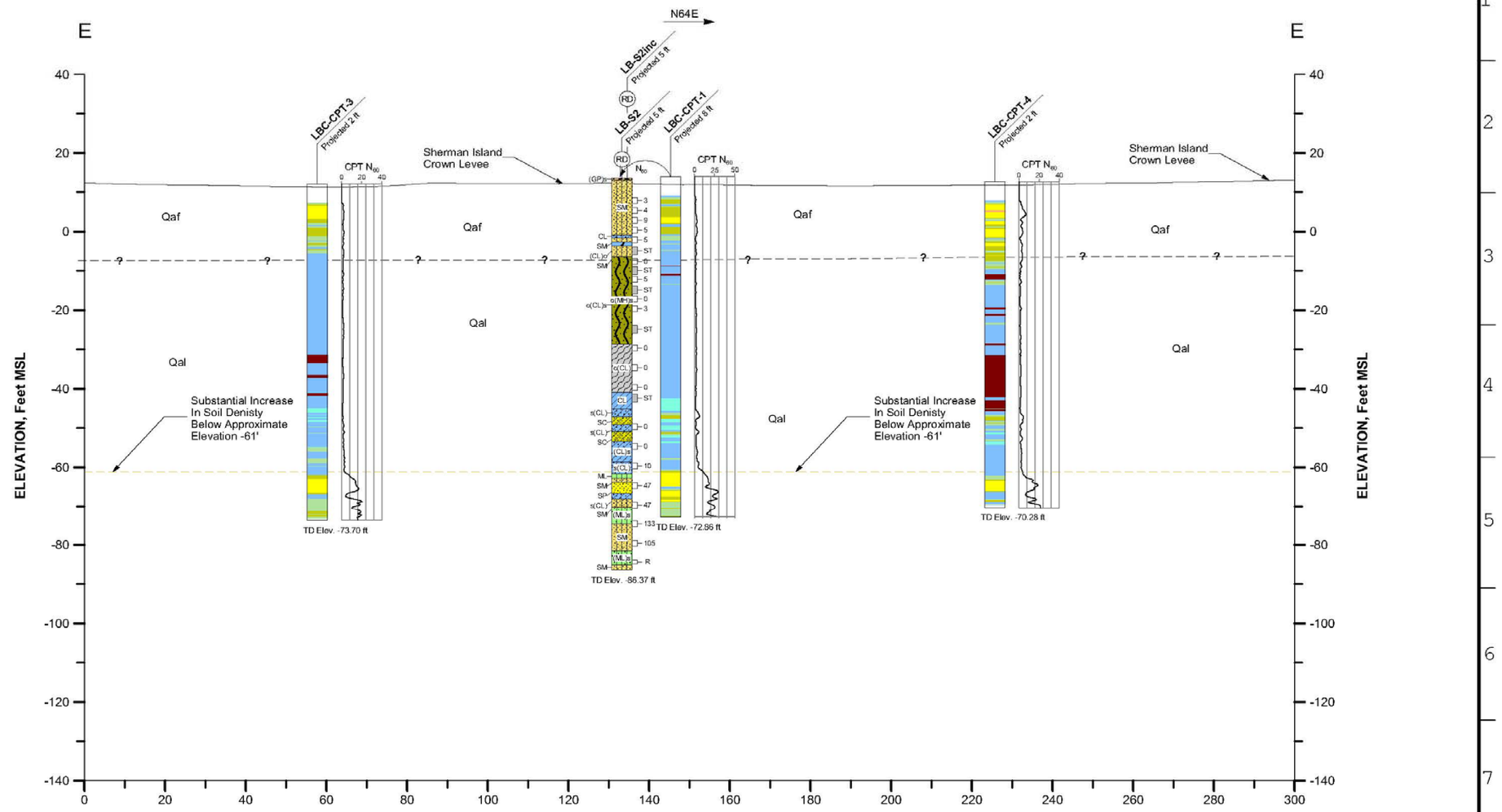
12/5/13 PG 11X17 SPT CPT (SBT N60) NEW FISH RELEASE SITES.GPJ NEW SALVAGED FISH RELEASE SITES

Note: Geologic cross-section from the DWR Project Geology Report 80-10-39.

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Geologic Sections - Little Baja

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 6



Notes:
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2) See Plate 10 for explanation of graphic logs.

THINK SAFETY - ACT SAFELY

DRAWING SCALES
Vertical Scale 25.00 ft/in.
Horizontal Scale 25.00 ft/in.

REV.	DATE	DESCRIPTION

GEOLOGY REPORT No. 80-10-39
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No. PG-D10-012
GEOLOGIC MAPPING AND/OR LOGGING BY: 1 D. Perry 2 N. Hightower
DRAWING PREPARED BY: M. Pagenkopp DATE: 12/05/2013

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

STATE WATER PROJECT
DELTA FIELD DIVISION
NEW SALVAGED FISH RELEASE SITES
LITTLE BAJA FISH RELEASE SITE
GEOLOGIC SECTION E - E

RELEASE DATE: 01/21/2014
SHEET No. 1 of 1
PLATE 8

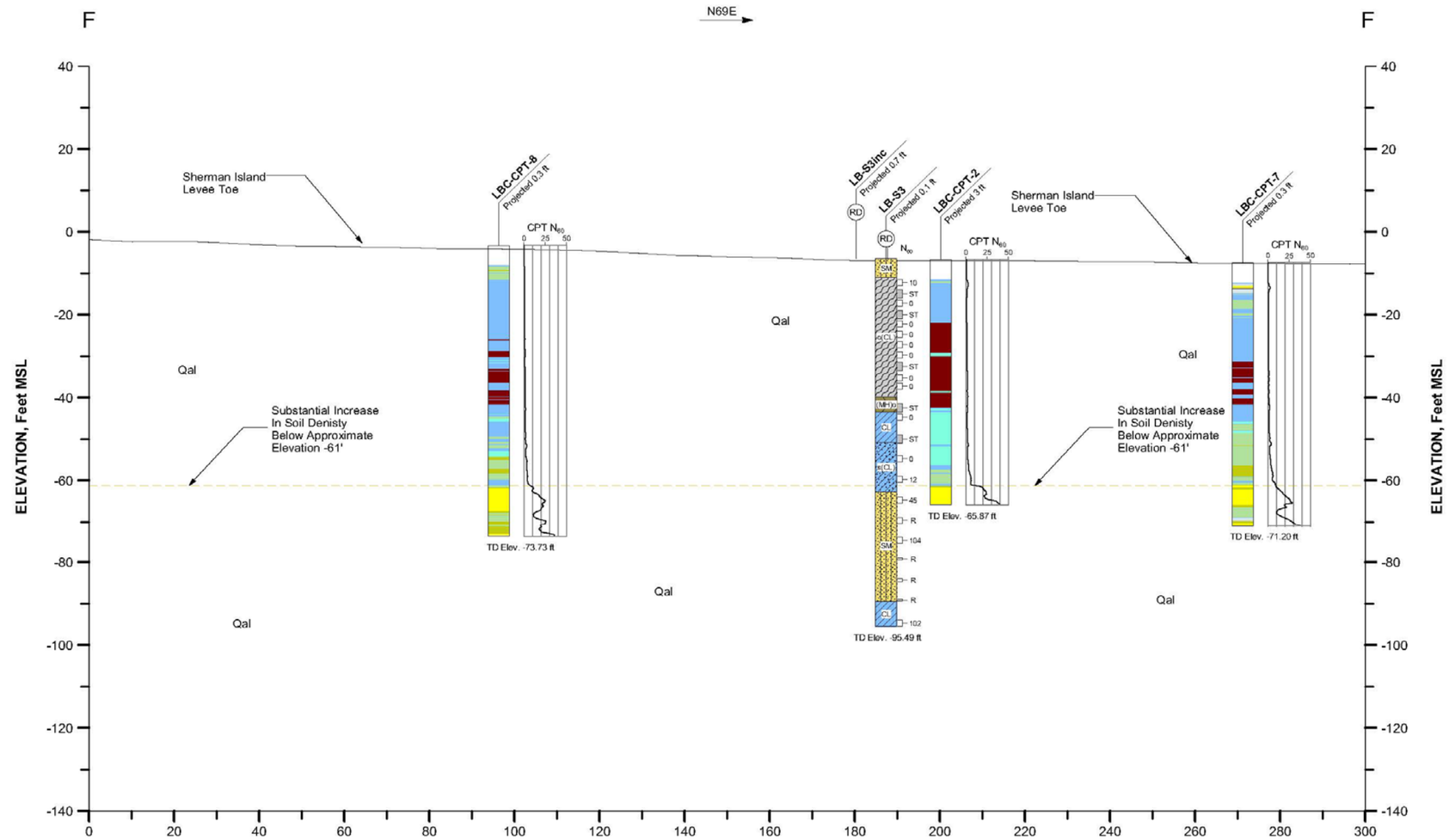
12/5/13 PG 11X17 SPT CPT (SBT N60) NEW FISH RELEASE SITES.GPJ NEW SALVAGED FISH RELEASE SITES

Note: Geologic cross-section from the DWR Project Geology Report 80-10-39.

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Geologic Sections - Little Baja

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 7



Notes:
1) See Plate 3 for geologic section and exploration locations.
2) See Plate 10 for explanation of graphic logs.

DRAWING SCALES
Vertical Scale 25.00 ft/in.
Horizontal Scale 25.00 ft/in.

GEOLOGY REPORT No. 80-10-39
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No. PG-D10-013

GEOLOGIC MAPPING AND/OR LOGGING BY: 1 D. Perry 2 N. Hightower
DRAWING PREPARED BY: M. Pagenkopp DATE: 12/05/2013

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

THINK SAFETY - ACT SAFELY
STATE WATER PROJECT
DELTA FIELD DIVISION
NEW SALVAGED FISH RELEASE SITES
LITTLE BAJA FISH RELEASE SITE
GEOLOGIC SECTION F - F

RELEASE DATE: 01/21/2014
SHEET No. 1 of 1
PLATE 9

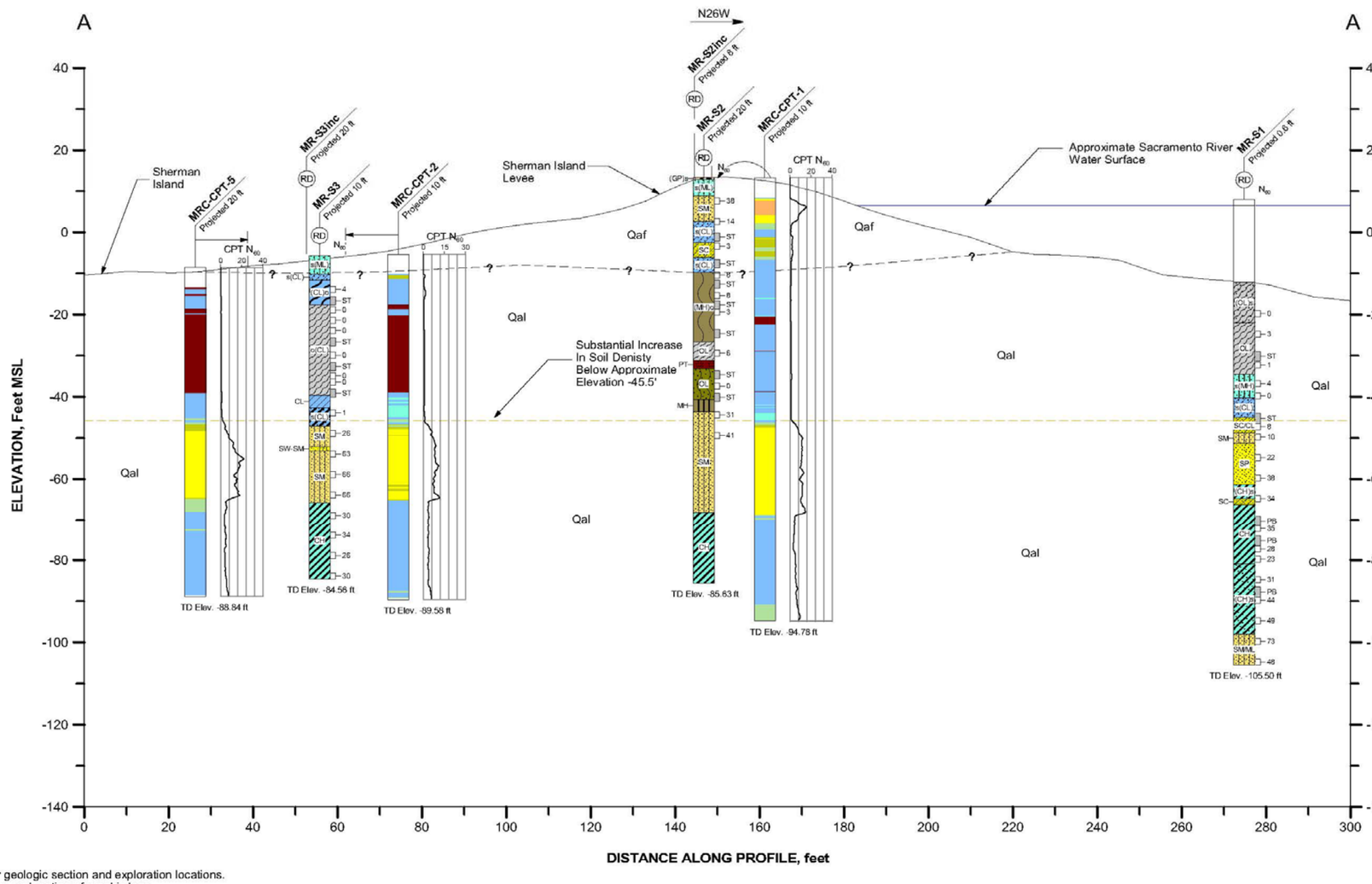
12/5/13 PG 11X17 SPT CPT (SBT N60) NEW FISH RELEASE SITES.GPJ NEW SALVAGED FISH RELEASE SITES

Note: Geologic cross-section from the DWR Project Geology Report 80-10-39.

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Geologic Sections - Little Baja

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 8



Notes:
1) See Plate 2 for geologic section and exploration locations.
2) See Plate 10 for explanation of graphic logs.

DRAWING SCALES
Vertical Scale 25.00 ft/in.
Horizontal Scale 25.00 ft/in.

GEOLOGY REPORT No. 80-10-39
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No. PG-D10-008
GEOLOGIC MAPPING AND/OR LOGGING BY: 1 D. Perry 2 N. Hightower
DRAWING PREPARED BY: M. Pagenkopp DATE: 12/05/2013

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

THINK SAFETY - ACT SAFELY

STATE WATER PROJECT
DELTA FIELD DIVISION
NEW SALVAGED FISH RELEASE SITES
MANZO RANCH FISH RELEASE SITE
GEOLOGIC SECTION A - A

RELEASE DATE 01/21/2014
SHEET No. 1 of 1
PLATE 4

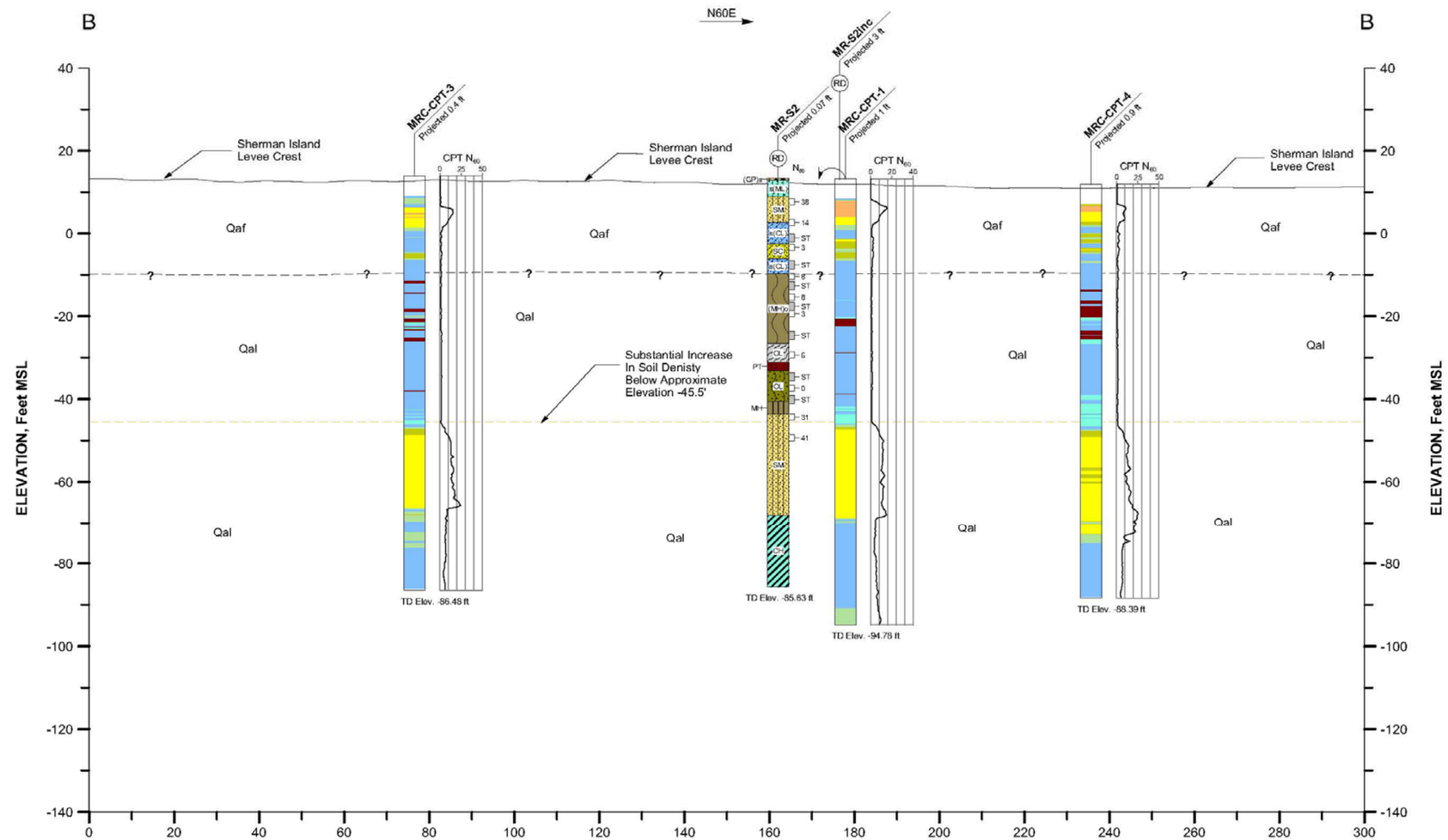
12/5/13 PG 11X17 SPT CPT (SBT N60) NEW FISH RELEASE SITES.GPJ NEW SALVAGED FISH RELEASE SITES

Note: Geologic cross-section from the DWR Project Geology Report 80-10-39.

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Geologic Sections - Manzo Ranch

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 9



Notes:
1) See Plate 2 for geologic section and exploration locations.
2) See Plate 10 for explanation of graphic logs.

DRAWING SCALES
Vertical Scale 25.00 ft/in.
Horizontal Scale 25.00 ft/in.

GEOLOGY REPORT No. 80-10-39
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No. PG-D10-009

GEOLOGIC MAPPING AND/OR LOGGING BY: 1 D. Perry 2 N. Hightower
DRAWING PREPARED BY: M. Pagenkopp DATE: 12/05/2013

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

THINK SAFETY - ACT SAFELY
STATE WATER PROJECT
DELTA FIELD DIVISION
NEW SALVAGED FISH RELEASE SITES
MANZO RANCH FISH RELEASE SITE
GEOLOGIC SECTION B - B

RELEASE DATE: 01/21/2012
SHEET No. 1 of 1
PLATE 5

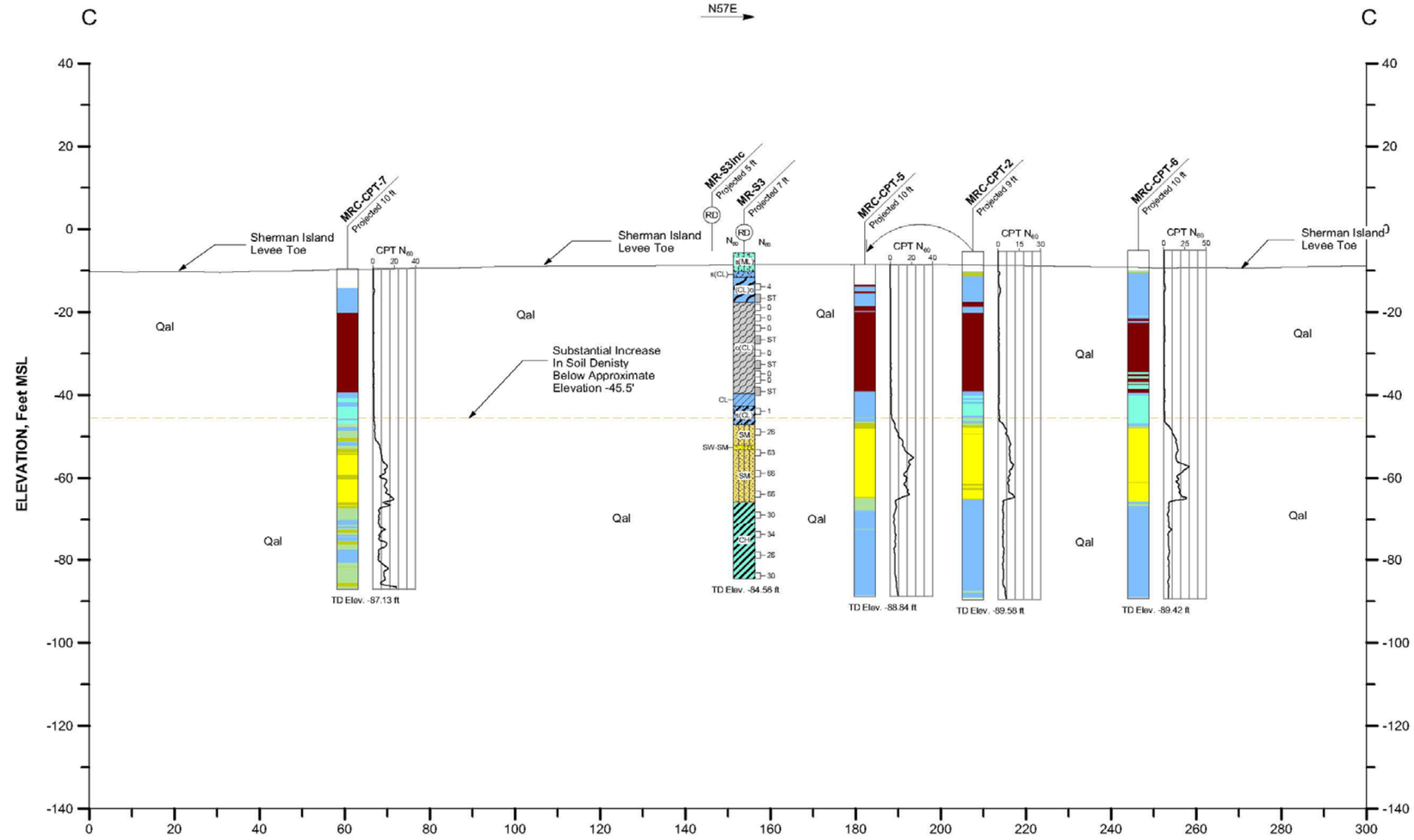
12/5/13 PG 11X17 SPT CPT (SBT N60) NEW FISH RELEASE SITES.GPJ NEW SALVAGED FISH RELEASE SITES

Note: Geologic cross-section from the DWR Project Geology Report 80-10-39.

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Geologic Sections - Manzo Ranch

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 10



Notes:
1) See Plate 2 for geologic section and exploration locations.
2) See Plate 10 for explanation of graphic logs.

THINK SAFETY - ACT SAFELY

DRAWING SCALES
Vertical Scale 25.00 ft/in.
Horizontal Scale 25.00 ft/in.

GEOLOGY REPORT No. 80-10-39
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No. PG-D10-010

GEOLOGIC MAPPING AND/OR LOGGING BY: 1 D. Perry 2 N. Hightower
DRAWING PREPARED BY: M. Pagenkopp DATE: 12/05/2013

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

STATE WATER PROJECT
DELTA FIELD DIVISION
NEW SALVAGED FISH RELEASE SITES
MANZO RANCH FISH RELEASE SITE
GEOLOGIC SECTION C - C

RELEASE DATE: 01/21/2014
SHEET No. 1 of 1
PLATE 6

12/5/13 PG 11X17 SPT CPT (SBT N60) NEW FISH RELEASE SITES.GPJ NEW SALVAGED FISH RELEASE SITES

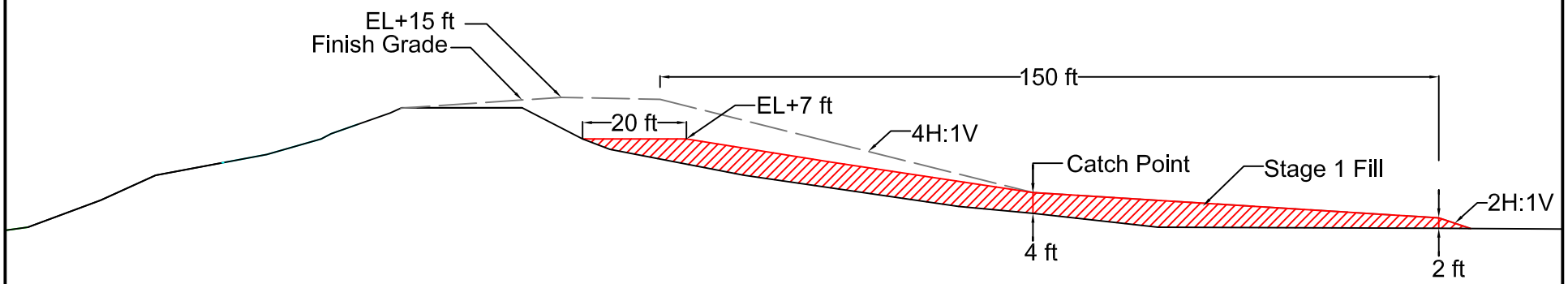
Note: Geologic cross-section from the DWR Project Geology Report 80-10-39.

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Geologic Sections - Manzo Ranch

Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 11

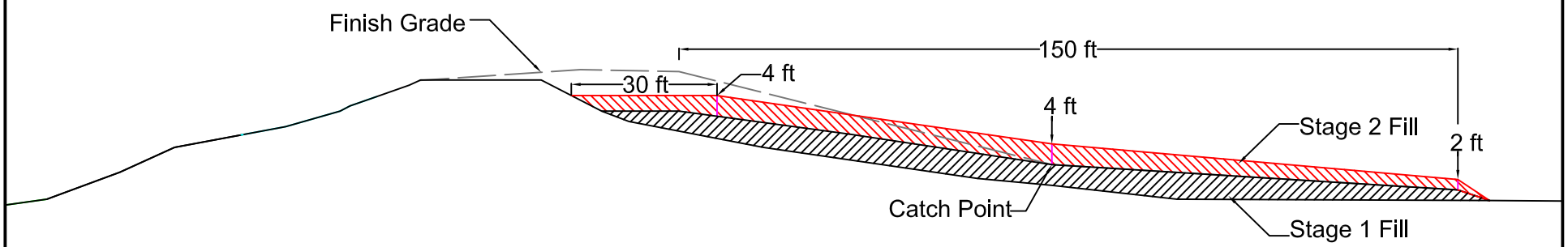
Stage 1



Notes:
1. New fill of up to 4 feet thick should be placed on the levee crest / slope and toe berm area.
2. Place new fill to Elevation +7 feet and construct a level bench of 20 feet wide.
3. Place 4 feet thick fill at the theoretical catch point (where the 4H:1V slope meets the toe berm slope).
4. Place 2 feet thick fill at the edge of toe berm.
5. The toe berms should be constructed before the slope is graded.

Not to Scale	Sherman Island - Two Fish Release Sites Reclamation District 341 Sacramento County, California	**Typical Design Configuration - Stage 1**	
	Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 12

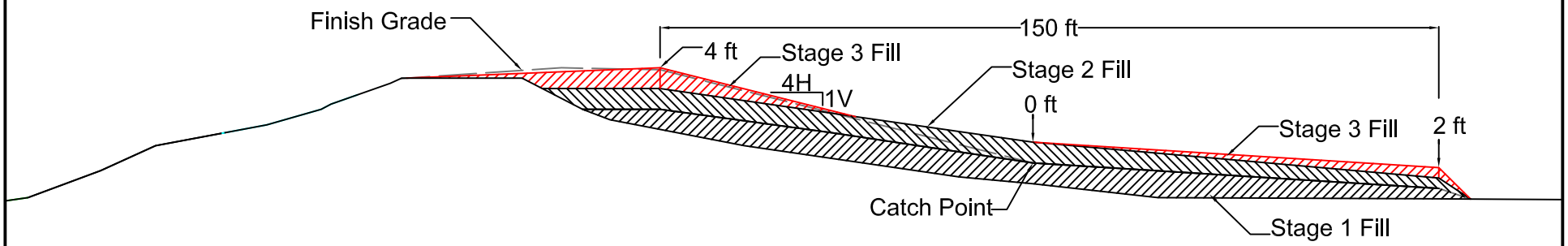
Stage 2 (4 months)



Notes:
1. Stage 2 fill should be placed at least 4 months after Stage 1.
2. Place 4 feet thick fill on the levee crest and slope and construct a 30 feet wide level bench (approximately Elevation +10.5 feet).
3. Place 4 feet thick fill at the theoretical catch point.
4. Place 2 feet thick fill at the edge of toe berm.

Not to Scale	Sherman Island - Two Fish Release Sites Reclamation District 341 Sacramento County, California	**Typical Design Configuration - Stage 2**	
	Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 13

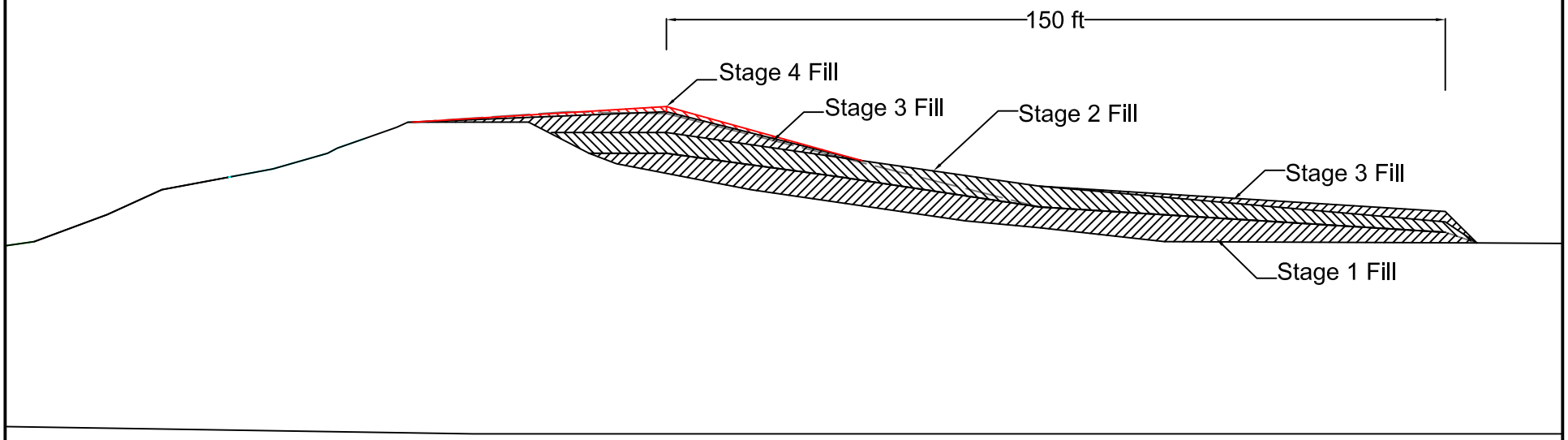
Stage 3 (8 months)



Notes:
1. Stage 3 fill should be placed at least 4 months after Stage 2.
2. Place 4 feet thick fill to the full levee crest width.
3. Place 2 feet thick fill at the edge of toe berm. Taper to no fill at the theoretical catch point.

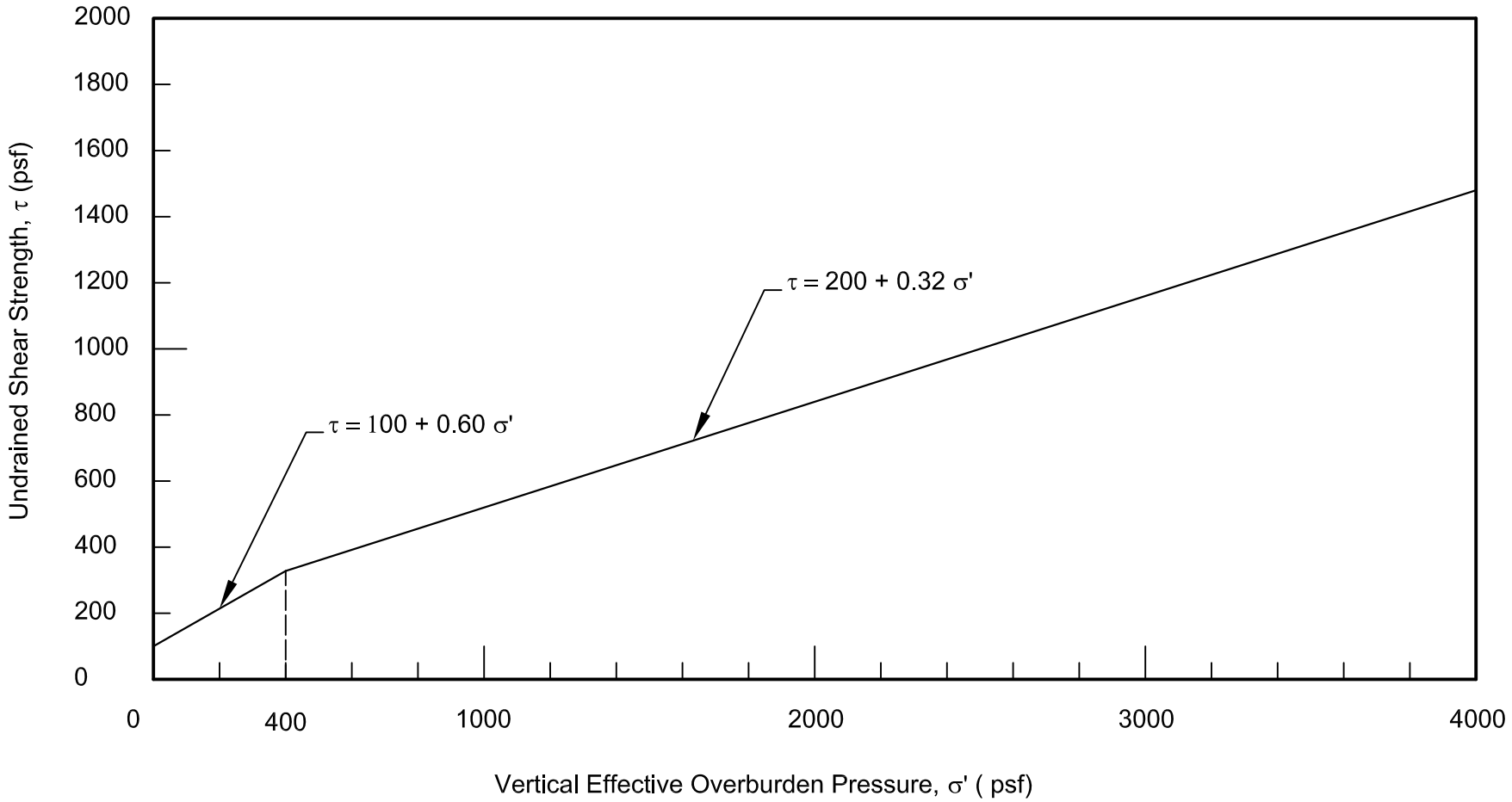
Not to Scale	Sherman Island - Two Fish Release Sites Reclamation District 341 Sacramento County, California	**Typical Design Configuration - Stage 3**	
	Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 14

Stage 4 (12 months)

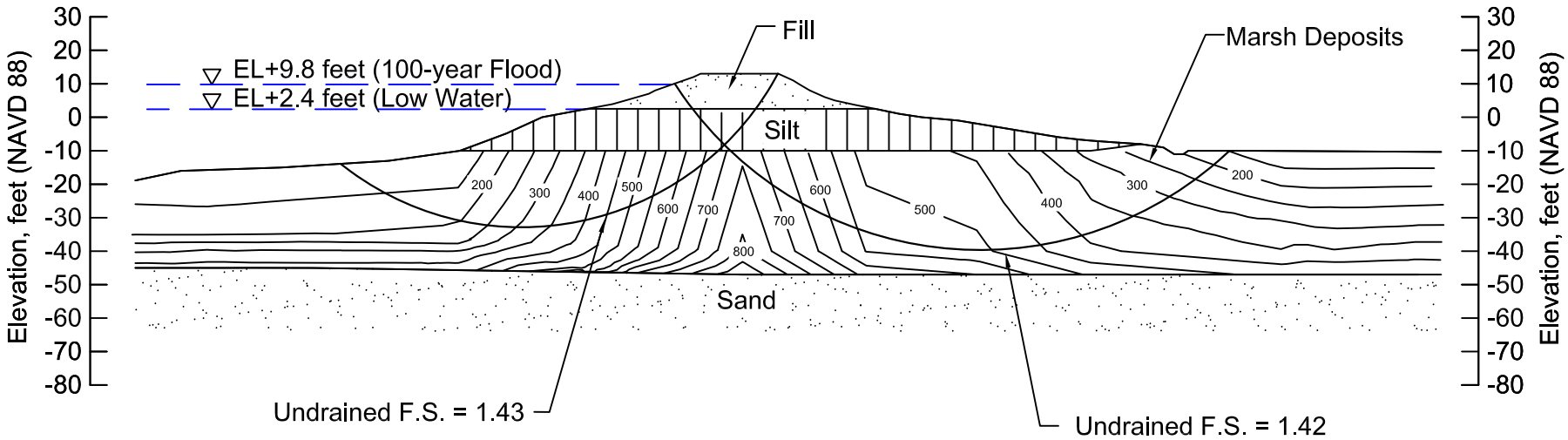


Notes:
1. Stage 4 fill should be placed at least 4 months after Stage 3.
2. Raise crest as needed to accommodate the first year settlement and future settlement.

Not to Scale	Sherman Island - Two Fish Release Sites Reclamation District 341 Sacramento County, California	**Typical Design Configuration - Stage 4**	
	Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 15



Not to Scale	Sherman Island - Two Fish Release Sites Reclamation District 341 Sacramento County, California	**Undrained Strength Envelope for Stability Analysis (End of Construction Conditions)**	
	Hultgren - Tillis Engineers	Project No. 789.04	Plate No. 16



SOIL PARAMETERS

Soil Type	Unit Weight (pcf)	Undrained Strength		Effective Strength	
		Cohesion (psf)	Friction Angle (°)	Cohesion (psf)	Friction Angle (°)
Fill	115	-	-	50	32
Marsh Deposits	70	See Undrained Strength Contours above			
Silt	100	500	-	100	32
Sand	125	-	-	50	38
New Fill	115	-	-	50	32

Note: River stages at 9.8 ft flood level and at 2.4 ft low water level were used in the slope stability analysis for the landside and waterside, respectively.

SCALE
0 50 feet
1 inch = 50 feet

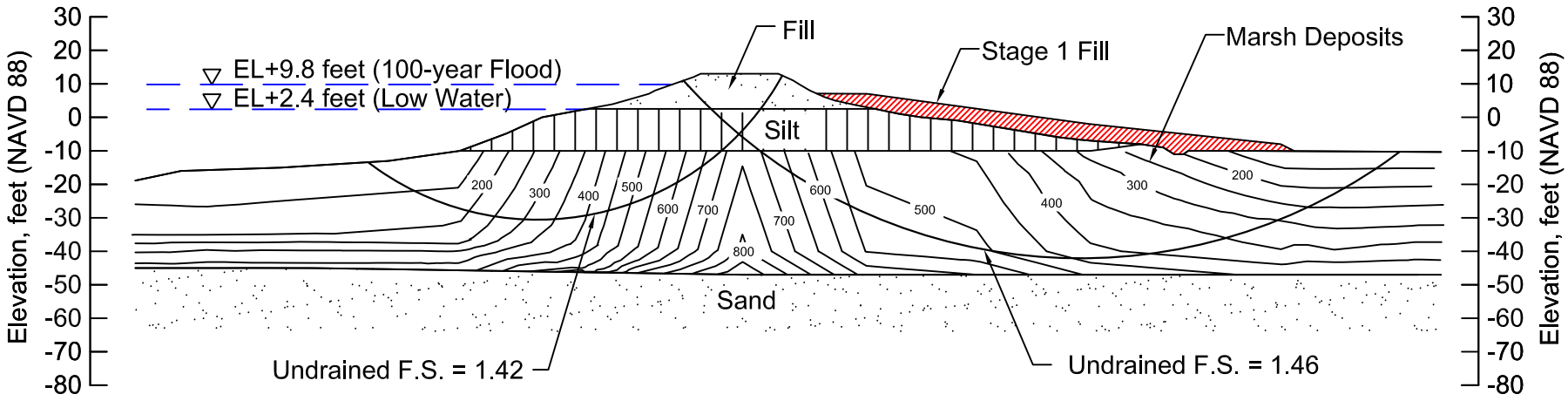
Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Slope Stability Results
Existing Levee
Manzo Ranch

Hultgren - Tillis Engineers

Project No. 789.04

Plate No. 17



SOIL PARAMETERS

Soil Type	Unit Weight (pcf)	Undrained Strength		Effective Strength	
		Cohesion (psf)	Friction Angle (°)	Cohesion (psf)	Friction Angle (°)
Fill	115	-	-	50	32
Marsh Deposits	70	See Undrained Strength Contours above			
Silt	100	500	-	100	32
Sand	125	-	-	50	38
New Fill	115	-	-	50	32

Note: River stages at 9.8 ft flood level and at 2.4 ft low water level were used in the slope stability analysis for the landside and waterside, respectively.

SCALE
0 50 feet
1 inch = 50 feet

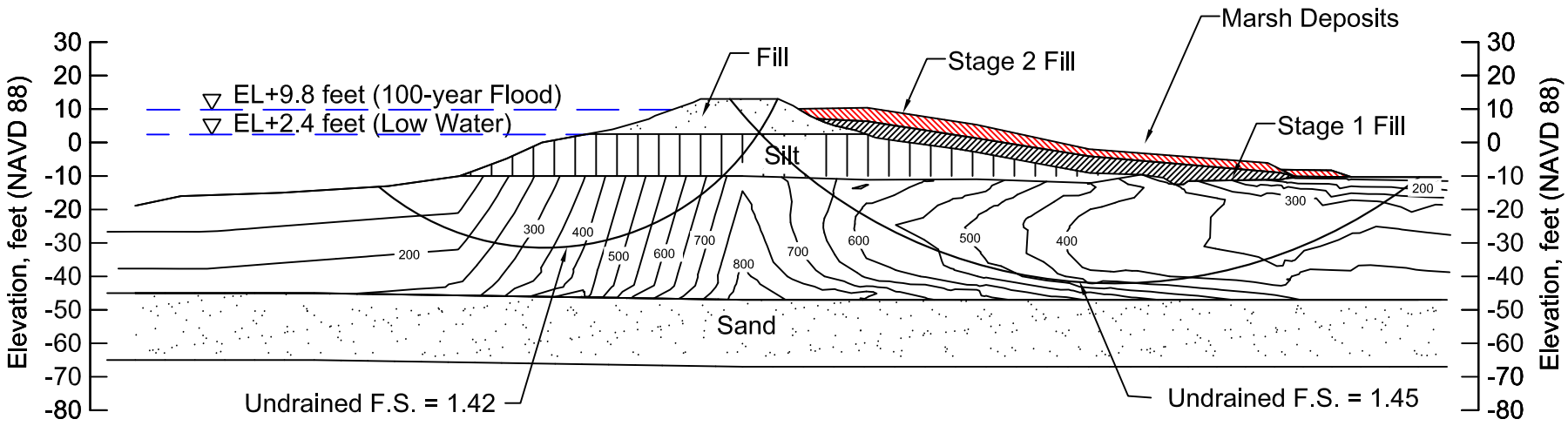
Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Slope Stability Results
End of Construction - Stage 1
Manzo Ranch

Hultgren - Tillis Engineers

Project No. 789.04

Plate No. 18



SOIL PARAMETERS

Soil Type	Unit Weight (pcf)	Undrained Strength		Effective Strength	
		Cohesion (psf)	Friction Angle (°)	Cohesion (psf)	Friction Angle (°)
Fill	115	-	-	50	32
Marsh Deposits	70	See Undrained Strength Contours above			
Silt	100	500	-	100	32
Sand	125	-	-	50	38
New Fill	115	-	-	50	32

Note: River stages at 9.8 ft flood level and at 2.4 ft low water level were used in the slope stability analysis for the landside and waterside, respectively.

SCALE
0 50 feet
1 inch = 50 feet

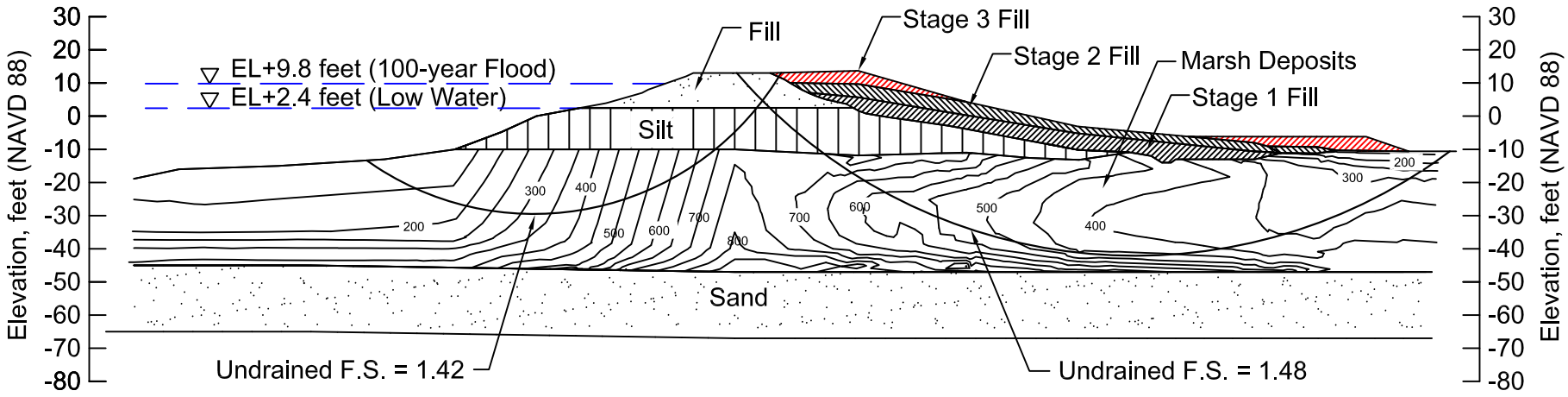
Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Slope Stability Results
End of Construction - Stage 2
Manzo Ranch

Hultgren - Tillis Engineers

Project No. 789.04

Plate No. 19



SOIL PARAMETERS

Soil Type	Unit Weight (pcf)	Undrained Strength		Effective Strength	
		Cohesion (psf)	Friction Angle (°)	Cohesion (psf)	Friction Angle (°)
Fill	115	-	-	50	32
Marsh Deposits	70	See Undrained Strength Contours above			
Silt	100	500	-	100	32
Sand	125	-	-	50	38
New Fill	115	-	-	50	32

Note: River stages at 9.8 ft flood level and at 2.4 ft low water level were used in the slope stability analysis for the landside and waterside, respectively.

SCALE
0 50 feet
1 inch = 50 feet

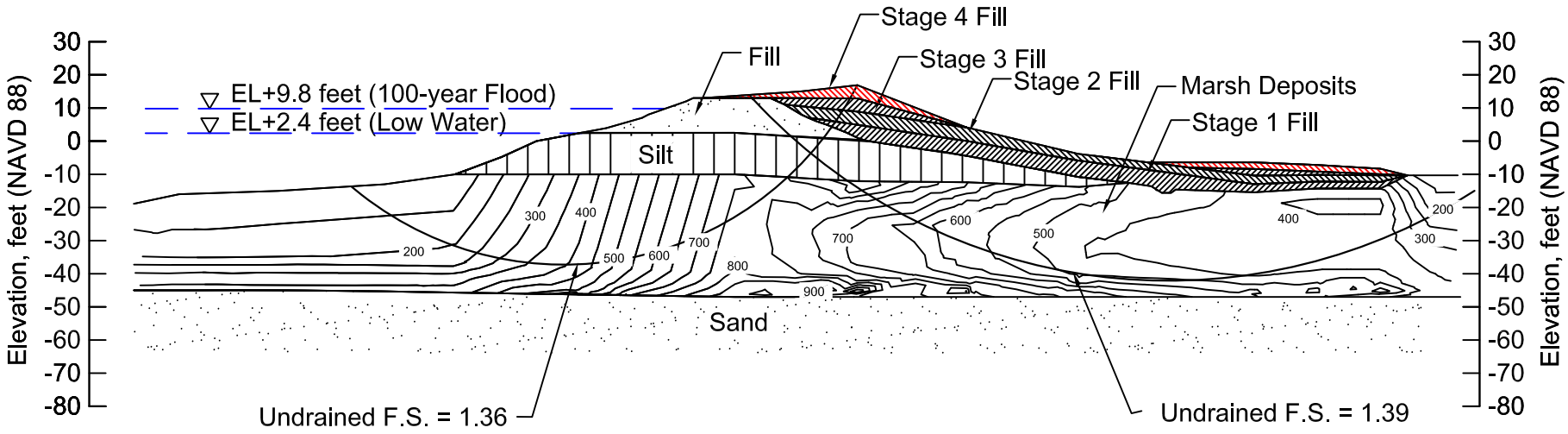
Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Slope Stability Results
End of Construction - Stage 3
Manzo Ranch

Hultgren - Tillis Engineers

Project No. 789.04

Plate No. 20



SOIL PARAMETERS

Soil Type	Unit Weight (pcf)	Undrained Strength		Effective Strength	
		Cohesion (psf)	Friction Angle (°)	Cohesion (psf)	Friction Angle (°)
Fill	115	-	-	50	32
Marsh Deposits	70	See Undrained Strength Contours above			
Silt	100	500	-	100	32
Sand	125	-	-	50	38
New Fill	115	-	-	50	32

Note: River stages at 9.8 ft flood level and at 2.4 ft low water level were used in the slope stability analysis for the landside and waterside, respectively.

SCALE
0 50 feet
1 inch = 50 feet

Sherman Island - Two Fish Release Sites
Reclamation District 341
Sacramento County, California

Slope Stability Results
End of Construction - Stage 4
Manzo Ranch

Hultgren - Tillis Engineers

Project No. 789.04

Plate No. 21