Attachments:

3a FID/JID Southwest Groundwater Banking Project Memorandum of Understanding

3b Fresno ID Southwest Groundwater Banking Project Feasibility Study

3c Fresno ID Reconnaissance Investigation

3d Fresno ID Supplement to Reconnaissance Investigation

3e Fresno ID Preliminary Topographic Survey and Preliminary Drawings

3f Fresno ID Option for Purchase of Property

3g RCWD Groundwater Recharge Feasibility Study

Memorandum of Understanding

Between James Irrigation District and Fresno Irrigation District

for the

Southwest Groundwater Banking Project

Fresno Irrigation District (FID) and James Irrigation District (JID) have been working together to develop a project known as the Southwest Groundwater Banking Project (Project). The project consists of conveyance improvements along Lower Dry Creek between the FID boundary and the JID boundary to increase the capacity to 200 cfs, and the construction of a 60 acre groundwater banking basin. Fresno Irrigation District is submitting the project through the Kings Basin Water Authority for a grant from the California Department of Water Resources Integrated Regional Water Management Implementation Round 2 Grant Program.

FID and JID have a long history of working together regarding flood water routings through FID and other projects, and both District's believe it beneficial to pursue a project together that will provide critical dry year water supply to the region.

The two Districts now desire to enter into this Letter of Intent to proceed with the project and further develop an Agreement for the construction, operation and maintenance of the project.

- Fid has access to Kings River floodwater, local floodwater and stormwater, and other supplies that will serve as supply for the project
- FID has an existing basin within the area and has historically directed floodwater to lands included in project for years
- FID has a flood rights area agreement for conveying and flooding properties in the project area
- JID has a deed for pumping groundwater from the lands in project
- JID has Kings and CVP supplies that may be available for exchange of pumped groundwater

The purpose of the agreement will be to bind FID and JID as joint project proponents to share in the cost of development, utilization of facilities, operation, maintenance, operation and monitoring of the facilities. If at the time of construction that one or the other does not wish to or have their local cost share amount, either party can pay a higher proportionate share of the costs but in return also receives that proportionate increase in the benefits of the project.

The agreement that will be developed will include the following:

- Make clear the obligations of each party
- Require measurement facility at the boundaries of both FID and JID
- Require FID to secure the purchase of additional lands, right of way, or title needed for project
- Require FID to operate recharge basin
- Require FID to provide local water supplies for use in project
- Require the use of the existing JID well field in proximity of project for recovery of banked water
- Require FID and JID to coordinate as needed to schedule operations of bank
- When surface supplies greater than bank capacity allow JID to take surface water supplies when available
- JID water to be made available to FID in exchange for groundwater pumped by JID wells
- The term and duration of the agreement

Signed:

JAMES IRRIGATION DISTRICT	FRESNO IRRIGATION DISTRICT
By:	By:
Name: JOHN MALLYON	Name: GARY R. SERRATO
Title: GENERAL MANAGER	Title: GENERAL MANAGER
Date: MARCH 27, 2013	Date: 3-27-2013

Fresno Irrigation District

Feasibility Study
for
Phase I Southwest Flood Water Protection & Utilization Project

January 2013

Prepared by:

Provost and Pritchard
Consulting Group

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TABLE OF CONTENTS

1 – INTRODUCTION 1
2 – BACKGROUND 1
3 – PREVIOUS STUDIES 4
4 – LOCAL HYDROLOGY & GEOLOGY 7
4.1 – Groundwater 7
4.2 – Based on Previous Investigations 8
4.3 – Recharge Potential Based on Previous Investigations 8
5 – SITE DESCRIPTION 11
5.1 - Project Location 11
5.2 - Site Features 11
5.3 - Topographic Survey 11
6 – PROJECT YIELD 12
6.1 – Water Availability 12
6.2 – Recharge Potential 12
7 – PROJECT DESIGN 14
8 – MONITORING, ASSESSMENT, AND PERFROMANCE MEASURES 16
9 – ENVIRONMENTAL AND PERMITTING ISSUES 18
9.1 – Endangered Species 18
9.2 - Contaminated Materials 18
9.3 – Permits& Approvals 19
9.4 – Land Acquisition 19
10 – COST ESTIMATE AND FINANCIAL ANALYSIS 20
10-.1 – Cost Estimate 20
10-.2 - Financial Analysis 20
11 – PROJECT SCHEDULE 23
12 – CONCLUSIONS AND RECOMENDATIONS 24
13 – REFERENCES 26

Plates

1- Conceptual Southwest Flood Water Protection & Utilization Project
2- Phase I - Southwest Flood Water Protection & Utilization Project
3- Source and Delivery Map

Figures

4.1.1 Groundwater Overdraft Map
4.1.1 WRIME Change in Water Levels Map
4.2.1 WRIME Recharge Potential Map
4.2.2 WRIME Groundwater Level Increase Map
8.1 Preliminary Rare & Endangered Species Map

Tables

1-Cost Estimate Summary
2-Summary of Recent Water Sales

Attachment

1 - Groundwater Recharge Feasibility Study (2012)
2 - Draft Supplement to Reconnaissance Investigation Possible Banking Project/Opportunities
3 - Preliminary Design Drawings
4 - Floodwater Availability
5 – Cost Estimate
6 - Financial Analysis
7 – Schedule
8 – Easements and Right-of-Way Documentation
9 – Supplemental Reports

List of Abbreviations

AF Acre-feet
bgs below ground surface
DWR Department of Water Resources
IRWMP Integrated Regional Water Management Plan
JID James Irrigation District
FID Fresno Irrigation District
NRCS Natural Resources Conservation Service
RCWD Raisin City Water District

1 – INTRODUCTION

Fresno Irrigation District (FID) submitted and the Upper Kings Water Authority has included The Southwest Flood Water Protection & Utilization Project on the project list (as Project ID #66). This project is envisioned to consist of the addition of approximately 160 acres to FID's existing Lower Dry Creek Tail Flood Basin to increase the recharge capacity at the site. With the use of James Irrigation District (JID) adjacent wells and/or the addition of new wells on the property the facility will operate as a groundwater banking facility. The project is envisioned to include improvements to the conveyance facilities (ie Lower Dry Creek Canal) to provide flood and stormwater flows to and from the basin. The project is expected to recharge and potentially create an average annual water supply of between 10,000 and 15,000 acre feet (AF). The project is located in an area that does not have surface supplies and relies exclusively on groundwater to meet demands of agriculture. The area is dominated by a large pumping depression to the South located in and around the Raisin City Water District (RCWD).

The project is important to halt, and ultimately reverse, the current overdraft and provide for sustainable management of surface and groundwater. The project will capture and recharge local flood water lost to the region, and the recharge water will be available for pumping nearby or new wells during dry years. The project would expand the available water supply for the Kings River Region and be directed to an area that is projected to have the largest groundwater level declines within the Authority boundaries. The project would also provide an additional facility to divert flood waters and increase the capacity to handle flood waters in the area.

The ultimate project consists of conveyance improvements along Lower Dry Creek at four Reaches (A, B, C and D) to increase capacity to 200 cfs, and the construction of a 160 acre groundwater banking basin (See Plate 1). The total project cost is estimated to be approximately $20,000,000. Due to the high initial cost to complete the project, and limitations in funding, FID has decided to pursue completion in Phases. This feasibility study is for the first phase of the total project and covers the area along a portion of Reach C and Reach D; and the construction of a 60 acre portion of the 160 acre groundwater banking basin (See Plate 2).

2 – BACKGROUND

Geographically the JID lies southwesterly of the FID within Fresno County. The slope of the land falls from the Northeast (NE) to the Southwest (SW) from FID to JID. Since the founding of the Districts, surface water supplies, especially stormwater, flowed from the foothills to the East of the FID, through FID into the "dry sinks" of Fresno. When filled, the "dry sinks" overflowed, and water flowed overland to the southwest and towards the JID. As development occurred in both districts the irrigation district's conveyance and distribution systems were constructed. Within the FID, stormwater flows were discharged and conveyed from the foothill stream group as well as from the City into the irrigation system. These stormwater flows were directed out of the "dry sinks" and to

the southwest. To allow for disposal of stormwater, FID acquired rights to flood large sections of land. An example is three Sections 8, 17 and 18, T15 S, R18 E MDB&M that is situated between FID and JID. In an effort to limit storm water damage, the FID and others entered into an agreement with JID on June 7, 1953 and April 6th, 1970 to allow for conveyance of flood waters from the Central Wasteway and Dry Creek extension, respectively.

In furthering the need to utilize this resource locally rather than lose it, the Districts have identified an opportunity to construct recharge /banking facilities along the path of the historic storm water flow area. The proposed project consists of a basin situated on the site where the FID has historic flood inundation rights, and JID has contractual groundwater pumping rights. The conveyance to the site from the FID boundary would consist of a 200 cfs channel that is capable of conveying the ultimate flows for the total project. A 100 cfs canal to the JID McMullin Grade canal was also sized for the ultimate project.

It is envisioned that FID would convey both Kings River flood water as well as local flood water to the new banking site. Flows are expected in the winter months. It is also possible that flows could also occur in the summer months to meet irrigation demands. Preliminary routings suggest that a 60 acre site could produce an average yield through intentional recharge of 4,200 acre feet (AF) per year (yr). The conveyance canal would also afford some possibility of storm water delivery (1,300 AF/yr) to existing JID basins as well as conveyance for in-lieu use within the JID.

This report provides a feasibility level study for a portion of the first phase of the *Southwest Flood Water Protection and Utilization* (See Plate 2). The proposed project will consist of the addition of approximately 60 acres to FID existing Dry Creek Tail Flood Basin to increase the recharge capacity at the site, and will use the adjacent wells along McMullin Grade Canal to operate the facility as a groundwater banking facility. The project also includes improvements to conveyance facilities along Reaches C and D as shown on Plate 2 to provide capacity for flood and stormwater flows to and from the basin. This project is expected to recharge and potentially create an average annual water supply of 5,500 acre feet (AF).

The motive for the project is to address groundwater overdraft and beneficial use of floodwaters that flow out of the region. In an average year, surface flows from the Kings River are insufficient to meet the total water demand of irrigated agriculture. Landowners are forced to pump groundwater to make up the difference. Above average years mean less groundwater pumping, but surface water availability often does not match agronomic needs. A common strategy in the region to increase surface water usage and reduce stress on the groundwater is floodwater capture. Expansion of

existing conveyance facilities for routing water to and from the basin are also included in this project. This particular area in the IRWM region urgently needs additional recharge to meet demands for an area near Raisin City that relies solely on groundwater.

The goals of the project include the following:

- Capture and recharge flood water lost to the region, and the recharge water will be available for pumping by nearby wells.
- Expand the available water supply of the Kings River region, and provide an additional 5,500 AF of average annual water supply.
- Reduce reliance on water supplies from the Delta.
- Allow higher quality surface water supplies to percolate and blend with the groundwater at the site.
- Provide an additional facility to divert floodwaters and increase the capacity to handle floodwater in a critical groundwater reliant area.
- Establish additional ponding area for waterfowl, and may be utilized to route water required for sustaining the Kings River Fisheries Management Program.

The project is needed for the following reasons:

- The region is in an area dominated by a large pumping depression. Groundwater levels are declining in the area.
- Most critical area for groundwater decline in the Upper Kings Water Authority area.
- Capture and recharge water typically lost to the region during times when demands are limited.
- Water will be available to be pumped out during dry years and delivered to meet other demands, thereby offsetting groundwater pumping that has occurred.
- The project is estimated to generate a new annual water supply averaging 5,500 AF, which would be available during dry years.
- To increase the water supply reliability of the region to meet IRWMP goals.
- Expansion of existing conveyance facilities to and from the basin to allow for the capture of greater flow volumes during storm events.
- Increase surface storage and provide another location for FID to bank diverted supply.
- Beneficially utilize water that must be diverted to maintain the fishery along Kings River.
- Provide additional recharge and additional water supply to meet the demands near Raisin City which solely relies on groundwater.

This study documents the site's previous studies, local geology, site features, estimated annual recharge capacity, preliminary project design, monitoring and performance measurements, discussion of permitting and environmental issues, cost estimate, financial analysis, and a project schedule.

3 – PREVIOUS STUDIES

In August 2012 a *Groundwater Recharge Feasibility Study* was prepared for Raisin City Water District (RCWD) by WRIME. The study was funded through the Local Groundwater Assistance Grant (AB303 Program) from California Department of Water Resources (DWR) to identify required land, water, and conveyance structures and determine efficient cost effective methods to replenish the groundwater supply through recharge projects, contributing to the attainment of groundwater stability.

The Study included:

- Recharge Site Feasibility Investigation: an evaluation of recharge capacity of potential recharge sites within the boundaries of and in the vicinity of RCWD.
- Conveyance Alternative Analysis: an evaluation of the existing canal inventory and proposed improvements to the existing conveyance facilities and infrastructure.
- Water Availability: identifying the source of water and availability for recharge.
- Site Characterization: presentation of the exploratory program for potential recharge facilities
- Integrated Groundwater and Surface Water Model (Kings IGSM) and Kings IGSM Existing Conditions Baseline scenario overview was provided.
- Recharge Rates and Schedules: summary of the volume and timing of surface water availability.
- Project Impacts and Benefits: summary of the impacts and benefits of the recharge operations at the potential recharge sites.
- Project Prioritization and Preferred Project: summary of recharge scenarios and impact on groundwater storage in the RCWD.

A groundwater recharge feasibility study evaluated suitable lands in the Raisin City Water District (RCWD). The proposed project site along with 3 other sites was identified as favorable based on data sets (including land use, soil type, evidence of A- and E-clay, specific yield, and depth to groundwater) and numerous practical considerations. A copy of portions of the study is included in **Attachment 1**.

A conceptual evaluation and cost analysis to further verify the technical and economic feasibility of the propose project was prepare. In a November *2012 a Draft Supplement to Reconnaissance Investigation Possible Banking Project Opportunities* was prepared for Fresno Irrigation District (FID) and James Irrigation District by Provost & Pritchard Consulting Group to evaluate the larger project. The study was originally conducted in February 2011 to document general information about the James Irrigation District to assist FID with evaluating opportunities that could benefit both districts. The *Draft Supplement* was prepared to present more current water supply information and specifically to evaluate enlargement and interconnections of the irrigation systems as well as evaluate a specific water banking project.

The main topics of the *Draft Supplement* included:

- JID Water Supply and Storage
- FID water supply available to JID
- Interconnection of systems through Lower Dry Creek connection
- Conceptual Banking Program on Lower Dry Creek System
- Identification of Benefits
- Conceptual estimated facility capital improvement costs

The proposed Phase 1 project is a portion of the conceptual groundwater banking project and facility improvements evaluated in the study. A copy of the study is included in **Attachment 2.**

In 2010, JID and the City of San Joaquin in a joint effort prepared an integrated *Groundwater Management Plan (GMP)* to better coordinate efforts, share data, and improve regional management of groundwater resources. The Plan was the first effort by the City of San Joaquin to develop a GMP, and the Plan was an update to JID's GMP prepared in 2001. The GMP satisfies the requirement of California Senate Bill No. 1938, which amends Section 10753 and 10795 of the California Water Code. The GMP also addresses recommended components described in Appendix C of the Department of Water Resources Bulletin 118 (2003 Update). This project is consistent with the goals and objectives of the GMP to stabilize water levels, increase groundwater storage, and prevent further land subsidence.

In 2006 the Kings River Conservation District (KRCD) began working with the Upper Kings Water Forum to evaluate, develop and implement a regional conjunctive use program as part of the Kings Basin IRWMP. On December 1, 2006 a Memorandum regarding *Kings Basin Conjunctive Use Feasibility Analysis* was issued. Information in the memorandum indicted that a feasibility evaluation of regional conjunctive use opportunities was conducted. The three important factors to consider in the conjunctive use project include 1) land availability and physical conditions for recharge; 2) conveyance- canals or pipelines with available capacity to transport water; and 3) water-surface water available within the region for import to the region for recharge. This project has been identified as having land with proximity to existing canals that are suitable for the development of groundwater recharge, and a water source (substantial amount of Kings River flood water).

A November 2005 *Report of Findings for Potential Banking Facilities* study was conducted for JID by Provost & Pritchard Engineering Group. The purpose of study was to investigate the technical aspects of developing an underground water storage project/banking for JID. The study concluded that it was feasible for JID to developed facilities on a large scale to intentionally bank water supplies underground within the District. The studies were based on subsurface soils, geology, and a large pumping depression to the southeast of JID. The subject project is located in an area favorable for long term banking.

KRCD conducted two Feasibility Studies for recharge sites located in vicinity of the project in 2000 and 2005. These studies were conducted as part of the solution to groundwater overdraft in the study area. It was shown that a total diversion of 500 cfs would be needed to negate the overdraft in the area. The subject project is consistent with the overall recommendation to construct recharge facilities so future flood releases can be utilized for maximum benefit within the area.

Portions of supplemental reports and studies discussed above are included in **Attachment 9.**

4 – LOCAL HYDROLOGY & GEOLOGY

4.1 – Groundwater

Groundwater is typically encountered at about 135 feet below the surface at the site, and due to local pumping generally flows south. South of the proposed site is the portion of the Kings Basin that receives no surface water and thus growers are solely dependent upon groundwater for irrigation. A large groundwater depression has formed in that region as a result (See Figure 4.1.1)

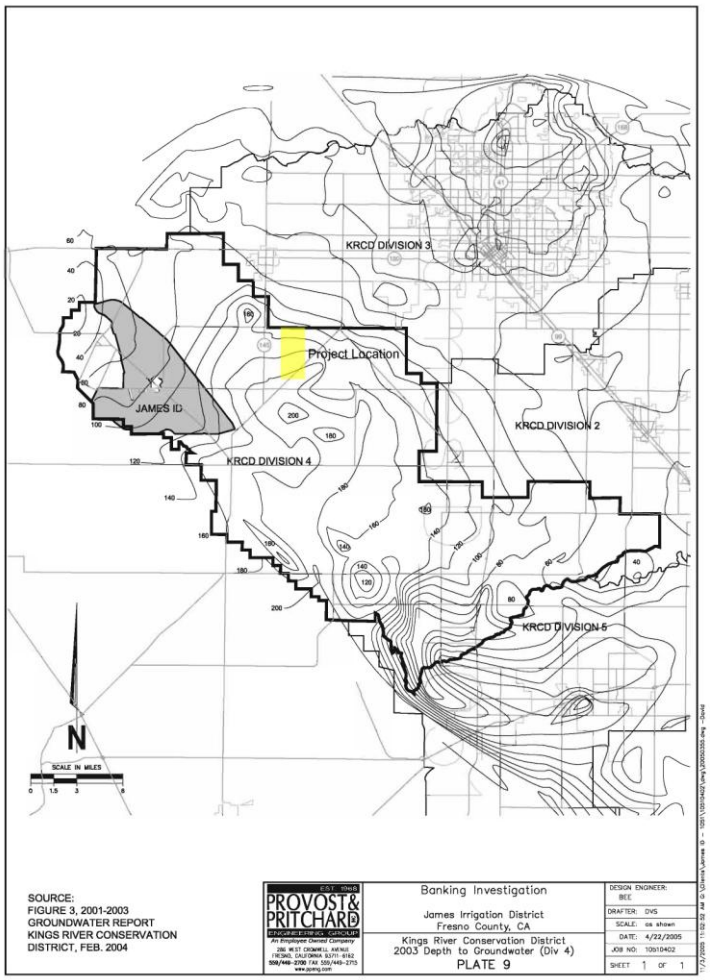

Figure 4.1.1 Groundwater Overdraft Map

In the 2007 Upper Kings Basin IRWMP, WRIME evaluated the change in groundwater levels between existing conditions and Fall 2004 (see Figure 4.1.2) and the 2030 Conditions and Existing Conditions. The figure shows continued decline in water level and a deeper and larger groundwater depression in the Raisin City Water District Area (RCWD) and area of the project. WRIME concluded that water level declines in the RCWD are more significant, and that projects that include reduction in groundwater

pumping and increase in surface water use could reduce the rate of decline in groundwater levels, and if sufficient quantities were provided could reverse the decline.

Based on the hydrologic flow patterns, local groundwater does move toward the depression, and added recharge in this area would eventually be a direct benefit to the region.

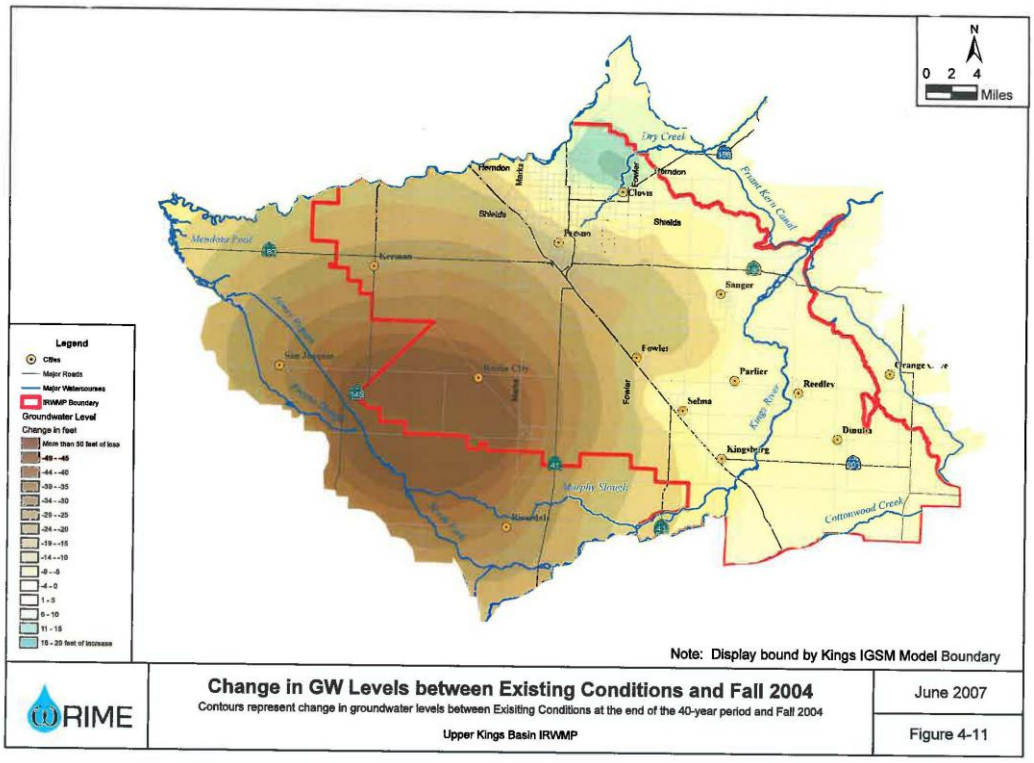

Figure 4.1.2 WRIME Change in GW levels (Upper Kings Basin IRWMP, 2007 Figure 4-11)

4.2 – Based on Previous Investigations

The project site is in an area of quaternary older alluvium. Major features at depth in the region are A-, C-, and E-Clays. The site is located northeast of the extent of the A-clay, and the C-Clay, regionally at depths of approximately 100 feet and 200 feet below ground surface (bgs), respectively. The E-clay (Corcoran Clay) is present in the area at a depth of approximately 600 feet bgs. The depths of wells in the area range from 400 feet to 450 feet deep. These depths suggest that the ability to recover recharged water would not be significantly impacted by the E-clay.

4.3 – Recharge Potential Based on Previous Investigations

WRIME evaluated suitable land based on maps and data sets available as GIS shapefiles which included land use, hydrologic soils, A- and E-clay, specific yield, and depth to groundwater. **Figures 2.5, 2.6, and 2.10** (Attachment 2) shows ranking for specific yield, recharge potential index, and recharge potential, respectively. The

project site was located in an area with a specific yield index of 13%, and a high potential recharge index.

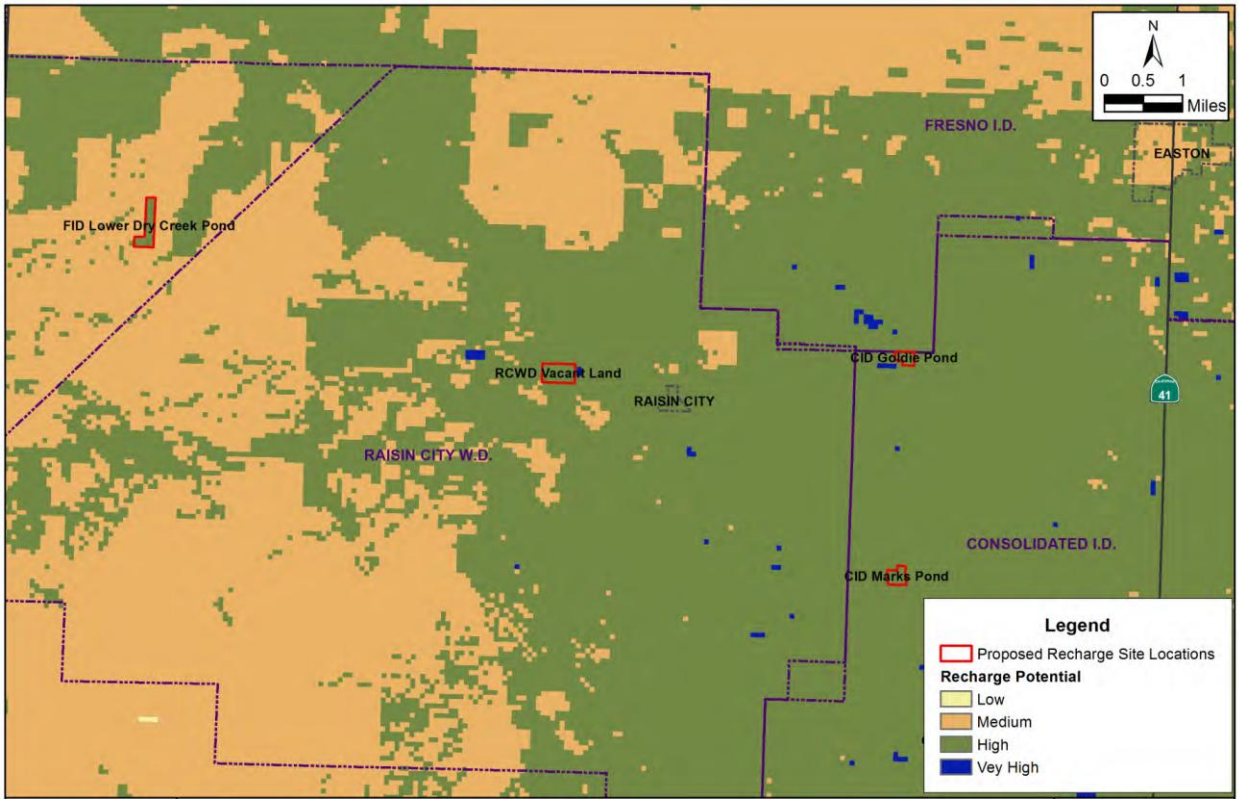

Figure 4.2.1 Recharge Potential from WRIME Study (Figure 2.10)

WRIME also modeled impacts of recharging Kings River flood water at low and high recharge rates scenarios at the FID Lower Dry Creek Pond site. **Figures 8.4, 8.5, and 8.6** (Attachment 2) show groundwater levels increase for low and high recharge scenarios over time. Groundwater levels were predicted to rise approximately 20 to 40 feet in year 21. WRIME calculated that the average groundwater recharge at the site was approximately 5,100 acre feet (AF) per year in the low flow scenario, and approximately 10,200 AF per year in a high flow scenario.

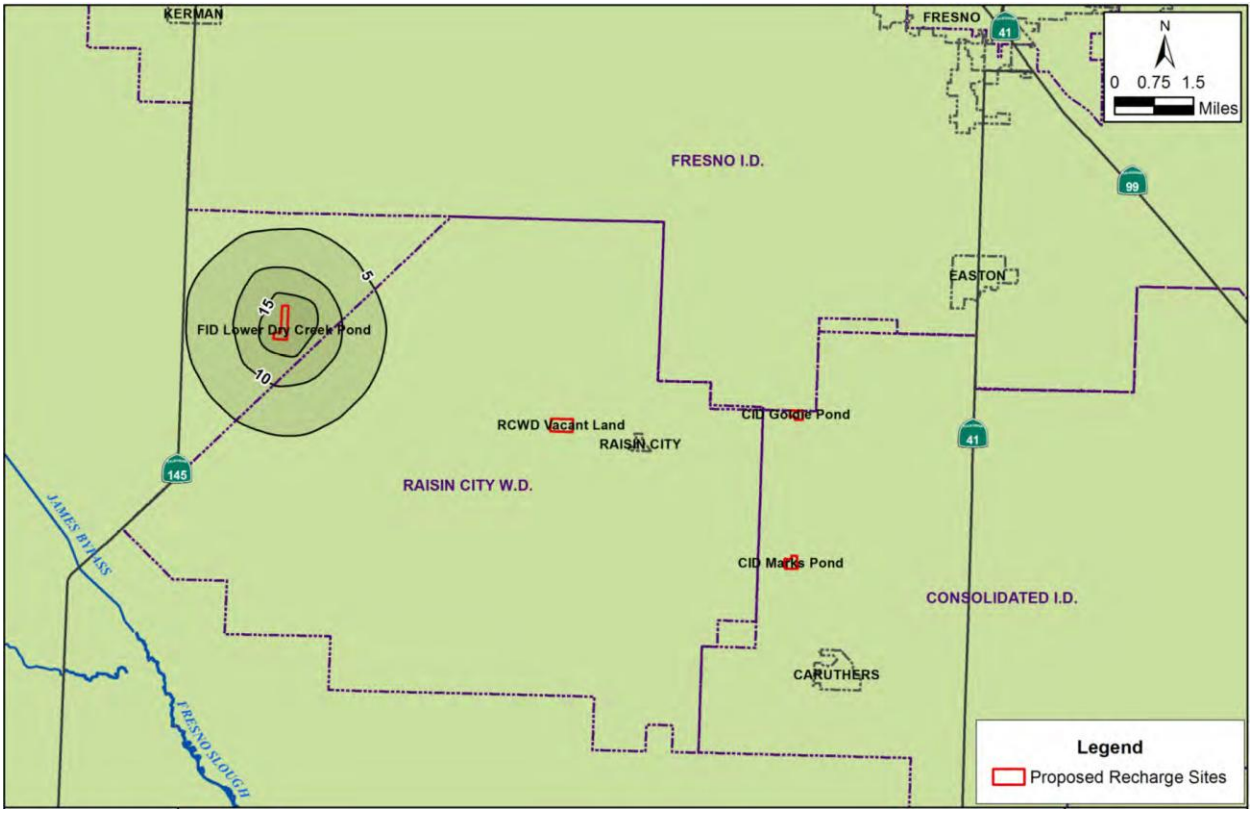

Figure 4.2.2 WRIME Contour Map of GW Level Increases Low Recharge Scenario (Figure 8.5)

5 – SITE DESCRIPTION

5.1 - Project Location

The project site is located in Fresno County, California at FID's existing Flood Rights Area (Lat:36.634952, Long:-120.026493). The project site is located between McMullin Grade Road and Lincoln Avenue between Highway 145 and Jameson Avenue. The site has access from Mc Mullin Grade Road along a canal connecting the pond and JID's McMullin Grade canal. The closest community is Raisin City which is about 7 miles to the southeast. A project location map is shown on Plates 1 and 2.

5.2 - Site Features

The important features on the site are described below:

Lower Dry Creek Canal. Lower Dry Creek Canal is an earthen-lined irrigation canal located along the eastern boundary of the project. The canal originates within the Fresno Irrigation District to the north. The canal has a current capacity of about 100 cubic feet per second (cfs). FID has easement rights with the canal. The canal is higher than the project site ground surface allowing water to be delivered by gravity. The Lower Dry Creek Canal turns east along the Adams Road alignment where the capacity is reduced to 50 cfs. Lower Dry Creek spills into the McMullin Grade Canal located adjacent McMullin Grade Road. McMullin Grade Canal has a capacity of 100 cfs.

Depressed Basin. The main portion of the site includes a depress basin that is part of the 160 acre FID Flood Rights area. The basin is below the natural ground level and has been leveled for agricultural purposes.

Check Structures. A total of four existing check structures are located within the Lower Dry Creek canal starting at the Malaga Avenue alignment and extending to the southern terminus at the intertie structure at Mc Mulling Grade Canal

Culvert Crossing. One County culvert crossing is located along this stretch of the Lower Dry Creek at Lincoln Avenue. Private culvert crossings exist at the Adams Avenue alignment, Jefferson Avenue alignment, and where the Lower Dry Creek Canal spills into the McMullin Grade Canal.

5.3 - Topographic Survey

A topographic survey was performed in December 2012 to assist with the preliminary design. The survey was performed in North American Datum 1983 (NAD 1983) and North American Vertical Datum 1988 (NAVD 88). The survey data confirmed that water could be delivered to the site by gravity from Lower Dry Creek Canal. The topographic data is shown on preliminary design drawings (**Attachment 3**).

6 – PROJECT YIELD

6.1 – Water Availability

Available water supplies for the project were based on data from local stormwater flows and from outflow from Big Dry Creek Reservoir and Little Dry Creek Reservoir, Fancher Creek Reservoir, discharge at James Bypass gaging station, Kings River Fish Flow and Kings River Floodwater. It is anticipated that floodwater would be the primary water source recharged in the basin (see **Plate 3**). Flood release events on the Kings River occur on average about every 3 years. Thousands of acre-feet of flood water have been lost from the region yearly because insufficient infrastructure exists to capture and retain these flows.

Appendix C includes data on the availability of floodwater from approximately 1955 through 2010 for the various water supplies (i.e. Big Dry Creek, Little Dry Creek, Fancher Creek Kings River Floodwater, local stormwater, and Kings River Fish Flows). James Bypass is at the terminus of the Kings River where it meets the San Joaquin River. Flows at this location represent real surplus water that was not used.

Several assumptions were made in calculating the available water supply including:

- A 20% conveyance loss was applied to local stream and local stormwater flow
- The first 200 cfs of Kings River floodwater is diverted by others (first 12,000 AF/month is not available)
- Kings River fish flows are only available every other year due to an agreement with Consolidated Irrigation District.
- A maximum of 750 AF/month is available for any given year.

Based on the historic data, flood water is potentially available for any given month throughout the year, with August, September, and October being the lowest for availability. The average available flood water supply is approximately 185,000 AF/year. (See **Attachment 4**.)

6.2 – Recharge Potential

Based on the proposed pond design and assuming a percolation rate of 0.5 ft/day, a maximum of 750 AF would be available for recharge at the proposed basins for any given month. The average simulated recharge potential was calculated to be approximately 4,200 AF/year at the proposed recharge basins (See **Attachment 4**). Of this 4,200 AF/year, it is anticipated that 10% of the estimated would remain in the aquifer and would not be available for extraction, leaving approximately 3,780 AF of banked water available for extraction and potentially available to be marketed.

By increasing the capacity of the Lower Dry Creek south of the proposed basins to the McMullin Grade Canal to 100 cfs, some of this floodwater could be conveyed to existing JID recharge facilities or be used as in-lieu recharge. JID currently uses Kings River floodwater supplies as its recharge water source. This project would allow floodwater

from other sources to be recharged at JID facilities when Kings River floodwater is not available, typically during the months of March through September. The additional average simulated recharge potential that this project would provide to JID recharge facilities was calculated to be approximately 1,300 AF/year (See **Attachment 4**). It is anticipated that all of this 1,300 AF/year could be available to be marketed and sold.

Combined, the total average annual recharge potential is estimated to be approximately 5,500 AF/year, with approximately 5,080 AF being available for sale on the market.

7 – PROJECT DESIGN

The preliminary project design is included in **Attachment 3**. The main project features include enlarging and, with some design alternatives, concrete lining the Lower Dry Creek Canal, relocation of private canal turnouts, replacement of canal culvert crossings, three recharge basins with levees, project diversion/turnout structure, sedimentation channel with an overflow structure, three interbasin distribution structures, a regulation structure in the Lower Dry Creek Canal, and monitoring wells. The project has various design parameters that are addressed below:

Lower Dry Creek Regulation Structure at FID Boundary (American Ave)
A new check structure is proposed in the Lower Dry Creek at the FID boundary at the American Avenue alignment. This structure would also include flow measurement capability to monitor flows leaving FID.

Lower Dry Creek Canal Enlarging and Lining
The existing Lower Dry Creek Canal would be improved to increase its capacity from approximately 100 cfs to 200 cfs between American Avenue and the proposed recharge basins. The Lower Dry Creek Canal would also be improved to increase its capacity from approximately 50 cfs to 100 cfs between the proposed recharge basins and the Mc Mullin Grade Canal. This would require widening the canal and, with some design alternatives, constructing concrete lining to improve the canal's hydraulic performance. Widening the existing canals would also require the relocation of existing private turnouts and canal weirs. One country road culvert crossing and three other culvert crossings would also need to be replaced or expanded to convey the increased flows.

Basins and Levees
Three recharge basins are proposed, each occupying approximately 20 acres. Levee heights vary with a maximum height of 6 feet above surrounding field grades. Exterior slopes are 3:1, while interior slopes are 5:1 to minimize erosion from wave action, and levee top widths are set to 15 ft to provide a more stable levee and adequate vehicular access.

Project Diversion Structure/Turnout
The turnout consists of an inlet box structure, two 42 inch concrete pipes that can accommodate open flow propeller meters. The outlet of this structure also has a set concrete sill that would maintain full pipe flow to maintain accuracy of the flow meters. The diversion pipelines were designed to accommodate 100 cfs. With this flowrate, the basins can be filled in about 1.5 days.

Settling Channel
A settling channel is proposed to help settle out medium sized silts to better maintain infiltration rates in the basin. An overflow weir structure would be constructed near the downstream end of this channel to allow only the top layer of water in the channel to

continue into the basins, preventing the water with suspended silts from entering the basins.

Lower Dry Creek Regulation Structure

A new check structure is proposed in the Lower Dry Creek just downstream of the basins where the canal turns east, in order to better control water level at the project diversion structure. Wooden boards will be placed in the check structure when water needs to be diverted. The closest check structure downstream of the site is approximately one half mile and would not be able to control water level as desired.

8 – MONITORING, ASSESSMENT, AND PERFORMANCE MEASURES

Monitoring equipment for the project will include the following:

Monitoring Wells. Three monitoring wells will be installed on the north, west, and south sides of the basin. Long term monitoring of the effects of the recharge to the project will be accomplished through monitoring groundwater levels and periodic water quality testing in these wells as well as a suite of neighboring wells located along McMullin Grade Road within the JID well field. These wells are located downgradient with respect to the basin.

Flow meters (Project Inlet Pipe). A propeller flowmeter will be installed in each of the two 42-inch diameter inlet pipes leading to the project's sedimentation channel. The meters will measure water deliveries to the recharge basins.

Staff gauges. One staff gauge will be installed in each of the recharge basins to monitor water levels. These will be used to assist with operations and help to monitor long-term recharge rates.

Performance measures will include the following:

Volume Recharged. The volume of water recharged will be equal to the volume diverted in the recharge basin from Lower Dry Creek Canal minus evaporation losses, which are expected to be small.

Floodwater Diverted. Floodwater diverted will be equal to the volume of Kings River floodwater diverted into the basins. This will reduce floodflow peaks in downstream river sections. In most years, this parameter will be the entire volume diverted to the project.

Increase in Groundwater Levels. Groundwater levels will be monitored in new dedicated monitoring wells, existing nearby recovery wells along the McMullin Canal, and other wells in the vicinity. This data will be used to determine the change in groundwater storage and rate of groundwater outflow from the area. Improvements in groundwater storage would be evident in the accumulated groundwater monitoring efforts within the Kings Basin (KRCD's monitoring network, CASGEM, irrigation district monitoring efforts, etc.).

Maintenance of Recharge Rate. The recharge rate will be measured using staff gauges and accounting for new deliveries and evaporation losses. The success in maintaining the recharge rate with use of the settling channel and annual ripping/disking will also be evaluated with this parameter.

Improvement in Groundwater Quality. Groundwater quality may be periodically tested in the monitoring wells. Groundwater quality monitoring required under the

pending Long Term Irrigated Lands Regulatory Program could potentially show the improvements in groundwater quality from the introduction of large volumes of Kings River water.

9 – ENVIRONMENTAL AND PERMITTING ISSUES

9.1 – Endangered Species

The California Department of Fish and Game Natural Diversity Database was used to determine if special status species (threatened or endangered species) or signs of the species (i.e. burrows, nests, etc) have been seen on or near the site. **Figures 2.11.a and Figure 2.11b** taken from the WRIME Report (Attachment 1) are schematic maps showing the records of special status species in the area. No species are known to occur on the site or within a radius of one half to one mile radius. The site is previously disturbed farmland and probably has limited habitat for special status species. Prior to final design, it is recommended that a professional biologist perform a reconnaissance level survey to look for signs of federal and state rare and endangered plant, animal, and vegetation types.

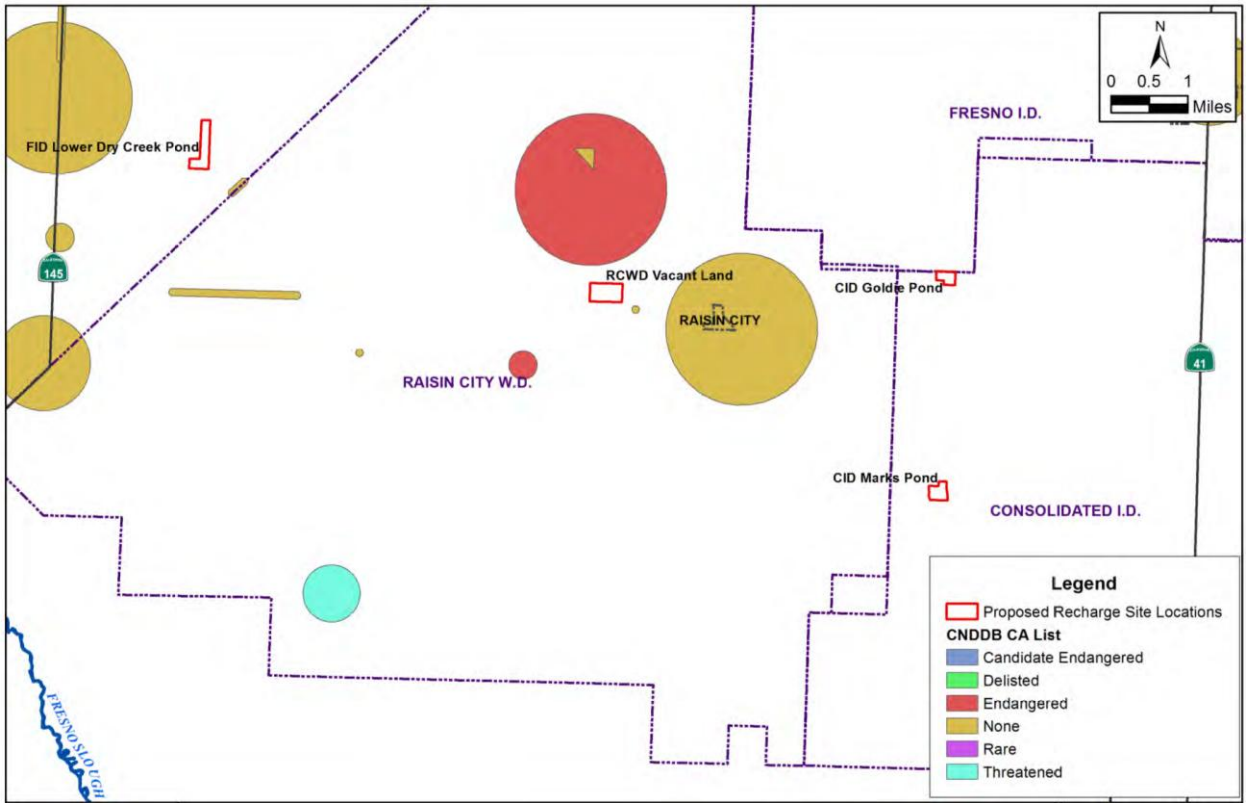

Figure 8.1 WRIME Areas Specified for Rare & Endangered Plant, Animals, and Vegetation Types (Figure 2.11.b)

9.2 - Contaminated Materials

The California State Water Resources Control Board maintains a database called Geotracker that includes records of known contamination sites. This database was used to look for present or past contamination on or near the project site. In reviewing the database no known contamination site were identified within two miles of the subject

site. Prior to construction, it is recommended that an environmental professional perform a Phase I environmental site assessment of the property to identify potential contamination not shown on the Geotracker Website.

9.3 – Permits& Approvals

The anticipated permits and approvals needed for the project are described below.

NEPA/CEQA

The two environmental regulations that need compliance relate to NEPA and CEQA. Since the project will not involve Federal monies nor a Federal Decision NEPA does not apply. The CEQA will include the preparation of an Initial Study for the project. This will include performing the necessary biological, cultural and archeological resource surveys. Based on the minimal impacts expected to agricultural land, it is expected that a Negative Declaration or Mitigated Negative Declaration will be filed.

Grading permit

In Fresno County, government agencies are exempt from the County Grading Ordinance, and therefore, a grading permit for the project will not be needed.

Storm Water Pollution Prevention Plan (SWPPP)

FID will prepare a SWPPP for the project. A SWPPP is required in California for any project disturbing one or more acres. A certified SWPPP designer will prepare the Plan according to the California Regional Water Quality Control Board guidelines.

Dust Control Plan

FID will prepare a Dust Control Plan (DCP) for the project. A DCP will be required by the San Joaquin Valley Air Pollution Control District (SJVAPCD) for this project. The DCP will be prepared according to SJVAPCD guidelines.

9.4 – Land Acquisition

It anticipated that fee title will be acquired for the land used for the conveyance canals outside of FID, and for the basin site. FID has existing agreements and easements for conveying flood water to the project site (**see Attachment 8**). Prior to construction, FID will acquire the land in fee title.

10 – COST ESTIMATE AND FINANCIAL ANALYSIS

10-.1 – Cost Estimate

Feasibility-level cost estimates were prepared for the design and construction of the project. The estimates are in 2012 dollars and include a 20% contingency. This contingency is considered appropriate for the feasibility-level design and accounts for uncertainty in dimensions, uncertainty in design, allowance for neglected items, and uncertainty in regulatory requirements. It is assumed that the project's construction will go through a public bid process and will be contracted out. Unit prices were developed from historical values on similar projects and judgment of constructability factors.

Three project alternatives were developed for this project, differing only by the amount of concrete canal lining and canal widening along the Lower Dry Creek Canal. A significant portion of the overall construction costs was attributed to the concrete canal lining, so the costs of varying amounts of lining the canal were reviewed. In addition, the use of canal lining reduced the proposed channel width, so slightly less land would have to be purchased. The table below summarizes the project costs for each alternative. A detailed breakdown of the costs is provided in **Attachment 5.**

Table 1 – Cost Estimate Summary

No.	Description	Alternative 1 (Full Concrete Lining)	Alternative 2 (Lining on Canal Sides Only)	Alternative 3 (No Canal Lining)
a	Direct Project Admin Costs	$242,000	$242,000	$242,000
b	Land Acquisition	$1,120,000	$1,120,000	$1,140,000
c	Planning/Design/Engineering/ Environmental Documentation	$182,000	$182,000	$177,000
d	Construction	$3,540,000	$3,130,000	$2,340,000
e	Environmental Compliance/Mitigation	$5,000	$5,000	$5,000
f	Construction Admin	$128,000	$128,000	$107,000
g	Legal Services	$20,000	$20,000	$20,000
h	Contingency (20%)	$770,000	$688,000	$525,000
	TOTAL	$6,013,000	$5,523,000	$4,562,000

10-.2 - Financial Analysis

Value of Benefit

The value of the recharge benefit is assumed to be the typical cost for Kings River contractors to purchase dry-year water supplies. A review of recent water sales was

used to determined a reasonable water supply cost. The table below summarizes some recent water sales in the region.

Table 2. Summary of Recent Water Sales

Year	Supply From	Supply To	Price ($/AF)	Volume (AF)	% Kings River Water Year
2012	Ag – East side	Ag – West side	100	5,000	55%
2010	Ag – East side	Ag – West side	275	30,000	121%
2010	Ag – East side	Ag – West side	200	15,000	121%
2009	Ag – East side	Ag – West side	400	12,000	79%
2009	Ag – East side	Ag – East side	50	5,000	79%
2009	Ag – West side	Ag – West side	400	12,000	79%
2009	Ag – East side	Ag – West side	100	10,000	79%
2009	Ag	Urban	500+	14,000	79%
2009	Ag	Urban	500+	3,000	79%

From the information provided it is clear that water demand continues to cause the value of water to rise. The price that has been paid in recent years varies from about $100/AF in normal years to a high of $400/AF in a recent dry year. It is questionable whether the $400/AF is an anomaly or is sustainable given current agricultural economics.

Urban demand continues to expand. Cities, municipalities, and developers continue to search and acquire water supplies for new development. As shown in the above table, the price for dependable supplies to urban uses is greater than that for agriculture, continues to rise, and is expected to continue into the future.

Based on this comparison, a value of $225 per acre-foot was assumed as the project benefit. It should be noted that this amount is considered conservative, as the proposed project will provide dry-year supply.

Operation and Maintenance Costs

Operation and maintenance will include operating the valves and weirs, recording flowmeter data, maintaining levees, monitoring wells, and disking and ripping the basin interior each year to loosen soils and maintain a good recharge rate. Most of these tasks will require minimal effort, and be performed as part of the regular duties of district staff. The primary water supply would come from Kings River floodwater, which is free to members of the Kings River Water Association. Other banking projects in the region have maintenance costs that are roughly 0.5% of the project capital costs (including land purchase).

Replacement Costs

Replacement costs will be needed for mechanical equipment (gates, valves, and flowmeters), and monitoring well equipment. However, since this project does not include recovery wells or other expensive and complex machinery, it is assumed that

the replacement costs for the items listed above would be included in the "operation and maintenance costs" discussed previously.

Cost Analysis

Alternative 3 provides the same water supply benefit, but cost significantly less than the other two alternatives. The benefit to cost ratios would be lower for Alternatives 1 and 2.

A financial analysis was performed over a 50-year period using a six percent discount rate. The costs (initial, maintenance and replacement) and benefits (recharged water) were calculated over a 50-year period. The project benefit cost ratio is provided below:

$$\frac{\text{Project Benefits}}{\text{Project Costs}} = \frac{\$16{,}090{,}000}{\$7{,}860{,}000} = \mathbf{2.0}$$

Details of the financial analysis are provided in **Attachment 6**.

11 – PROJECT SCHEDULE

The preliminary project schedule is shown on the Gant Chart in **Attachment 7**. The schedule assumes that James ID applies for an Integrated Regional Water Management (IRWM) Implementation Grant by March 29, 2013, and that the grant funds will be awarded in October 2013.

12 – CONCLUSIONS AND RECOMENDATIONS

Favorable Project Characteristics

The project has many favorable characteristics for a groundwater recharge/banking project including:

Existing flood rights. The project site has been designated as an area for conveyance of flood waters from the Central Wasteway and Dry Creek Extension.

Favorable soils. The area has been identified as a favorable area with high potential index for recharge.

Lower Dry Creek Canal. The project is located adjacent to Lower Dry Creek Canal which can deliver water directly to the site.

Topographic depression. The site is located in an excavated depression that allows water to be delivered by gravity, and will reduce the height of levees needed to develop the project. Groundwater mounding in adjacent areas is a small concern since the water will be percolated below the ground surface.

Area not served by surface water. The project will recharge 4200 AF water in an area that does not receive surface water.

Groundwater Recharge Study. In a 2012 study the site was identified as an area having good potential for groundwater recharge.

Project Benefits

The project will provide the following benefits:

Reduce Overdraft. The area is dominated by a large pumping depression due to agriculture solely dependent upon groundwater for irrigation. The recharge/banking project will help to reduce continued overdraft in the area by adding an average 4200 AF/year.

Groundwater Recharge. A simulation of historical Kings River floodwater shows that an average of 4200 AF/year could be recharged in the basin. Total recharge may be higher if flood water can be diverted to James ID recharge basins, which could add an additional average annual water supply of 1300 AF. This recharged water will help to raise groundwater levels, lower pumping costs, and provide a dry year water supply.

Floodwater. The project will have the capacity to divert up to 200 cfs of floodwater and provide 271 AF of storage capacity. This will reduce water levels and peak flows on the Kings River during flood periods, and thereby reduce flood damage.

Fishery improvement. The project may provide a beneficial place for use of the water diverted from storage

Habitat creation. The project will provide 60 acres to create temporary habitat for waterfowl and a water supply for terrestrial creatures when it is filled with water.

Improve reuse & water delivery. The project will include increasing the capacity of Lower Dry Creek Canal to the recharge basins and McMullin Grade Canal. This increased conveyance capacity will provide other benefits to deliver surface water to the McMullin Canal and other reclamation basins in JID.

Rural Residential Area. The project will have secondary benefits to the rural residential area locate directly southeast of the site next to McMullin Grade Canal. The recharged water will help to maintain or raise groundwater levels, and improve water quality.

Disadvantaged Communities. The project will have secondary benefits to disadvantaged Communities including the Community of Raisin City. The recharged water will eventually flow to these communities and help to improve their water quality and raise groundwater levels.

Joint working relationship. Both FID and JID will have developed a program that will mutually benefit both agencies.

Recommendations

Each of the three project alternatives (varying by the amount of concrete lining in the Lower Dry Creek Canal) would provide the same approximate water supply benefit to the region. Thus, Alternative 3 (unlined canal) would provide the highest cost to benefit ratio, and is the recommended alternative for this project.

However, there are benefits to lining the Lower Dry Creek Canal in the future. Primarily, lining the canal would allow the districts to better direct groundwater recharge water to areas in greater need for groundwater recharge. FID estimates that there is a 20% conveyance loss through its system due to canal percolation. While canal percolation does provide the benefit of groundwater recharge, being able to direct recharge water to areas of greater need and higher levels of groundwater overdraft lining the Lower Dry Creek Canal could prove to be cost effective.

13 – REFERENCES

WRIME, Groundwater Recharge Feasibility Study, August 2012.

Provost & Pritchard Consulting Group, Draft Supplement to Reconnaissance Investigation Possible Banking/Opportunities, November 2012

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Kings River Conservation District, *Draft McMullin Recharge Feasibility Study,* 2005

Provost & Pritchard Engineering Group, Report of Findings for Potential Banking Facilities, November 2005

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FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

PLATES

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 1

GROUNDWATER RECHARGE FEASIBILITY STUDY (2012)

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 2

DRAFT SUPPLEMENT TO RECONNAISSANCE INVESTIGATION POSSIBLE BANKING PROJECT/OPPORTUNITIES (2012)

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 3

PRELIMINARY DESIGN DRAWINGS

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 4

KINGS RIVER FLOODWATER AVAILABILITY

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 5

COST ESTIMATE

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 6

FINANCIAL ANALYSIS

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 7

SCHEDULE

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 8

EASEMENTS

FRESNO IRRIGATION DISTRICT

SOUTHWEST FLOOD WATER PROTECTION AND UTILIZATION PROJECT

ATTACHMENT 9

SUPPLEMENTAL REPORTS

Kings River Flood Release to San Joaquin River
Monthly Discharge in Acre-Feet at James Bypass Gaging Station

(units in acre-feet)

Water Year	Year % of Avg	Water Year Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1949															
1950	40%	Dry	0	0	0	0	1,845	168	0	0	0	0	28,643	43,760	74,416
1951	93%	Normal	308	0	0	0	887	35	0	0	0	0	0	0	1,228
1952	166%	Wet	35,800	6,110	22,400	20,050	170,800	150,400	30,910	8	0	0	0	0	436,478
1953	67%	Dry	3,455	0	0	0	0	0	0	0	0	0	0	0	3,455
1954	78%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	66%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	153%	Wet	468	57,672	29,384	0	0	0	0	0	0	0	0	3,681	91,205
1957	74%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	149%	Wet	0	0	958	27,241	93,363	90,610	625	0	0	0	0	0	212,797
1959	48%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	42%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	34%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	110%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	112%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	52%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	117%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	72%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	196%	Wet	0	0	0	48,657	194,665	149,853	88,811	0	0	0	0	2,884	484,870
1968	50%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	258%	Wet	38,510	184,090	285,920	278,860	302,640	318,170	132,580	10,570	0	0	0	0	1,551,340
1970	78%	Normal	53,320	4,780	2,700	0	0	0	0	0	0	0	0	1,370	62,170
1971	69%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	50%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	125%	Wet	0	0	0	0	0	139	0	0	0	0	0	0	139
1974	123%	Normal	93	0	0	18,340	19,940	47,980	0	0	0	0	0	0	86,353
1975	93%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	32%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	23%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	203%	Wet	0	6,670	94,810	198,670	202,040	48,820	176	0	0	0	0	0	551,186
1979	102%	Normal	0	397	218	640	9,430	730	337	0	0	0	0	0	11,752
1980	179%	Wet	57,150	86,990	252,370	77,650	70,020	12,230	23,170	0	0	0	0	0	579,580
1981	61%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	183%	Wet	0	0	0	157,860	213,240	62,480	19,160	8	0	0	0	0	452,748
1983	263%	Wet	218,320	260,350	319,270	301,490	303,280	292,440	183,520	66,190	48,290	0	91,790	224,340	2,309,280
1984	116%	Normal	185,000	900	650	200	0	0	0	0	0	105,920	140,620	135,320	568,610
1985	74%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	192%	Wet	0	10,584	211,518	215,285	139,539	90,824	0	0	0	0	0	0	667,750
1987	46%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	49%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	53%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	40%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	63%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	41%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	150%	Wet	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	51%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	203%	Wet	0	0	32,644	158,918	228,382	87,044	77,364	2,158	0	0	0	0	586,510
1996	123%	Normal	0	0	6,637	0	67,441	464	0	0	0	0	0	0	74,542
1997	156%	Wet	169,558	223,588	38,887	0	0	0	0	0	0	0	0	5,080	437,113
1998	182%	Wet	494	6,179	65,325	212,350	278,273	266,025	157,807	0	0	0	0	0	986,453
1999	74%	Dry	0	0	0	0	0	0	0	0	0	0	3,501	16,542	20,043
2000	90%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	59%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	67%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	84%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	62%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	149%	Wet	0	0	0	0	48,545	14,648	0	0	0	0	0	0	63,193
2006	173%	Wet	0	0	0	186,228	256,443	169,468	0	0	0	0	0	0	612,139
2007	40%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	72%	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	79%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	121%	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
Total			762,474	848,310	1,363,691	1,902,439	2,600,773	1,802,528	714,460	78,934	48,290	105,920	264,554	432,977	10,925,350
Min			0	0	0	0	0	0	0	0	0	0	0	0	0
Max			218,320	260,350	319,270	301,490	303,280	318,170	183,520	66,190	48,290	105,920	140,620	224,340	2,309,280
Average			12,500	13,907	22,356	31,188	42,636	29,550	11,712	1,294	792	1,736	4,337	7,098	185,889

Kings River Fish Flow Required for FID
Kings River Fisheries Agreement Exhibit C

(units in acre-feet)

Water Year	Year % of Avg	Water Year Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1951	93%	Normal	2,066	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,246
1952															
1953	67%	Dry	0	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	9,180
1954															
1955	66%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1956															
1957	73%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1958															
1959	48%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1960															
1961	33%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1962															
1963	111%	Normal	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1964															
1965	115%	Normal	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1966															
1967	194%	Wet	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	0	9,180
1968															
1969	255%	Wet	0	0	0	0	0	0	0	0	0	2,372	2,295	2,372	7,038
1970															
1971	68%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1972															
1973	124%	Normal	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1974															
1975	92%	Normal	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1976															
1977	23%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1978															
1979	101%	Normal	2,372	1,745	0	0	0	0	0	0	0	2,372	2,295	2,372	11,155
1980															
1981	60%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1982															
1983	260%	Wet	0	0	0	0	0	0	0	0	0	2,372	0	0	2,372
1984															
1985	73%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1986															
1987	45%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1988															
1989	53%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1990															
1991	63%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1992															
1993	148%	Wet	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1994															
1995	201%	Wet	2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
1996															
1997	154%	Wet	0	0	0	0	0	0	0	0	0	2,372	2,295	0	4,667
1998															
1999	73%	Dry	2,372	2,142	0	0	0	0	0	0	0	2,372	0	0	6,885
2000															
2001	59%		2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
2002															
2003	84%		2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
2004															
2005	149%		2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
2006															
2007	40%		2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
2008															
2009	79%		2,372	2,142	0	0	0	0	0	0	0	2,372	2,295	2,372	11,552
2010															
		Total	61,353	57,437	0	0	0	0	0	0	0	71,145	64,260	61,659	315,854
		Average	2,045	1,915	0	0	0	0	0	0	0	2,372	2,142	2,055	10,551

Notes: 1) Monthly flowrate estimated assuming 45cfs per day for 30 days for the months of October thru February, when the monthly total did not exceed this amount.
2) 20% conveyance losses were considered
3) Kings River fish flows are only available every other year due to an agreement with Consolidated Irrigation District

Flowrate	45	45	45	45	45	45	45	45	45	45	45	45
Acre-feet per day =	90	90	90	90	90	90	90	90	90	90	90	90
Days in month =	31	28	31	30	31	30	31	31	30	31	30	31
Total =	2790	2520	2790	2700	2790	2700	2790	2790	2700	2790	2700	2790
15% conveyance loss =	418.5	378	418.5	405	418.5	405	418.5	418.5	405	418.5	405	418.5
Total =	2371.5	2142	2371.5	2295	2371.5	2295	2371.5	2371.5	2295	2371.5	2295	2371.5

Available Water Supplies (1955-2010)

(Water Supplies include Big Dry Creek, Little Dry Creek, Fancher Creek, Kings River Floodwater, Local Stormwater and Kings River Fish Flows)

(units in acre-feet)

Water Year	Water Year % of Avg	Water Year Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1955	66%	Dry	3,201	2,595	522	229	30	58	18	72	0	2,400	2,396	10,378	21,898
1956	153%	Wet	7,708	50,003	19,937	1,104	1,002	458	90	371	0	146	69	1	80,889
1957	73%	Dry	2,789	2,677	317	229	180	70	21	87	0	2,406	2,316	2,602	13,694
1958	147%	Wet	1,162	3,166	6,516	22,342	82,629	78,892	84	346	0	136	64	1	195,339
1959	48%	Dry	2,492	3,293	67	0	0	0	0	0	0	2,372	2,295	2,372	12,890
1960	42%	Dry	277	350	0	128	0	0	0	0	0	0	448	0	1,203
1961	33%	Dry	2,504	2,142	10	0	0	0	0	0	0	2,372	2,449	2,453	11,930
1962	109%	Normal	531	5,883	1,862	315	82	157	47	194	0	76	36	1	9,184
1963	111%	Normal	3,184	3,784	1,232	1,833	486	165	48	199	0	2,449	2,726	2,372	18,477
1964	51%	Dry	0	0	69	0	0	0	0	0	0	59	126	418	671
1965	115%	Normal	4,460	3,600	1,428	2,426	194	174	52	215	0	2,456	2,768	2,560	20,331
1966	71%	Dry	214	385	301	125	35	67	20	82	0	33	161	906	2,330
1967	194%	Wet	4,414	5,585	4,164	43,955	184,312	138,480	76,955	593	0	2,604	2,546	12	463,620
1968	49%	Dry	13	26	126	0	0	0	0	0	0	138	241	369	912
1969	255%	Wet	40,618	187,760	287,863	271,711	292,104	307,901	120,826	1,015	0	2,769	2,484	2,410	1,517,462
1970	77%	Normal	43,696	926	1,610	223	42	80	24	98	0	38	351	617	47,706
1971	68%	Dry	3,176	2,740	442	141	135	62	18	77	0	2,402	2,309	2,771	14,275
1972	50%	Dry	0	0	0	0	0	0	0	0	0	0	640	102	742
1973	124%	Normal	3,396	6,331	4,608	1,225	833	202	60	248	0	2,474	2,441	2,562	24,380
1974	122%	Normal	2,046	1,259	1,766	9,206	8,247	36,174	58	239	0	206	45	67	59,314
1975	92%	Normal	2,730	3,024	1,924	766	116	112	34	138	0	2,444	2,321	2,372	15,980
1976	31%	Dry	0	952	0	0	0	0	0	0	49	141	0	0	1,142
1977	23%	Dry	2,372	2,142	10	0	41	0	0	0	0	2,372	2,295	2,888	12,120
1978	201%	Wet	4,203	13,131	94,420	194,851	194,203	37,909	154	638	13	250	206	2	539,977
1979	101%	Normal	3,288	3,705	3,121	2,074	564	134	40	164	0	2,436	2,328	2,372	20,225
1980	177%	Wet	47,978	82,435	246,049	70,147	58,498	634	11,291	498	0	195	92	2	517,818
1981	60%	Dry	2,799	2,218	566	118	0	0	0	0	0	2,372	2,351	2,372	12,792
1982	181%	Wet	2,119	3,175	6,650	151,979	201,970	50,900	7,286	518	26	352	1,068	3,684	429,726
1983	260%	Wet	216,216	268,007	331,886	297,148	294,597	281,515	171,776	55,247	36,298	2,786	80,545	214,214	2,250,235
1984	115%	Normal	174,476	1,526	1,360	570	120	172	51	212	0	94,003	128,900	123,572	524,962
1985	73%	Dry	2,598	2,548	505	132	37	71	22	87	0	2,406	2,828	2,372	13,604
1986	190%	Wet	1,759	12,058	209,588	204,327	127,779	79,286	138	569	0	222	106	334	636,165
1987	45%	Dry	2,610	2,234	356	0	0	0	0	0	0	2,372	2,295	2,420	12,287
1988	48%	Dry	133	0	0	361	0	0	0	0	0	0	107	374	974
1989	53%	Dry	2,372	2,188	320	0	0	0	0	0	28	2,372	2,295	2,372	11,946
1990	40%	Dry	466	85	0	0	166	0	0	0	0	0	0	0	717
1991	63%	Dry	2,372	2,144	3,838	832	0	0	0	0	0	2,372	2,295	2,428	16,280
1992	41%	Dry	241	1,283	484	0	0	0	0	0	0	305	0	430	2,743
1993	148%	Wet	4,354	4,145	1,474	530	149	442	86	352	0	2,509	2,401	2,380	18,821
1994	50%	Dry	38	235	0	92	77	0	0	0	0	0	146	85	673
1995	201%	Wet	9,980	6,081	39,546	149,916	218,073	75,765	65,519	638	0	2,622	2,413	2,650	573,204
1996	122%	Normal	306	4,327	3,343	630	55,441	0	0	0	0	248	241	4,959	69,496
1997	154%	Wet	168,111	225,141	28,632	958	370	0	0	0	0	2,372	2,720	0	428,302
1998	180%	Wet	2,701	16,111	58,253	209,921	270,407	257,075	145,872	50	54	0	0	0	960,444
1999	73%	Dry	2,840	3,004	584	533	144	130	61	30	0	2,949	274	4,542	15,090
2000	90%	Normal	550	7,648	5,476	288	274	6	328	1,443	0	371	0	0	16,386
2001	59%	Dry	2,796	2,454	0	222	0	0	0	0	0	2,372	2,549	2,615	13,008
2002	67%	Dry	32	0	0	0	0	0	0	0	0	0	200	320	552
2003	84%	Normal	2,372	2,198	0	471	0	0	0	0	0	2,372	2,295	2,866	12,573
2004	62%	Dry	0	177	138	0	0	0	0	0	0	371	0	553	1,239
2005	149%	Wet	3,023	2,720	1,443	608	36,803	2,749	0	0	0	2,372	2,295	2,628	54,641
2006	173%	Wet	955	0	1,396	183,731	245,298	157,470	46	10	0	0	0	85	588,990
2007	40%	Dry	2,372	2,436	0	0	0	0	0	0	0	2,372	2,295	2,722	12,196
2008	72%	Dry	861	295	103	98	76	0	0	0	0	0	136	54	1,423
2009	121%	Normal	2,436	2,488	0	0	0	0	0	0	0	2,474	2,295	2,771	12,463
2010	195%	Wet	0	30	1,623	0	0	0	0	0	0	0	0	0	1,654
		Average	14,252	17,229	24,570	32,616	40,634	26,916	10,733	1,151	651	2,970	4,950	7,579	184,252

Notes: 1) A 20% conveyance loss was applied to local streams and local stormwater flow
2) Assumes first 200 cfs of Kings River floodwater is diverted by others (i.e. first 12,000 AF/month is not available)

Additional Water Supplies Available to James ID (1955-2010) with Project

(Water Supplies include Big Dry Creek, Little Dry Creek, Fancher Creek, Local Stormwater and Kings River Fish Flows. Does not include Kings River Floodwater)

Assumes James ID is already taking Kings River floodwater when available, so only new supplies are included in this table.
(units in acre-feet)

Water Year	Water Year % of Avg	Water Year Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1955	66%	Dry	3,201	2,595	522	229	30	58	18	72	0	2,400	2,396	10,378	21,896
1956	153%	Wet	7,708	4,331	2,553	1,104	1,002	458	90	371	0	146	69	1	17,833
1957	73%	Dry	2,789	2,677	317	229	180	70	21	87	0	2,406	2,316	2,602	13,694
1958	147%	Wet	1,162	3,166	6,516	7,101	1,266	282	84	346	0	136	64	1	20,125
1959	48%	Dry	2,492	3,293	67	0	0	0	0	0	0	2,372	2,295	2,372	12,890
1960	42%	Dry	277	350	0	128	0	0	0	0	0	0	448	0	1,203
1961	33%	Dry	2,504	2,142	10	0	0	0	0	0	0	2,372	2,449	2,453	11,930
1962	109%	Normal	531	5,883	1,862	315	82	157	47	194	0	76	36	1	9,184
1963	111%	Normal	3,184	3,784	1,232	1,833	486	165	48	199	0	2,449	2,726	2,372	18,477
1964	51%	Dry	0	0	69	0	0	0	0	0	0	59	126	418	671
1965	115%	Normal	4,460	3,600	1,428	2,426	194	174	52	215	0	2,456	2,768	2,560	20,331
1966	71%	Dry	214	385	301	125	35	67	20	82	0	33	161	906	2,330
1967	194%	Wet	4,414	5,585	4,164	7,298	1,647	627	144	593	0	2,604	2,546	12	29,634
1968	49%	Dry	13	26	126	0	0	0	0	0	0	138	241	369	912
1969	255%	Wet	14,108	15,670	13,943	4,851	1,464	1,731	246	1,015	0	2,769	2,484	2,410	60,692
1970	77%	Normal	2,376	926	1,610	223	42	80	24	98	0	38	351	617	6,386
1971	68%	Dry	3,176	2,740	442	141	135	62	18	77	0	2,402	2,309	2,771	14,275
1972	50%	Dry	0	0	0	0	0	0	0	0	0	0	640	102	742
1973	124%	Normal	3,396	6,331	4,608	1,225	833	202	60	248	0	2,474	2,441	2,562	24,380
1974	122%	Normal	2,046	1,259	1,766	2,866	307	194	58	239	0	206	45	67	9,054
1975	92%	Normal	2,730	3,024	1,924	766	116	112	34	138	0	2,444	2,321	2,372	15,980
1976	31%	Dry	0	952	0	0	0	0	0	0	49	141	0	0	1,142
1977	23%	Dry	2,372	2,142	10	0	41	0	0	0	0	2,372	2,295	2,888	12,120
1978	201%	Wet	4,203	13,131	11,610	8,181	4,163	1,089	154	636	13	250	206	2	43,637
1979	101%	Normal	3,288	3,705	3,121	2,074	564	134	40	164	0	2,430	2,328	2,372	20,225
1980	177%	Wet	2,828	7,445	5,679	4,497	478	404	121	498	0	195	92	2	22,238
1981	60%	Dry	2,709	2,216	566	118	0	0	0	0	0	2,372	2,351	2,372	12,792
1982	181%	Wet	2,119	3,175	6,650	6,119	730	420	126	518	26	352	1,068	3,684	24,986
1983	260%	Wet	9,896	19,657	24,616	7,658	3,317	1,075	256	1,057	8	2,786	755	1,874	72,955
1984	115%	Normal	1,476	1,526	1,360	570	120	172	51	212	0	83	280	252	6,102
1985	73%	Dry	2,598	2,548	505	132	37	71	22	87	0	2,406	2,828	2,372	13,604
1986	190%	Wet	1,759	12,058	10,070	1,042	240	462	138	509	0	222	106	334	26,999
1987	45%	Dry	2,610	2,234	356	0	0	0	0	0	0	2,372	2,295	2,420	12,287
1988	48%	Dry	133	0	0	361	0	0	0	0	0	0	107	374	974
1989	53%	Dry	2,372	2,188	320	0	0	0	0	0	28	2,372	2,295	2,372	11,946
1990	40%	Dry	466	85	0	0	166	0	0	0	0	0	0	0	717
1991	63%	Dry	2,372	2,144	3,836	832	0	0	0	0	0	2,372	2,295	2,428	16,280
1992	41%	Dry	241	1,283	484	0	0	0	0	0	0	305	0	430	2,743
1993	148%	Wet	4,354	4,145	1,474	530	149	442	86	352	0	2,509	2,401	2,380	18,821
1994	50%	Dry	38	235	0	92	77	0	0	0	0	0	146	85	673
1995	201%	Wet	9,980	6,081	18,902	2,998	1,691	721	155	638	0	2,622	2,413	2,650	48,852
1996	122%	Normal	306	4,327	3,343	630	0	0	0	0	0	248	241	4,959	14,055
1997	154%	Wet	10,553	13,553	1,745	956	370	0	0	0	0	2,372	2,720	0	32,269
1998	180%	Wet	2,701	16,111	4,928	9,571	4,134	3,050	65	50	54	0	0	0	40,664
1999	73%	Dry	2,840	3,004	584	533	144	130	61	30	0	2,949	274	0	10,548
2000	90%	Normal	550	7,648	5,478	288	274	6	328	1,443	0	371	0	0	16,386
2001	59%	Dry	2,796	2,454	0	222	0	0	0	0	0	2,372	2,549	2,615	13,008
2002	67%	Dry	32	0	0	0	0	0	0	0	0	0	200	320	552
2003	84%	Normal	2,372	2,198	0	471	0	0	0	0	0	2,372	2,295	2,866	12,573
2004	62%	Dry	0	177	138	0	0	0	0	0	0	371	0	553	1,239
2005	149%	Wet	3,023	2,720	1,443	608	258	101	0	0	0	2,372	2,295	2,628	15,448
2006	173%	Wet	955	0	1,396	9,503	855	2	46	10	0	0	0	85	12,851
2007	40%	Dry	2,372	2,436	0	0	0	0	0	0	0	2,372	2,295	2,722	12,196
2008	72%	Dry	661	295	103	98	76	0	0	0	0	0	136	54	1,423
2009	121%	Normal	2,436	2,488	0	0	0	0	0	0	0	2,474	2,295	2,771	12,463
2010	195%	Wet	0	30	1,623	0	0	0	0	0	0	0	0	0	1,654
		Average	2,648	3,789	2,746	1,588	459	227	47	183	3	1,293	1,228	1,504	15,715

Notes: 1) A 20% conveyance loss was applied to local streams and local stormwater flow

Simulated Recharge Potential at Project Basins
(Assumes 0.5 ft/day infiltration and 50 acres of recharge basins)

Water Year	Water Year % of Avg	Water Year Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1955	66%	Dry	750	750	522	229	30	58	18	72	0	750	750	750	4,679
1956	153%	Wet	750	750	750	750	750	458	90	371	0	146	69	1	4,885
1957	73%	Dry	750	750	317	229	180	70	21	87	0	750	750	750	4,654
1958	147%	Wet	750	750	750	750	750	750	84	346	0	136	64	1	5,131
1959	48%	Dry	750	750	67	0	0	0	0	0	0	750	750	750	3,817
1960	42%	Dry	277	350	0	128	0	0	0	0	0	0	448	0	1,203
1961	33%	Dry	750	750	10	0	0	0	0	0	0	750	750	750	3,760
1962	109%	Normal	531	750	750	315	82	157	47	194	0	76	36	1	2,938
1963	111%	Normal	750	750	750	750	486	165	48	199	0	750	750	750	6,148
1964	51%	Dry	0	0	69	0	0	0	0	0	0	59	126	418	671
1965	115%	Normal	750	750	750	750	194	174	52	215	0	750	750	750	5,885
1966	71%	Dry	214	385	301	125	35	67	20	82	0	33	161	750	2,173
1967	194%	Wet	750	750	750	750	750	750	750	593	0	750	750	12	7,355
1968	49%	Dry	13	26	126	0	0	0	0	0	0	138	241	369	912
1969	255%	Wet	750	750	750	750	750	750	750	750	0	750	750	750	8,250
1970	77%	Normal	750	750	750	223	42	80	24	98	0	38	351	617	3,724
1971	68%	Dry	750	750	442	141	135	62	18	77	0	750	750	750	4,626
1972	50%	Dry	0	0	0	0	0	0	0	0	0	0	640	102	742
1973	124%	Normal	750	750	750	750	750	202	60	248	0	750	750	750	6,510
1974	122%	Normal	750	750	750	750	750	750	58	239	0	206	45	67	5,116
1975	92%	Normal	750	750	750	750	116	112	34	138	0	750	750	750	5,650
1976	31%	Dry	0	750	0	0	0	0	0	0	49	141	0	0	940
1977	23%	Dry	750	750	10	0	41	0	0	0	0	750	750	750	3,801
1978	201%	Wet	750	750	750	750	750	750	154	636	13	250	206	2	5,760
1979	101%	Normal	750	750	750	750	564	134	40	164	0	750	750	750	6,152
1980	177%	Wet	750	750	750	750	750	634	750	498	0	195	92	2	5,920
1981	60%	Dry	750	750	566	118	0	0	0	0	0	750	750	750	4,433
1982	181%	Wet	750	750	750	750	750	750	750	518	26	352	750	750	7,645
1983	260%	Wet	750	750	750	750	750	750	750	750	750	750	750	750	9,000
1984	115%	Normal	750	750	750	570	120	172	51	212	0	750	750	750	5,626
1985	73%	Dry	750	750	505	132	37	71	22	87	0	750	750	750	4,604
1986	190%	Wet	750	750	750	750	750	750	138	569	0	222	106	334	5,869
1987	45%	Dry	750	750	356	0	0	0	0	0	0	750	750	750	4,106
1988	48%	Dry	133	0	0	361	0	0	0	0	0	0	107	374	974
1989	53%	Dry	750	750	320	0	0	0	0	0	28	750	750	750	4,098
1990	40%	Dry	466	85	0	0	166	0	0	0	0	0	0	0	717
1991	63%	Dry	750	750	750	750	0	0	0	0	0	750	750	750	5,250
1992	41%	Dry	241	750	484	0	0	0	0	0	0	305	0	430	2,210
1993	148%	Wet	750	750	750	530	149	442	86	352	0	750	750	750	6,058
1994	50%	Dry	38	235	0	92	77	0	0	0	0	0	146	85	673
1995	201%	Wet	750	750	750	750	750	750	750	638	0	750	750	750	8,138
1996	122%	Normal	306	750	750	630	750	0	0	0	0	248	241	750	4,426
1997	154%	Wet	750	750	750	750	370	0	0	0	0	750	750	0	4,870
1998	180%	Wet	750	750	750	750	750	750	750	50	54	0	0	0	5,354
1999	73%	Dry	750	750	584	533	144	130	61	30	0	750	274	750	4,755
2000	90%	Normal	550	750	750	288	274	6	328	750	0	371	0	0	4,067
2001	59%	Dry	750	750	0	222	0	0	0	0	0	750	750	750	3,972
2002	67%	Dry	32	0	0	0	0	0	0	0	0	0	200	320	552
2003	84%	Normal	750	750	0	471	0	0	0	0	0	750	750	750	4,221
2004	62%	Dry	0	177	138	0	0	0	0	0	0	371	0	553	1,239
2005	149%	Wet	750	750	750	608	750	750	0	0	0	750	750	750	6,608
2006	173%	Wet	750	0	750	750	750	750	46	10	0	0	0	85	3,890
2007	40%	Dry	750	750	0	0	0	0	0	0	0	750	750	750	3,750
2008	72%	Dry	661	295	103	98	76	0	0	0	0	0	136	54	1,423
2009	121%	Normal	750	750	0	0	0	0	0	0	0	750	750	750	3,750
2010	195%	Wet	0	30	750	0	0	0	0	0	0	0	0	0	780
		Average	584	604	463	376	274	218	121	160	16	447	454	470	4,187

Total (1955-2010): 234,460

Notes: 1) A 20% conveyance loss was applied to local streams, local stormwater flow and Fish Flows.
2) Assumes first 200 cfs of Kings River floodwater is diverted by others (i.e. first 12,000 AF/month is not available)
3) Evaporation is assumed to be the same as direct precipitation onto the basin

Simulated Additional Recharge Potential at Existing James I.D. Basins
(Assumes 0.5 ft/day infiltration at existing JID basins)

Total James I.D Recharge Basin Floor Area =	381	acres
Assumed infiltration rate =	0.5	ft/day
Assumed max monthly infiltration =	5794	AF

Water Year	Water Year % of Avg	Water Year Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1955	66%	Dry	3,201	2,595	522	229	30	58	18	72	0	2,400	2,393	5,754	829
1956	153%	Wet	5	0	0	1,104	1,002	458	90	371	0	146	69	0	3,026
1957	73%	Dry	2,789	2,877	317	229	180	70	21	87	0	2,400	2,316	2,602	904
1958	147%	Wet	1,152	1,050	0	0	0	0	0	346	0	135	64	1	346
1959	48%	Dry	1,192	293	67	0	0	0	0	0	0	2,372	2,205	2,372	67
1960	42%	Dry	1,171	350	0	128	0	0	0	0	0	0	148	0	128
1961	33%	Dry	2,594	2,142	10	0	0	0	0	0	0	3	2,449	2,453	10
1962	109%	Normal	1,531	1,194	1,862	315	82	157	47	194	0	3	36	1	2,857
1963	111%	Normal	3,194	2,784	1,232	1,833	486	165	48	199	0	9	2,726	2,372	3,962
1964	51%	Dry	9	0	69	0	0	0	0	0	0	59	128	418	69
1965	115%	Normal	0	600	1,428	2,426	194	174	52	215	0	3	2,768	2,560	4,489
1966	71%	Dry	1,174	395	301	125	35	67	20	82	0	3	361	906	630
1967	194%	Wet	7,414	5,555	4,164	0	0	0	0	593	0	1,194	2,510	0	4,757
1968	49%	Dry	13	36	126	0	0	0	0	0	0	3	241	369	126
1969	255%	Wet	5	0	0	0	0	0	0	0	0	2,762	1,194	2,410	0
1970	77%	Normal	3	0	0	223	42	80	24	98	0	3	351	0	467
1971	68%	Dry	3	740	442	141	135	62	18	77	0	3	409	2,771	876
1972	50%	Dry	0	0	0	0	0	0	0	0	0	0	540	102	0
1973	124%	Normal	3	794	4,608	1,225	833	0	60	248	0	4	441	2,562	6,974
1974	122%	Normal	0	259	1,766	0	0	0	58	239	0	35	45	67	2,063
1975	92%	Normal	3	1,024	1,924	766	116	112	34	138	0	4	2,321	2,372	3,090
1976	31%	Dry	0	352	0	0	0	0	0	0	49	141	0	0	49
1977	23%	Dry	2	142	10	0	41	0	0	0	0	2	295	2,398	51
1978	201%	Wet	5	0	0	0	0	0	0	636	13	250	3	2	649
1979	101%	Normal	3	0	0	0	0	0	0	164	0	3	295	2,372	164
1980	177%	Wet	3	0	0	0	0	0	0	498	0	45	92	2	498
1981	60%	Dry	2,789	2,216	566	118	0	0	0	0	0	2	2,351	2,372	683
1982	181%	Wet	3,139	2,175	5,794	0	0	0	0	0	26	352	2,368	3,684	5,820
1983	260%	Wet	0	0	0	0	0	0	0	0	0	743	0	0	0
1984	115%	Normal	0	0	0	0	120	172	51	212	0	0	0	0	555
1985	73%	Dry	2,558	548	505	132	37	71	22	87	0	3	295	2,372	854
1986	190%	Wet	1,753	0	0	0	0	0	138	569	0	73	106	334	706
1987	45%	Dry	1,170	234	356	0	0	0	0	0	0	2	295	2,420	356
1988	48%	Dry	3	0	0	361	0	0	0	0	0	0	167	374	361
1989	53%	Dry	2	180	320	0	0	0	0	0	28	0	1,195	2,372	348
1990	40%	Dry	2,159	85	0	0	166	0	0	0	0	0	0	0	166
1991	63%	Dry	2,372	2,144	3,838	832	0	0	0	0	0	3	295	2,428	4,670
1992	41%	Dry	941	1,280	484	0	0	0	0	0	0	3,95	0	400	484
1993	148%	Wet	4	145	1,474	530	149	442	86	352	0	2	2,401	2,380	3,031
1994	50%	Dry	3	95	0	92	77	0	0	0	0	0	148	85	169
1995	201%	Wet	754	84	0	0	0	0	0	0	0	2	413	2,650	0
1996	122%	Normal	789	327	0	630	0	0	0	0	0	3	241	4,959	630
1997	154%	Wet	3	0	0	958	370	0	0	0	0	2	720	0	1,327
1998	180%	Wet	2	0	0	0	0	0	0	50	54	0	0	0	104
1999	73%	Dry	2,4	901	584	533	144	130	61	30	0	3	0	0	1,482
2000	90%	Normal	5	5,734	5,478	288	274	6	328	1,443	0	1	0	0	7,816
2001	59%	Dry	3	54	0	222	0	0	0	0	0	3	2,549	2,615	222
2002	67%	Dry	2	0	0	0	0	0	0	0	0	9	200	320	0
2003	84%	Normal	2	138	0	471	0	0	0	0	0	2	2,295	2,668	471
2004	62%	Dry	9	137	138	0	0	0	0	0	0	1	0	553	138
2005	149%	Wet	3	2,720	1,443	608	0	0	0	0	0	2,372	2,295	2,628	2,051
2006	173%	Wet	5	0	1,396	0	0	0	46	10	0	0	0	85	1,451
2007	40%	Dry	2	436	0	0	0	0	0	0	0	2,372	2,295	2,722	0
2008	72%	Dry	1	295	103	98	76	0	0	0	0	0	136	54	278
2009	121%	Normal	2,498	483	0	0	0	0	0	0	0	2,474	2,295	2,771	0
2010	195%	Wet	9	30	1,623	0	0	0	0	0	0	0	0	0	1,623
		Average	1,014	1,909	767	261	82	40	22	125	3	1,29	1,205	1,373	1,300
														Total (1955-2010):	72,779

Assumed to be diverted from Kings River floodwater to JID during Kings River Floodwater Flows

JID unable to divert Kings River floodwater to JID during Kings River Floodwater Flows

Notes: 1) A 20% conveyance loss was applied to local streams, local stormwater flow and Fish Flows.
2) Assumes theoretical maximum additional supply that can be delivered to James ID is limited to 100 cfs, or 6,000 AF/month.
3) Evaporation is assumed to be the same as direct precipitation onto the basin
4) Assumes James ID recharge basins are already full of Kings River floodwater during the months of October through February, and cannot take new supply.

James Irrigation District
Reconnaissance Investigation

February 2011

Prepared for:

Fresno Irrigation District

Prepared by:

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Table of Contents

1 Background Information 1

1.1 History 1

1.2 Organization 1

1.3 Crops 2

1.4 District Assessments 2

1.5 Water Rates 2

2 Water Supply 3

2.1 USBR 3

2.2 Kings River Water 3

2.3 Groundwater 4

2.4 Transfers and Spills 4

3 Facilities and Capacities 5

3.1 P-Booster 5

3.2 Main Canal 5

3.3 Laterals 5

3.4 K-Basin 5

3.5 San Luis Drain 6

3.6 James Weir 6

3.7 East Side Well Field 6

3.8 McMullin Grade Canal 6

3.9 Fresno Slough Bypass Facilities 7

3.10 Spill points 7

4 Water Demand and Timing 8

4.1 Normal Year 8

4.2 Wet Years 8

4.3 Dry Year 8

4.4 Water Augmentation Project 8

5 Project Opportunities 10

5.1 Water Banking Prospectus 10

5.2 Water Augmentation Project 10

5.3 Potential Programs or Opportunities 11

Attachments

Attachment 1 – District Map

Attachment 2 – Intra-Association Agreement and J-T Agreement

Attachment 3 – Water Augmentation Project Improvements

Attachment 4 – Hydrographs

Attachment 5 – Water Banking Prospectus

1 BACKGROUND INFORMATION

1.1 History

Lands within the James Irrigation District (JID or District) were originally part of a 72,000-acre patent received by the pioneer Jefferson G. James in 1858. Much of the lands within today's District were periodically flooded by Kings River high flows, and consisted of grassland and swampland, traversed by a series of slough channels. Mr. James grazed cattle on the overflowed lands and excavated channels to control the spreading of Kings River water. In 1914, Reclamation District 1606 constructed two channels through the District to make a continuous connection from the Kings River to the San Joaquin River and pass flood water through the area. The western channel is known as the Fresno Slough; the eastern channel is known as the Fresno Slough Bypass (or James Bypass).

The District was formed in 1920 as the successor to a portion of the privately owned San Joaquin Valley Farm Lands Company, the initial developer for much of the area. The District came into formation by a vote of the landowners on February 6, 1920. The assets of the Farm Lands Company included the drainage channels obtained by Reclamation District 1606, numerous deep wells, and multiple canals for the delivery of pumped and diverted water.

The James Irrigation District is situated in the central San Joaquin Valley of California approximately thirty miles southwest of the City of Fresno in Fresno County. The community of San Joaquin lies near the middle of the District, but is excluded from the Districts' boundary. Located adjacent to the Fresno Slough, lands within the District boundaries are at the trough of the valley floor. State Highways 145, 180, and 33 are in close proximity. Adjacent agricultural water agencies include the Tranquillity Irrigation District, Westlands Water District, Stinson Canal and Irrigation Company, Mid Valley Water District, Fresno ID, and the Raisin City Water District. A map of the District is shown in **Attachment 1**.

The District encompasses and provides service to approximately 25,335 acres. Water delivery is provided to approximately 24,340 acres, where there are approximately 961 acres of exempt land and 34 acres of pasture land.

1.2 Organization

The James Irrigation District, organized in 1920, is a California Irrigation District, pursuant to the California Irrigation District Law (Division 11 of the California Water Code). The District is governed by a board of five directors. Each director is at large and is elected to a term of four years by qualified voters. Regular board meetings are held once a month, on the second Tuesday of the month.

1.3 Crops

The climate and soils in the service area provide ideal conditions for the establishment of a vibrant agricultural industry with many varieties of annual crops. However, the District is experiencing a trend of conversion of field crops to permanent crops. This trend is expected to continue at a gradual rate. Currently, the crops most grown through the district consist of: cotton, alfalfa, wheat, and canning tomatoes.

1.4 District Assessments

District costs are currently allocated to landowners and/or water users through special benefit assessments and/or volumetric water charges. The assessment charges are paid by the 24,340 irrigated acres of the District. The 961 acres of farmland not irrigated by the District are exempt from assessment charges, and 34 acres of pasture land pay reduced assessment charges based upon valuation. Only landowners who have the ability to receive irrigation water from the District pay assessment charges.

The District levies a flat assessment charge of $21.00 per acre to all lands. The assessment includes a $17.20/acre general assessment, and a $3.80 benefit assessment to pay off a 20-year loan for a canal-lining project (which will end in 2012). After the loan for the canal-lining project is repaid, the $3.80 assessment will be moved into the general assessment, resulting in no net change to the landowner. Pasture lands are charged a special rate of $1.29/acre.

1.5 Water Rates

The District charges for water by quantity (acre-foot), at a uniform rate. Lands within the District are subject to Reclamation Law. There are two different rates that a grower may pay, depending upon the status of the land receiving the water under Federal Reclamation Law. Lands that are in excess of the 160-acre limitation of the Reclamation Reform Act of 1982 are charged the 'Excess Lands' rate (Excess lands cannot receive Federal surface water but do receive groundwater from JID wells). Lands that are farmed (operated) over the 960-acre threshold are charged the District "Full Cost" rate and are supplied with non-project water. All other water is billed at the 'Cost of Service' rate.

In January and February 2009 water rates were $73/AF for District lands and $76/AF for excess lands. The District raised their water rates $15/acre-foot on March 1, 2009. This raised the cost to $88/AF for District lands and $91/AF for excess lands.

2 WATER SUPPLY

The District delivers approximately 80,000 acre-feet of water annually to its landowners. In a normal year, the District would receive 45,000 acre-feet of surface water from the Central Valley Project (CVP). Of this 45,000 acre-feet of CVP water, 9,700 acre-feet is developed from the District's historic right to San Joaquin River water (Schedule 2). The remainder of the grower demand is met by groundwater wells and surface water supplies from the North Fork of Kings River by way of the Fresno Slough Bypass. Although, the District historically sells their Kings River water allocation for additional revenue, JID diverts Kings River high flows for recharge (direct and in-lieu) approximately every two to three years.

2.1 USBR

2.1.1 Long Term Contract

The James Irrigation District has a Central Valley Project contract (no. 14-06-200-700A-LTR1) for up to 35,300 acre-feet of water each year. The water is generally delivered in the spring and summer months and varies each year based on demand, availability, and schedules set by the USBR. These water deliveries averaged 20,051 AF/year between 2000 and 2009.

2.1.2 Schedule 2 Water

Schedule 2 CVP Water (aka Riparian or Exchange Water) is delivered without charge as a settlement of the District's water rights claims to San Joaquin River water in Fresno Slough. During normal and wet years 9,700 AF is available, during dry years 7,600 AF is available. The contract (no. 14-06-200-700-A) requires that the District take delivery of this water according to the schedule shown in the following table. In practice, the USBR has allowed some flexibility on when this water is taken.

Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Normal	0	600	800	1,300	1,900	2,500	2,000	400	200	0	0	0	9,700
Dry	0	600	800	1,000	1,500	1,900	1,400	300	100	0	0	0	7,600

2.2 Kings River Water

2.2.1 JT Agreement

Stated in the "Intra-Association Agreement" of 1963 (amended in 2003) James ID is allotted 20,000 AF of storage in Pine Flat Reservoir. It is also stated that Tranquillity ID is allotted 8,000 AF. In addition, it appears that along with the storage allotment, the renter is also entitled to the District's supply downstream of Peoples Weir. It is not clear if these allotments can be rented separately. This agreement is included as **Attachment 2**.

The "Agreement for Rental of James Irrigation District and Tranquillity Irrigation District Kings River Water Entitlement and Storage Space" (J-T Agreement) effective 12/23/2003, details the terms and distribution of the James and Tranquillity supplies with the Lower River Units. Based on Section 6, the agreements term is 12 years, ending in 12/31/2015. On four year cycles (2007 and 2011) the agreement can be terminated by any party if a 2-year notice is provided to the other parties. Of note in the Agreement is the Right of First Refusal identified in Section 20 on page 7 of the Agreement; if James or Tranquillity wants to terminate and create a new agreement to the rental, use, ownership, occupancy, or transfer of Kings River water or storage to another entity, it must provide a 5-year notice to the other parties, and provide a 90-day notice to all Lower River Units to be part of the new agreement on the new terms.

2.2.2 Flood Frequency

High flow water from Pine Flat Reservoir is available on a 2.3 year on average. On an average annual basis, 210,370 AF over a 40-day period is available to the District. This equates to about 5,259 AF/day (2,650 cfs). This is based on a 50 year period from 1955-2006.

2.3 Groundwater

The District has about 63 production wells. The well locations are shown on the Facilities map in **Attachment 1**. 28 of these are within the District boundary and 35 are in the Districts East Side Well Field. The estimated capacity of all the wells is about 200 cfs. Most of JID's wells are between 500 and 600 feet deep, and extend to the top of the Corcoran Clay. A few of JID's older wells are 700 to 900 feet deep and penetrate the confined aquifer beneath the Corcoran Clay. Depth to water ranges from about 40 to 150 feet below ground surface. Two privately owned agricultural wells, and multiple private domestic wells for homesteads, are inside JID's boundary.

Location	Area	# of Wells	Capacity (cfs)
East Side Well Field	Lassen Ave	12	36.4
East Side Well Field	McMullin Grade	23	72.6
Within JID	Main Canal	18	53.7
Within JID	West of Colorado Ave	4	13.5
Within JID	Lateral K Basin	6	23.6
	Total	**63**	**199.8**

2.4 Transfers and Spills

Typically water transfers are made with FID, TID, and San Luis WD. Inflows from FID average 1,500 AF/year. TID can take water from JID spill points, but these transfers are sporadic. In recent years SLWD has made arrangements to bank and purchase water from JID.

3 FACILITIES AND CAPACITIES

3.1 P-Booster

P-Booster is the only point of diversion for the District to withdrawal water from the Mendota Pool. It is equipped with multiple pumps capable of a combined flow rate of 240 cfs. Also located here is a spill structure capable of spilling 130 cfs into the pool.

3.2 Main Canal

The Main Canal is the main artery of the Districts distribution system. The canal parallels the Fresno Slough Bypass and slopes from south to north. Turnout to laterals are typically every ½ mile. The Main Canal is capable of flowing both in forward and reverse flow. With supply from the Mendota Pool, the canal will operate in reverse flow, lifting water into "pools" to move the water up-grade. If water is taken from the McMullin Grade Canal or diverted from the Fresno Slough Bypass at the James Weir, the canal will operate in forward flow.

The Main Canal has three combination check/pump structures (J, H, & E). In forward flows boards and/or ITRC flap gates maintain water level upstream. In this regime, the canal has a capacity of 300 cfs. In reverse flow, pumps are operated off of level switches, and maintain water level in the upper pool. As water is pumped into each successive pool, the flow rate decreases at each pump structure up-grade, due to decreasing demand.

Pump Station	Flow Rate (cfs)
P-Booster	240
J-Booster	185
H-Booster	140
E-Booster	100

3.3 Laterals

The 17 lateral canals flow westerly, starting from head gates in the Main Canal. The laterals distribute water by gravity to the turnout gates, which are located on the banks of the laterals. Most of the lateral canals have cross connection canals to neighboring laterals. These are used to help balance the flow of water in the system and augment local capacity limitations. All of the lateral canals are unlined earthen ditches, with the exception of: Laterals G, O, & M.

3.4 K-Basin

K-Basin functions as both a groundwater recharge site and a regulation basin for the Main Canal. As a groundwater recharge site, the basin can divert up to 120 cfs, and store up to 1,050 AF. It has typical recharge rates of 0.3 ft/day.

3.5 San Luis Drain

In 2007, the District signed a 10-year lease (2007-2017) with the USBR to utilize approximately 4 miles of the San Luis Drain (68 acre-feet) near the District, and conducted a pilot operation using the drain as a regulating reservoir. Based on the difficulty of using existing infrastructure to deliver water to drain, the District is re-evaluating the use of this facility as a regulating reservoir.

3.6 James Weir

In the Fresno Slough Bypass, just west of McMullin Grade, is the James Weir. This structure stretches the width of the Slough, and acts as a check to divert Kings River high flows into the Main Canal. It also acts to control flow down the Fresno Sloughs Main and Auxiliary channels. The weir is capable of diverting 150 cfs from the Bypass into the Main Canal.

3.7 East Side Well Field

The District retained the right to pump groundwater (up to 200 cfs) from the "East Side Well Field" which is to the east of the Districts boundary and along the McMullin Grade. Currently the District has roughly 35 wells in the East Side Well Field. These wells are generally along two different alignments; The Lassen Avenue and McMullin Grade Alignment. The Lassen Alignment has 12 wells, and the McMullin Alignment has 25 wells. The Lassen line is piped on the upstream end and open channel downstream; max flow rate is 45 cfs. The McMullin is completely open channel; max flow rate is 100 cfs. Both ditches are concrete lined. All pumps that discharge into these ditches are delivered to the Main Canal first through a common ditch (145 cfs capacity) then into two parallel siphons with a combined capacity of 170 cfs.

3.8 McMullin Grade Canal

The McMullin Grade Canal is the only facility connecting James ID to Fresno ID. FID can spill into the McMullin Grade Canal through two separate facilities; the Central Wasteway No. 33, and the Lower Dry Creek No. 77.

The Central Wasteway is documented in an agreement dated June 7, 1953 between JID and FID. The Agreement granted FID perpetual right to facilities upstream of JID's Well C-36 (SW ¼, NW ¼, Sec 2, T15S, R18E, MDB&M), in the McMullin Grade Canal. FID is allowed to, but not obligated to, discharge up to 15 cfs.

The agreement to construct, maintain, and operate the Dry Creek extension was entered into on the 6th of April, 1970. The agreement is between the County of Fresno, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District and James Irrigation District. The purpose of this agreement is to allow the Fresno Irrigation District to spill up to 56 cfs of water into the McMullin Grade canal at the quarter section of Section 16, Township 15 South, Range 18 East, just downstream of well C-74.

3.9 Fresno Slough Bypass Facilities

3.9.1 Regulation Basins

Currently 3 basins exist inside the Fresno Slough Bypass; Basins 1, 2, and 3. These basins are just north of where the siphon crosses under the Bypass. Basin 1 is a regulation basin that regulates well water coming in from the Well Field, and can be fed into the canal by a 25 cfs pump. Basin 2 serves as an overflow of Basin 1, and a recharge site for Kings River high flows. The top portion of Basin 2 can be recaptured by the pump in Basin 1. Basin 3 is solely a recharge site. Water can only be brought in during high flows in the Kings River. Basins 2 and 3 are proposed to be modified by the Water Augmentation Project.

Basin	Capacity (AF)
1	95
2	620
3	50

3.9.2 Water Augmentation Project

In the Fresno Slough Bypass the Basins 2 and 3 described above will be increased from their current capacity to 800 AF and 280 AF respectively. New infrastructure will be installed to move water between the basins and the Main Canal. In addition to the Basins, 125 acres of recharge cells are proposed between Basin 3 and Manning Ave, with roughly 5 recovery wells to be installed in the vicinity. These facilities are shown in **Attachment 3**.

3.10 Spill points

3.10.1 P-Booster Spill

Two weirs in the Main Canal at the P-Booster station have the ability of spilling approximately 130 cfs from the Main Canal into the Fresno Sough Bypass and thus the Mendota Pool.

3.10.2 E-Stub Spill

E-stub collects a majority of the spill on the Westside of the District (west of the Fresno Slough) and discharges into the Tranquillity ID's "Slough Canal" pool. This spill structure is controlled by a gate and is capable of passing 15 cfs.

3.10.3 I and J Spill

Laterals I and J both discharge into the Fresno Slough. Once in the Slough it can be utilized by Tranquillity ID or be sent into the Mendota Pool. The capacities of these spills are approximately 15 cfs each.

4 WATER DEMAND AND TIMING

A typical demand curve for the District has a small peak in February to meet pre-irrigation needs, and a large peak in late June/early July coinciding with peak ET demands. The District usually stops delivering water in mid-November through the beginning of January. In recent years this window has shortened, to meet the growers demand through November. James ID tries to meet the growers demand in any situation; however, the water year type will dictate what supplies they use to do that.

Based on the climate, dry years will see higher demands, and wet years will have less of a demand. This is due to early and pre-irrigation being offset with precipitation, and cooler temperatures reducing the ET rates. Hydrographs for the following situations are provided in **Attachment 4**.

4.1 Normal Year

During a normal year, e.g. 1981, the District normally operates with their Contract water, Schedule 2 water, and groundwater. As peak months are approached, groundwater wells are used to “base load” the demand. Meaning wells will be turned on and left on, minimizing the need to constantly adjust wells to meet demand fluctuations. The fluctuations are met with supply coming from the P-Booster stations, so that changes can be made at one location.

4.2 Wet Years

During a wet year, e.g. 1983, in addition to their typical water supplies, they will also obtain Kings River high flow water. This water is used to offset groundwater pumping. If the Kings River supply is substantial, James ID may sell a portion of their Contract water.

4.3 Dry Year

During a dry year, e.g. 1989, the District still relies on Contract, Schedule 2, and groundwater; however, contract water will typically be reduced and the deficit will be made up by additional groundwater pumping. As critically dry years are encountered, and CVP supplies are severely reduced, the reliance on groundwater is even greater. The District will pump groundwater early in the season, and place in surface storage (Mendota Pool, local basins, and/or transfers) for later recovery during peak irrigation periods.

4.4 Water Augmentation Project

The Water Augmentation Project is based on 2007 demand data, in a scenario where no Contract water is available to the District. This causes the District to rely solely on groundwater and the 9,700 AF of Schedule 2 water. The District’s existing wells and storage facilities were then incorporated to determine what new infrastructure would be required for the District to sustain its current practices. This scenario is similar to the

critically dry year described above, but utilizes additional wells and internal storage to meet demands.

5 PROJECT OPPORTUNITIES

5.1 Water Banking Prospectus

A Water Banking Prospectus was developed for the District in December 2007 (**Attachment 5**). This is an attempt by the District to 1) sell new yield from recharge facilities, and 2) to provide other entities a location to bank water for later retrieval.

New yield generated through recharge facilities will be made available for purchase at the O'neill Forebay. The District will sell up to 1250 AF/year of CVP supply for the life of their current CVP long-term contract set to expire 2054. The water is available for a onetime cost of $450/AF for entitlement requested, plus an annual charge of $450/AF for the entitled supply (regardless of amount taken). The annual charge is subject to adjustment based on the Consumer Price Index.

Water banking agreements will operate separately from the water sales mentioned above. The District is interested in entering into a 25 year long term banking agreement that will make 1,250 AF available at the O'neill Forebay. The water placed into the bank is subject to a 10% reduction to account for losses. An entity can buy into the bank for a onetime cost of $1,750/AF for return capacity requested, and annual charges of $30/AF for placement and $30/AF for retrieval. The annual charges are subject to CPI adjustments, O&M charges of $18/AF, and $45/AF groundwater extraction. The banking partner will be allowed to store up to 3 times the return capacity purchased.

5.2 Water Augmentation Project

The District is in the process of implementing a Water Augmentation Project. The proposed plan is estimated to cost approximately $9.6 million. This project is being implemented due to the recent unreliability of CVP surface water availability, and ongoing drought conditions. These projects will help recharge the groundwater supply, and create a more reliable local water source for irrigation demand, especially during peak periods. A detailed map of the Water Augmentation Project can be found in **Attachment 3**. The following lists the major project features:

- Construction of 16 new wells;
- Construction of recharge basins totaling 170 acres to capture additional Kings River floodwater;
- Utilization of three large existing basins capable of 1,500 acre-feet of storage for short-term storage; and
- System Automation.

The proposed $9.6 million in project costs will meet the demands of the district to meet peak irrigation demands and recharge water to counter potential overdraft of district wells. In order to minimize the immediate fiscal impacts to the landowners, the District applied for and received a $300,000 grant from the U.S. Bureau of Reclamation (USBR). The District has also applied for $1.5 million in grant funding for a portion of the project to be funded by United States Bureau of Reclamation Drought Relief Stimulus

Package. The remaining amount not funded through the grants is envisioned to come from long-term loans and/or bonds. The completion of these projects will improve water reliability by reducing the districts dependency upon CVP water by diverting storm and flood waters into storage and recharge basins.

5.3 Potential Programs or Opportunities

- Purchase J/T storage and entitlement
- Deliver surface water to James/Tranquillity
    - On ag demand
    - For banking
    - Use local water supplies
    - Opportunities for SJR unscheduled
- Participate in banking programs
    - Within JID
    - Use flood rights lands
    - In other properties in between districts
- Provide for interconnection between districts to move water (both ways)
- Participation with SJR restoration activities
- CVP water to James afford opportunities for other storage use of Pine Flat?
- Delivery of SJR restoration flows to JID?
- Other possible benefits:
    - Conveyance/exchange between FID and JID – unknown flexibility
    - Water Quality to JID
    - Use of flood rights lands and payment for storm water control
    - Land retirement in JID
    - Fallowing program for flexibility

Avg Water supply

CVP						
2	Contract	Kings R	Gwtr	Total	SW cost	Gwtr Cost
8,400	24,000	11,600	30,000	74,000	$1.6 mil	$1.9 mil

Worst Case

CVP						
2	Contract	Kings R	Gwtr	Total	SW cost	Gwtr Cost
7,600	0	0	67,000	74,000	$0.15 mil	$4.2 mil

Proposed – Transfer J/T and CVP supply to FID – JID get 40,000 af/year

Avg Water supply

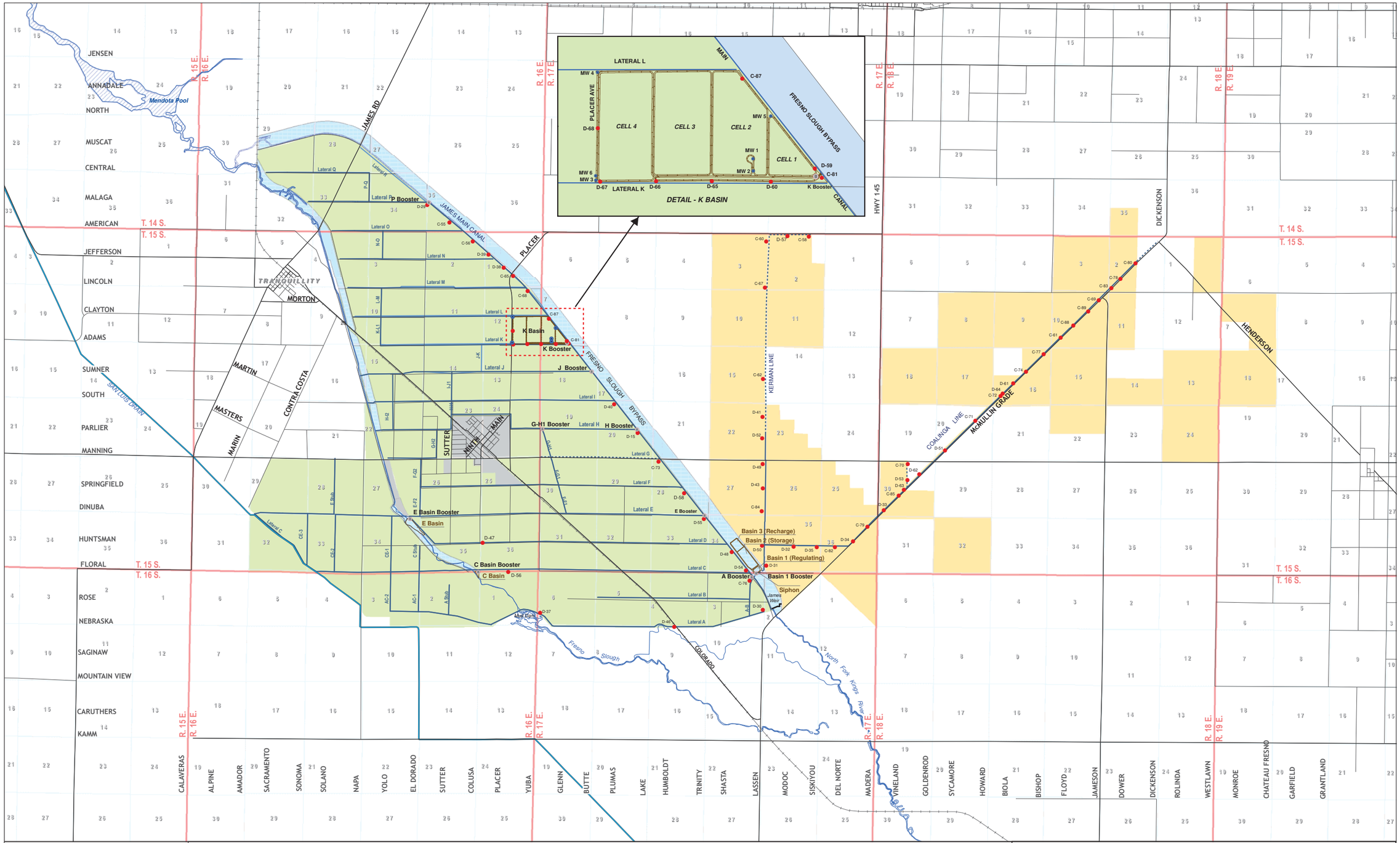
CVP						
2	FID	Kings R	Gwtr	Total	SW cost	Gwtr Cost
8,400	40,000	11,600	14,000	74,000	$?	$0.9 mil

Worst Case

CVP						
2	FID	Kings R	Gwtr	Total	SW cost	Gwtr Cost
7,600	40,000	0	27,000	74,000	$?	$1.7 mil

ATTACHMENT 1

District Map



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MAJOR ROAD
STREET
RAILROAD
TOWNSHIP/RANGE
SECTION
CITY OF SAN JOAQUIN
JAMES ID
CITY OF SAN JOAQUIN/JID OVERLAP
RECLAMATION DISTRICT 1606
JAMES ID WELL FIELD
CANAL
PIPELINE
BASIN
KINGS RIVER
BOOSTER
MONITOR WELL
PRODUCTION WELL

JAMES IRRIGATION DISTRICT
SAN JOAQUIN, CA

James Irrigation District

Fresno County, CA

August 2010

8/24/2010 \\Evolution\clv_clients\Clients\James ID-1051\GIS\Map\JID_and_wellfield_24x36.mxd

ATTACHMENT 2

Intra-Association Agreement and J-T Agreement

AGREEMENT SUPPLEMENTING AND AMENDING
WATER RIGHT INDENTURE DATED MAY 3, 1927,
AND ADMINISTRATIVE AGREEMENT DATED MAY 3, 1927,
EACH AS AMENDED AND SUPPLEMENTED JUNE 1, 1949,
RELATING TO KINGS RIVER WATER ASSOCIATION

Table of Contents

Paragraph No.	Title	Pages
	Preamble	5
	Explanatory Recitals	5
1	Definitions	11
2	Division and Allocation of Waters of Kings River	12
3	Right to Store – Conditions	12
4	Allocation and Crediting of Stored Water	13
5	Determination of Quantity of Stored Water Available for Release	13
6	Reservoir Gains and Losses – Water and Space	14
7	Use of United States Geological Survey Station at Piedra	14
8	Measuring Stations Upstream from Piedra	14
9	Use of Measuring Stations Upstream from Piedra	15
10	Distribution and Charging of Flood Releases	16
11	Priority in Right to Divert Flood Releases	16
12	Disposition of Refused Water	16
13	Administration of Unstorable Waters Originating between Pine Flat Dam and Piedra	17

Table of Contents

ESTIMATES AND FORECASTS OF RIVER CHANNEL LOSSES

28. (a) That on the 1st day of April of each water year, or as soon thereafter as possible, and based upon all then available pertinent data and information, the Kings River Water Master shall make proper estimates and forecasts of the total runoff or natural flow of Kings River in such water year, and shall make proper estimates and forecasts of the probable river channel losses to be sustained by the parties hereto diverting water from Kings River at and below the Peoples Weir for such water year, subject to appropriate adjustments to be made later in the same water year in case of errors in such estimates and forecasts.

(b) That all contributions of storage space and water to the Storage Operations Pool shall be based upon such estimates and forecasts, but shall be subject to appropriate adjustments to be made later in the same water year in case of errors in such estimates and forecasts.

ACQUISITION OF WATER ENTITLEMENTS AND STORAGE ALLOTMENTS OF JAMES IRRIGATION DISTRICT AND TRANQUILLITY IRRIGATION DISTRICT

29. (a) That the parties hereto which divert water from Kings River at and downstream from the Peoples Weir other than James Irrigation District and Tranquillity Irrigation District, shall, concurrently herewith and at their sole cost and expense, and under an appropriate agreement, acquire on a rental basis the entire entitlements of said James Irrigation District and Tranquillity Irrigation District in and to the waters of Kings River, and also the entire Storage Allotment of said James Irrigation District in Pine Flat Reservoir amounting to 20,000 acre-feet of storage space, and also the entire Storage Allotment of Tranquillity Irrigation District in Pine Flat Reservoir amounting to 8,000 acre-feet of storage space.

(b) That the entire rental cost of so acquiring such water entitlements and Storage Allotments shall be allocated between and shall be borne and paid by the parties hereto which divert water from Kings River at and downstream from the Peoples Weir, in the respective percentages specified in the Schedule hereto attached marked Exhibit D.

CONTRIBUTIONS OF STORAGE SPACE

30. (a) That the parties hereto which divert water from Kings River at and downstream from the Peoples Weir other than James Irrigation District and Tranquillity Irrigation District, shall contribute and permit the Kings River Water Master to use the Storage Allotments acquired by them in accordance with the provisions of the preceding Paragraph 29 hereof, in order to provide Storage Operations Pool space sufficient to hold 26,600 acre-feet of water.

(b) That in addition to the foregoing contribution, each of the parties hereto shall contribute and permit the Kings River Water Master to use up to five per cent (5%) of its Storage Allotment in order to provide Storage Operations Pool space sufficient to hold not more than 50,000 acre-feet of water; provided, however, that no such contribution shall be required at any time when the operation of Pine Flat Reservoir or the maintenance or operation of the Storage Operations Pool does not require such a contribution. When there is vacant or unused storage space in Pine Flat Reservoir, such vacant or unused storage space shall be used first for the maintenance and operation of the Storage Operations Pool instead of any storage space to be contributed by any party hereto under the provisions of this sub-paragraph (b).

(c) That water stored in said Storage Operations Pool space and not exceeding a maximum of 50,000 acre-feet of water, shall not be released for flood control or maintenance

AGREEMENT FOR RENTAL OF
JAMES IRRIGATION DISTRICT AND
TRANQUILLITY IRRIGATION DISTRICT
KINGS RIVER WATER ENTITLEMENT AND
STORAGE SPACE

THIS AGREEMENT is made and effective as of December 23, 2003 by and between (i) the James Irrigation District, a California irrigation district ("James"), (ii) the Tranquillity Irrigation District, a California irrigation district ("Tranquillity") and (iii) the public agencies and mutual water companies listed on the attached Exhibit A (the "Lower River Units"), with reference to the following facts:

A. James, Tranquillity and all of the Lower River Units are members of the Kings River Association (the "KRWA"), and each has the right to divert, store and use waters of the Kings River in accordance with various agreements administered to which they are parties.

B. James and the Lower River Units (or their predecessors) are the parties to that certain James-Kings River Water and Storage Use Agreement dated as of December 23, 1963 pursuant to which James granted the Lower River Units the right to use James' Kings River water entitlement and storage rights for the period through and including December 23, 2003. That agreement was subsequently modified by that certain Revised and Restated James-Kings River Storage, Use and Exchange Agreement Partial Assignment and Acceptance effective as of April 12, 1987 and the related Recision Agreement dated as of January 1, 1989. The James-Kings River Water and Storage Use Agreement referenced in the first sentence of this Recital B, as modified by the other documents referenced in this Recital B, shall be referred to herein as the "1963 James-Kings River Agreement."

C. Tranquillity and the Lower River Units (or their predecessors) are the parties to that certain Tranquillity-Kings River Water and Storage Use Agreement dated as of December 23, 1963 pursuant to which Tranquillity granted the Lower River Units the right to use Tranquillity's Kings River water entitlement and storage rights for the period through and including December 23, 2003. That Agreement was subsequently modified by that certain Revised and Restated Tranquillity-Kings River Storage, Use and Exchange Agreement Partial Assignment and Acceptance effective as of April 12, 1987 and the related Recision Agreement dated as of January 1, 1989. The Tranquillity-Kings River Water and Storage Use Agreement referenced in the first sentence of this Recital B, as modified by the other documents referenced in this Recital C, shall be referred to herein as the "1963 Tranquillity-Kings River Agreement."

D. The parties to this Agreement wish to renew and revise the arrangements described in the 1963 James-Kings River Agreement and the 1963 Tranquillity-Kings River Agreement on the terms set forth below.

THEREFORE, in consideration of the terms, covenants and conditions set forth below, the parties agree as follows:

1. Termination of 1963 James-Kings River Agreement. James and the Lower River Units hereby agree that, except as provided in Section 3 of this Agreement, as of the effective

date of this Agreement the 1963 James-Kings River Agreement has been terminated and is of no further force or effect. All parties acknowledge that, except as provided in Section 3 of this Agreement, all obligations any of them may have had under the 1963 James-Kings River Agreement have been fully satisfied, and none of the parties hereto shall have any further obligation to any of the other parties hereto arising from or relating to the 1963 James-Kings River Agreement. Accordingly, except as provided in Section 3 of this Agreement, each of the parties hereby releases each of the other parties from all liabilities, claims, obligations, costs and expenses of any kind relating to or arising under the 1963 James-Kings River Agreement.

2. Termination of 1963 Tranquillity-Kings River Agreement. Tranquillity and the Lower River Units hereby agree that, except as provided in Section 3 of this Agreement, as of the effective date of this Agreement the 1963 Tranquillity-Kings River Agreement has been terminated and is of no further force or effect. All parties acknowledge that, except as provided in Section 3 of this Agreement, all obligations any of them may have had under the 1963 Tranquillity-Kings River Agreement have been fully satisfied, and none of the parties hereto shall have any further obligation to any of the other parties hereto arising from or relating to the 1963 Tranquillity-Kings River Agreement. Accordingly, except as provided in Section 3 of this Agreement, each of the parties hereby releases each of the other parties from all liabilities, claims, obligations, costs and expenses of any kind relating to or arising under the 1963 Tranquillity-Kings River Agreement.

3. Reconciliation. Notwithstanding Sections 1 and 2, the parties acknowledge that a final reconciliation of the amounts owed by, and to be credited to, the Lower River Units under the 1963 James-Kings River Agreement and the 1963 Tranquillity-Kings River Agreement will be completed after the effective date of this Agreement. The Lower River Units acknowledge that they are responsible for any "operations and maintenance" deficits (and any associated interest) and other charges payable to the United States or San Luis and Delta-Mendota Water Authority accruing during the term of the 1963 James-Kings River Agreement and the 1963 Tranquillity-Kings River Agreement attributable to water purchased by James and Tranquillity under those contracts for which the Lower River Units were obligated to pay. James and Tranquillity acknowledge that issues concerning the proper allocation of revenues derived from sales or transfers of such water by James and Tranquillity must also be determined. Nothing in this Agreement shall be interpreted to relieve any of the parties of the monetary obligations arising under the 1963 James-Kings River Agreement and the 1963 Tranquillity-Kings River Agreement described in the preceding two sentences.

4. Use of Kings River Water. While this Agreement is in effect, the Lower River Units shall have the right to store, divert, dispose of and otherwise use all waters of the Kings River that James and Tranquillity would otherwise have had the right to store, divert, dispose of or otherwise use, subject to all contractual, legal or other restrictions imposed on such water, including without limitation those imposed by agreements to which James and Tranquillity are parties that are administered by the KRWA. Notwithstanding the foregoing, flood water that reaches the Kings River channel below Stinson Weir and that reaches the points of diversion in the Kings River channel of James and Tranquillity may be diverted by James and Tranquillity and utilized in accordance with agreements to which James and Tranquillity are parties.

5. Use of Storage. While this Agreement is in effect, the Lower River Units shall have the right to use all storage space in Pine Flat Reservoir and in upstream reservoirs on the Kings River that James and Tranquillity would otherwise have had the right to use, subject to all contractual, legal or other restrictions imposed on the use of such storage space, including without limitations imposed by agreements to which James and Tranquillity are parties that are administered by the KRWA.

6. Term.

(a) This Agreement shall commence on December 23, 2003 and shall expire on December 31, 2015; provided, that this Agreement shall be automatically renewed without further action by any of the parties for successive periods of four years each, unless the Lower River Units acting jointly as provided in Section 14 of this Agreement, or James, or Tranquillity, provide written notice of termination to each of the other parties at least two years prior to the expiration of the then-current term. Should such a notice of termination be provided, the parties shall immediately and in good faith endeavor to renegotiate this Agreement on mutually acceptable terms and conditions. If, despite the parties' good faith efforts, no such mutually acceptable terms and conditions have been negotiated after one year, the parties shall no longer be obligated to negotiate and this Agreement shall terminate on the date specified in the two-year notice of termination.

(b) Any Lower River Unit may, by written notice of withdrawal to all other Lower River Units at least three years prior to the expiration of the then-current term, may withdraw from participation in this Agreement effective as of the end of the then-current term. If such notice of withdrawal is not rescinded by the withdrawing Lower River Unit prior to the end of the then-current term, such Lower River Unit shall no longer participate in this Agreement for any successive terms of this Agreement, and the non-withdrawing Lower River Units shall assume the Participating Percentage of the withdrawing Lower River Unit in proportion to the non-withdrawing Lower River Units' Participating Percentages or as otherwise agreed by the non-withdrawing Lower River Units.

7. Procedures Upon Termination. In the event this Agreement terminates for any reason and thereafter either or both of James and Tranquillity begin taking delivery of their Kings River water entitlements on lands within their boundaries, the parties to this Agreement shall immediately and in good faith endeavor to negotiate means by which channel losses suffered by James and/or Tranquillity in receiving such deliveries will be compensated from the storage operations pools established by the KRWA and by the Lower River Units, James and Tranquillity in order that James and Tranquillity will be equitably compensated with the other parties hereto for losses sustained by James and Tranquillity as a result of storage by the remaining members of the KRWA. If, despite the parties' good faith efforts, no mutually acceptable terms and conditions have been negotiated after one year, the issues shall be submitted to arbitration. James and Tranquillity shall jointly select one arbitrator and the Lower River Units shall jointly select one arbitrator, and the two so chosen shall select a third. In the event that they cannot agree upon a third, s/he shall be selected by the presiding judge of the Federal District Court located in Fresno, California. The arbitration shall be conducted in accordance with the procedures for arbitrations then set forth in the California Code of Civil

Procedure. The decision reached by any two of the arbitrators as to the terms of said contract shall be binding upon all of the parties.

8. Rental. In consideration for the use of James and Tranquillity Kings River water and storage space pursuant to this Agreement, the Lower River Units shall pay annual rental in advance to James and Tranquillity on or before January 1 of each year while this Agreement is in effect, commencing January 1, 2004. 66.44 percent of each rental payment shall be paid to James, and 33.56 percent of each rental payment shall be paid to Tranquillity. The annual rental due on January 1, 2004 shall be $500,000. Commencing on January 1, 2008 and every four years thereafter, including during any renewal of this Agreement in accordance with Section 6, the amount of the annual rental shall be increased by $40,000. Therefore, by way of example only, the annual rental due commencing on January 1, 2008 shall be $540,000, the annual rental due commencing on January 1, 2012 shall be $580,000, and the annual rental due commencing on January 1, 2016 (assuming this Agreement is renewed in accordance with Section 6) shall be $620,000.

9. Payments to James and Tranquillity. The obligation of the Lower River Units to make payments to James and Tranquillity under this Agreement shall be joint and several. However, the Lower River Units hereby designate the KRWA as their agent for payments, and as between the Lower River Units, each Lower River Unit shall be responsible for a portion of each payment due to James and Tranquillity under this Agreement equal to the amount of such payment multiplied by the percentage opposite such Lower River Unit's named on the attached Exhibit A (the "Participating Percentages"). All Lower River Units shall make their respective payments in accordance with their Participating Percentages to the KRWA on or before the date specified in assessment(s) or other notice(s) of payment due under this Agreement to be forwarded to the Lower River Units by the KRWA. Any Lower River Unit making its payment after the specified due date shall also pay a late charge of ten percent of the delinquent payment, plus interest at the rate of ten percent per annum until the payment in full is received by the KRWA.

10. Other Costs and Benefits.

(a) Except for the payment of assessments to the KRWA pursuant to Paragraph 52 of that certain Agreement Supplementing and Amending Water Right Indenture Dated May 3, 1927, and Administrative Agreement Dated May 3, 1927, Each as Amended and Supplemented June 1, 1949, Relating to the Kings River Water Association (the "Intra-Association Agreement") while this Agreement is in effect, all obligations, rights and benefits of James and Tranquillity under any agreements to which some or all of the parties to this Agreement are also parties, including without limitation water use revenues, are hereby assigned to and assumed by the Lower River Units. The Lower River Units shall indemnify, defend and hold James and Tranquillity harmless from and against any losses suffered by James and/or Tranquillity as the result of the Lower River Units' failure to timely and adequately perform any obligation assumed under this Agreement.

(b) Notwithstanding any other provision of this Agreement, the Lower River Units do not hereby undertake any obligation to pay (i) any amounts which have been assessed or imposed on James or Tranquillity prior to the effective date of this Agreement or (ii) any

amounts that come due after termination of this Agreement for any reason. Further, to the extent capital or construction costs are incurred for new facilities that are payable by James and/or Tranquillity, the useful life of such new features (not to exceed 50 years) shall be determined by the parties to this Agreement and the costs payable by James and Tranquillity shall be prorated over that useful life in accordance with an agreement to be negotiated at the time by the parties. If the parties to this Agreement cannot agree on a useful life, it shall be fixed by the Watermaster of the KRWA, not to exceed 50 years. In the agreement to be negotiated, the parties shall determine which of them shall be responsible for the upfront funding of such capital and construction costs, how to finance it, and the terms for repayment between them.

(c) All obligations, rights and benefits of James and Tranquillity described in this Section 10 shall be shared by the Lower River Units in accordance with their respective Participating Percentages. With respect to amounts that would otherwise be due from James and Tranquillity, the payment of which is assumed by the Lower River Units while this Agreement is in effect, the Lower River Units hereby designate the KRWA as their agent for payment in accordance with the procedures described in Section 9 of this Agreement.

11. Beneficial Use. All Kings River water covered by this Agreement shall be put to reasonable and beneficial use by the Lower River Units, which use shall be for and on behalf of James and Tranquillity and their respective landowners for the purpose of preserving to James and Tranquillity and their landowners the continued right to use such water.

12. No Permanent Rights. This Agreement shall not be construed as a permanent conveyance, abandonment, or waiver of any water right, storage right or right to the use of Kings River water or storage by James or Tranquillity, or as conferring any right whatsoever upon any party that has not executed this Agreement, or to affect or interfere in any manner with any right of James or Tranquillity to the use of Kings River water, storage, channels, sloughs and tributaries, except in favor of the Lower River Units to the extent herein expressly provided. The rights of the Lower River Units in and to the water and storage space covered by this Agreement shall be temporary in nature, limited by the terms hereof, and shall be only for the term of this Agreement. It is specifically understood and agreed that the water and storage space covered by this Agreement are not dedicated to a public use for the benefit of the Lower River Units, and that James and Tranquillity each reserves all of the right, title and interest, except as provided for the enjoyment and use of the Lower River Units herein, therein and thereto upon the expiration or other termination hereof. No right to the continued use of the water or storage covered by this Agreement, except in accordance with the terms hereof, or to the continued use thereof either by users or any of their inhabitants shall be established by the implementation of this Agreement.

13. Indemnification. The Lower River Units shall indemnify, defend and hold James and Tranquillity harmless from any claims, demands, causes of action, suits, injunctions or damages brought for or on behalf of any party or person arising out of or in any way connected with the change of place of use of the waters and points of diversion covered by the terms of this Agreement, or with the use of the water and storage space covered by this Agreement by the Lower River Units. Each party shall indemnify, defend and hold the other parties to this Agreement harmless from and against any claims, demands, causes of action, suits, injunctions or damages brought for or on behalf of any party or person arising out of the indemnifying party's breach of this Agreement.

14. Action by Lower River Units. Any action or decision by the Lower River Units under this Agreement shall be taken upon the affirmative vote of the Lower River Units then holding at least 75% of the Participating Percentages.

15. Effective Date. In connection with the execution of this Agreement, the parties hereto are entering into that certain Amendment of 1963 Intra-Association Agreement, Water Use Revenue Agreement and Lower River Agreement of even date herewith with certain other members of the KRWA. This Agreement shall become effective only when (i) all of the parties have executed this Agreement and (ii) the referenced Amendment of 1963 Intra-Association Agreement, Water User Revenue Agreement and Lower River Agreement has been fully executed by the parties thereto and has become effective.

16. Assignment; Water Transfers.

(a) The Lower River Units shall not assign all or any portion of this Agreement, any portion of their respective Participating Percentages, or any of the rights to the use of the storage space described herein, nor enter into any sublease for the use thereof, without the written consent of James and Tranquillity, and no such assignment or attempted assignment or sublease shall be binding upon James or Tranquillity without its express written consent. Further, any proposed rental, lease, loan, hypothecation, conveyance, transfer or assignment of storage space described herein shall be subject to Paragraph 19 of the Intra-Association Agreement.

(b) In any year while this Agreement is in effect, a Lower River Unit may rent, lease, lend, hypothecate, convey, transfer or assign an amount of Kings River water equal to the amount of Kings River water such Lower River Unit acquires from James and Tranquillity that year under this Agreement without the consent of any other party and without compliance with Paragraph 18 of the Intra-Association Agreement; provided, that (i) the party receiving such water must be a Lower River Unit and must divert the water at or below Peoples Weir and upstream from Mendota Pool at its normal point of diversion from the Kings River, (ii) all members of the KRWA are to be compensated for any increased river channel losses adversely affecting those members resulting from the rental, lease, loan, hypothecation, conveyance, transfer or assignment in accordance with the policy described in Section 24 of this Agreement, and (iii) the KRWA Watermaster is to be notified at least 15 days prior to such rental, lease, loan, hypothecation, conveyance, transfer or assignment. The Watermaster shall promptly forward said notification to all parties to this Agreement specifying the terms and conditions of the transaction. Any such rental, lease, loan, hypothecation, conveyance, transfer or assignment may be for a single year or may be for multiple years, but (i) shall not result in the rental, lease, loan, hypothecation, conveyance, transfer or assignment in any year of an amount of Kings River water greater than the amount of Kings River water such Lower River Unit acquires from James and Tranquillity that year under this Agreement, and (ii) shall not extend past the termination of this Agreement. Each year when such rental, lease, loan, hypothecation, conveyance, transfer or assignment occurs, the KRWA Watermaster shall determine the river channel losses, if any, associated with the rental, lease, loan, hypothecation, conveyance, transfer or assignment during that year in accordance with the policy described in Section 24 of this Agreement. Once such determination has been made, the KRWA Watermaster shall provide notice thereof to the Lower

River Units. During the 15-day period following the provision of such notice, any Lower River Unit may object to such determination on the basis that it does not comply with the policy described in Section 24 of this Agreement, and upon such objection the KRWA Watermaster shall promptly meet with the objecting Lower River Unit(s) to resolve such objection. If such objection cannot be resolved, the determination of the KRWA Watermaster shall be final, subject only to challenge on the ground that such determination was not made in accordance with the policy described in Section 24 of this Agreement.

17. Waiver. The waiver of a breach of any provision of this Agreement shall not be deemed to be a continuing waiver of any other provision hereof, or of a subsequent breach of such provision.

18. Remedies. In the event the Lower River Units default or fail to perform any term, covenant or condition under this Agreement, James and/or Tranquillity may terminate this Agreement and all rights of the Lower River Units hereunder; provided, that the Lower River Units are to first be given 30 days written notice of the alleged default, and no right of termination shall exist if such default is cured during that notice period. Such right of termination, shall be cumulative with and in addition to all other rights and remedies available to James and/or Tranquillity under the laws of the State of California. In the event that any action or arbitration is commenced by any party to this Agreement to enforce or interpret any of the terms, covenants or conditions hereof, the prevailing party in such action or arbitration shall be entitled to an award of reasonable attorney's fee, costs and litigation expenses as established by the court or arbitrator.

19. Counterparts. This Agreement may be executed in one or more counterparts.

20. Right of First Refusal After the expiration of this Agreement by its terms or sooner termination thereof, and in the event that James or Tranquillity within five years of such expiration or sooner termination offers or agrees to the rental, use, ownership, occupancy, or other transfer of its water entitlements in and to the Kings River and/or rights to Kings River storage behind Pine Flat Dam or elsewhere, to any other person or entity, James and/or Tranquillity (as appropriate) shall concurrently therewith give 90 days' notice in writing to all the Lower River Units of such offer or agreement and invite the Lower River Units to rent, use, occupy, and receive such water and/or storage on the same terms and conditions as set forth in such offer or agreement. If any of the Lower River Units accept, then James and/or Tranquillity (as appropriate) shall enter into an agreement with such Lower River Units, on the terms and conditions set forth in such offer or agreement. If none of the Lower River Units accept within a 90 day period, then James and/or Tranquillity (as appropriate) shall be free to agree or contract for the rental, use, occupancy, sale or transfer of its said water and/or storage to any other persons or entities upon same terms and conditions provided to the Lower River Units, subject to limitations imposed by agreements to which James and Tranquillity are parties that are administered by the KRWA; provided, that if such rental, use, occupancy, sale or transfer is not consummated within 180 days after the expiration of the 90 day period described in the preceding sentence, it may not thereafter be consummated unless the Lower River Units are again afforded the right to accept the offer in accordance with this Section 20.

21. Entire Agreement. This Agreement supersedes all prior and contemporaneous

agreements with respect to the subject matter hereof, and may not be amended except by a writing signed by all parties.

22. Warranties. James and Tranquillity have made no representations, express or implied, to the Lower River Units as to the quantity or quality of the waters covered by this Agreement, nor the nature or extent of James' or Tranquillity's rights therein and thereto, and no warranties, either express or implied, as to the nature or extent of such water, its quality or title thereto is made by James or Tranquillity under this Agreement. The Lower River Units do hereby agree and affirm that they have made their own independent study of the nature and extent of such waters and the rights that James and Tranquillity have therein and thereto, and that this Agreement is executed by the Lower River Units solely as a result of such examination and not by reason of any statements, express or implied, or any warranties, express or implied, on behalf of James or Tranquillity.

23. Delivery and Use. The Lower River Units shall construct, maintain and operate all necessary works at their own cost and expense for delivery and use of the waters covered by this Agreement to the Lower River Units. Such works shall be so constructed that water reaching beyond the Stinson Weir in times of flood or other high flows may be diverted by James or Tranquillity in accordance with the terms hereof.

24. River Channel Losses. From the effective date of this Agreement through December 31, 2015, the Lower River Units shall direct the KRWA Watermaster to administer river channel losses (as defined in Paragraph 24 of the Intra-Association Agreement) suffered by any Lower River Units associated with the implementation of this Agreement in accordance with the "Policy Addressing River Channel Losses Related to Agreement for Rental of James Irrigation District and Tranquillity Irrigation District Kings River Water Entitlement and Storage Space" adopted by the Lower River Board of Directors on December 16, 2003, a copy of which is attached hereto as Exhibit B. Such policy shall not be revised or revoked if any Lower River Unit objects to such revision or revocation, and may be extended beyond December 31, 2015 upon (but only upon) the unanimous vote of the Lower River Units. Such policy shall not create any precedent for the administration of river channel losses in the event this Agreement terminates. Without limiting the foregoing, the manner in which river channel losses suffered by James and/or Tranquillity in receiving deliveries of their Kings River water entitlements following a termination of this Agreement will be compensated from the storage operations pools established by the KRWA shall be determined in accordance with Section 7 of this Agreement.

25. Further Assurances. The parties shall, from time to time, take such further actions as are necessary to carry out the intent of this Agreement.

26. Severability. In the event any of the terms or provisions of this Agreement shall be held to be invalid, then any such invalidity shall not affect any other term of provision contained herein, which terms and provisions shall remain in full force and effect, and the invalid terms or provisions shall be deemed reformed to be valid to the maximum extent permitted by law.

27. Construction. This Agreement has been prepared by the KRWA, which is not a party to this Agreement. This Agreement shall be construed as if all of the parties hereto jointly prepared it, and any uncertainty or ambiguity shall not be interpreted against any party.

IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Boards of Directors, have caused their names and corporate seals to be affixed by their proper and respective officers as of this 23rd day of December, 2003

JAMES IRRIGATION DISTRICT

By _____
President

By _____
Secretary

TRANQUILLITY IRRIGATION DISTRICT

By _____
President

By _____
Secretary

BURREL DITCH COMPANY

By _____
President

By _____
Secretary

CLARK'S FORK RECLAMATION DISTRICT
NO. 2069

By _____
President

By _____
Secretary

CORCORAN IRRIGATION COMPANY

By _____
President

By _____
Secretary

CRESCENT CANAL COMPANY

By _____
President

By _____
Secretary

EMPIRE WEST SIDE IRRIGATION DISTRICT

By _____
President

By _____
Secretary

JOHN HEINLEN MUTUAL WATER COMPANY

By _____
President

By _____
Secretary

LAGUNA IRRIGATION DISTRICT

By _____
President

By _____
Secretary

LAST CHANCE WATER DITCH COMPANY

By _____
President

By _____
Secretary

LEMOORE CANAL & IRRIGATION COMPANY

By _____
President

By _____
Secretary

LIBERTY CANAL COMPANY

By _____
President

By _____
Secretary

LIBERTY MILL RACE COMPANY

By _____
President

By _____
Secretary

LOVELACE WATER CORPORATION

By _____
President

By _____
Secretary

PEOPLES DITCH COMPANY

By _____
President

By _____
Secretary

REED DITCH COMPANY

By _____
President

By _____
Secretary

RIVERDALE IRRIGATION DISTRICT

By _____
President

By _____
Secretary

SOUTHEAST LAKE WATER COMPANY

By _____
President

By _____
Secretary

STINSON CANAL & IRRIGATION COMPANY

By _____
President

By _____
Secretary

STRATFORD IRRIGATION DISTRICT

By _____
President

By _____
Secretary

TULARE LAKE BASIN WATER
STORAGE DISTRICT

By _____
President

By _____
Secretary

TULARE LAKE CANAL COMPANY

By _____
President

By _____
Secretary

TULARE LAKE RECLAMATION
DISTRICT NO. 761

By _____
President

By _____
Secretary

UPPER SAN JOSE WATER COMPANY

By _____
President

By _____
Secretary

EXHIBIT A

Lower River Units and Participating Percentages

Lower River Units	Participating Percentages
Burrel Ditch Company	1.33
Clark's Fork Reclamation District No. 2069	0.35
Corcoran Irrigation Company	3.66
Crescent Canal Company	3.29
Empire West Side Irrigation District	1.29
John Heinlen Mutual Water Company	1.79
Laguna Irrigation District	9.31
Last Chance Water Ditch Company	10.79
Lemoore Canal & Irrigation Company	13.74
Liberty Canal Company	1.13
Liberty Mill Race Company	2.60
Lovelace Water Corporation	0.46
Peoples Ditch Company	20.00
Reed Ditch Company	1.29
Riverdale Irrigation District	3.94
Southeast Lake Water Company	2.51
Stinson Canal & Irrigation Company	2.31
Stratford Irrigation District	1.33
Tulare Lake Basin Water Storage District	7.15
Tulare Lake Canal Company	5.69
Tulare Lake Reclamation District No. 761	5.52
Upper San Jose Water Company	0.52
TOTAL	100.00

EXHIBIT B

Policy Addressing River Channel Losses
Related to Agreement for Rental of James Irrigation District and
Tranquillity Irrigation District
Kings River Water Entitlement and Storage Space

Lower River Board Policy 2003-1

River Channel Losses Related to the Agreement Entitled Rental of James and Tranquillity Irrigation Districts Kings River Water Entitlement and Storage Space

The following outlines the methodology to be used to determine the impacts, if any, to river channel losses resulting from the transfer of James and Tranquillity Irrigation Districts' entitlement upstream from its original point of diversion as is described in the agreement entitled Rental of Kings River Water Entitlement and Storage Space dated December 23, 2003.

1) In any year in which Crescent and/or Stinson take delivery of their Kings River entitlement water downstream of Island Weir, an analysis of potential loss impacts will be calculated assuming that all of the net James and Tranquility entitlement earned in that same year would have been delivered to James and Tranquility at their original points of diversion in that year. When calculating loss impacts, the Watermaster shall use the same method and assumptions (outlined in the Attachment B) as are used in evaluating Paragraph 18 transfers, and the Watermaster's determination will govern.

    a) Any adjustments resulting from the loss calculation identified above will be debited/credited to the storage accounts of the impacted Lower River Unit(s) in the same manner and at the same time as any other adjustments are made.

    b) Preliminary loss impact calculations will be made as J&T entitlement is earned and the corresponding debits/credits will be made. Refinement of those calculations will occur during the time frame described in paragraph 1.c. so as to minimize the magnitude of final adjustments.

    c) For the purpose of the above calculation, the net James and Tranquillity entitlement earned in that year will be assumed to be delivered during a coordinated run if such period is established for that year by the Lower River Board (per Lower River Board Resolution 89-1 unanimously adopted May 9, 1989). In the event a coordinated run period is not established, the actual dates of irrigation release for Crescent and/or Stinson diversion will be utilized.

    d) For the purpose of the above calculation any James and Tranquillity entitlement carried over from prior year(s) will not be included.

2) In any year in which neither Crescent nor Stinson takes delivery of their Kings River entitlement water downstream of Island Weir, no analysis of potential loss impacts will

be calculated and no make-up water will be owed from the net James and Tranquility entitlements earned in that year.

3) In any year when sufficient pool supplies are available to make up all river channel losses, no analysis of potential loss impacts will be calculated and no make-up water will be owed from the net James and Tranquility entitlements earned in that year.

4) In any year in which James and Tranquillity receive no net entitlement, no analysis of potential loss impacts will be calculated and no make-up water will be owed.

5) The following Table illustrates the types of water years in which an analysis of potential loss impacts would be calculated:

Table 1: Example for types of water years.

Year	J&T Entitlement	J&T Carryover	C &/or S Diversion	Pool Supply	Loss Impact Calculation Triggered
1	0	0	0	None	No
2	0	0	3000	None	No
3	0	0	3000	Partial	No
4	0	0	3000	Full	No
5	1000	0	0	None	No
6	0	1000	1000	None	No
7	1000	0	3000	None	Yes
8	1000	0	3000	Partial	Yes
9	1000	0	3000	Full	No

6) The following attachments are included as reference material and for illustration purposes and are incorporated in the policy of the Board of Directors of the Lower River Units related to these river channel losses:

a) Attachment A: Headgate Diversions for Water Years 1964 through 2003, Chronologically and Headgate Diversions for Water Years 1964 through 2003 ranked by the Magnitude of James and Tranquillity Kings River Entitlement.

b) Attachment B: Assumptions Used In Calculating the Impact to Losses Resulting From the Transfer of James and Tranquillity Irrigation Districts Kings River Entitlement Upstream.

c) Attachment C: Estimated 2002-03 Loss Impact Adjustment Resulting from Proposed 2003 James and Tranquillity Rental Agreement.

Attachment A, Sheet 1of 2

Headgate Diversions for Water Years 1964 though 2003 in sfd and rounded to the nearest 1,000 sfd
Provisional data from the KRWA Legacy database.
Ranked Chronologically

Water	Annual Entitlement			Net Annual Diversions Between Weirs			Pool Supplies Available for Channel			Loss Impact
Year	James and			Island to	Crescent to	Stinson to	Losses (Excluding J&T Entitlement)			Calculation
Thru	Tranquillity	Crescent	Stinson	Crescent	Stinson	James	Full	Partial	None	Triggered?
1964	2,000	2,000	2,000	5,000	2,000	0			x	yes
1965	14,000	14,000	12,000	14,000	11,000	1,000		x		yes
1966	4,000	4,000	4,000	7,000	5,000	0			x	yes
1967	57,000	27,000	23,000	20,000	21,000	29,000	x			no
1968	0	0	0	8,000	6,000	0		x		no
1969	50,000	36,000	29,000	45,000	39,000	14,000	x			no
1970	9,000	6,000	6,000	13,000	9,000	4,000		x		yes
1971	4,000	3,000	3,000	8,000	5,000	1,000		x		yes
1972	0	0	0	2,000	0	0		x		no
1973	24,000	17,000	12,000	12,000	9,000	1,000		x		yes
1974	18,000	13,000	12,000	13,000	13,000	14,000		x		yes
1975	14,000	9,000	5,000	11,000	10,000	1,000		x		yes
1976	0	0	0	7,000	1,000	0		x		no
1977	0	0	0	0	0	0			x	no
1978	35,000	28,000	24,000	13,000	20,000	38,000	x			no
1979	14,000	10,000	10,000	14,000	25,000	1,000		x		yes
1980	32,000	25,000	22,000	12,000	36,000	10,000	x			no
1981	6,000	5,000	4,000	13,000	14,000	0		x		yes
1982	33,000	24,000	21,000	28,000	23,000	11,000	x			no
1983	42,000	36,000	28,000	48,000	35,000	0	x			no
1984	11,000	11,000	9,000	-21,000	34,000	3,000		x		yes
1985	6,000	5,000	4,000	6,000	13,000	1,000		x		yes
1986	32,000	27,000	20,000	45,000	27,000	0	x			no
1987	0	1,000	0	12,000	8,000	1,000		x		no
1988	1,000	1,000	1,000	1,000	1,000	0			x	yes
1989	0	2,000	1,000	0	0	0			x	no
1990	0	0	0	0	0	0			x	no
1991	7,000	5,000	5,000	7,000	0	0			x	yes
1992	0	0	0	0	0	0			x	no
1993	27,000	20,000	18,000	24,000	22,000	0		x		yes
1994	1,000	1,000	1,000	7,000	0	0			x	yes
1995	37,000	30,000	25,000	34,000	35,000	20,000	x			no
1996	18,000	15,000	13,000	34,000	30,000	6,000		x		yes
1997	28,000	24,000	20,000	37,000	28,000	10,000	x			no
1998	30,000	25,000	22,000	31,000	27,000	0	x			no
1999	8,000	6,000	5,000	22,000	13,000	2,000	x			no
2000	13,000	10,000	9,000	16,000	5,000	0		x		yes
2001	8,000	5,000	5,000	13,000	0	0			x	yes
2002	10,000	8,000	8,000	8,000	0	0			x	yes
2003	10,000	6,000	6,000	7,000	0	0			x	yes

J&T PSOP SSOP data.xls *11/11/2003*

Attachment A, Sheet 2 of 2

Headgate Diversions for Water Years 1964 though 2003 in sfd and rounded to the nearest 1,000 sfd
Provisional data from the KRWA Legacy database.
Ranked by the Magnitude of James and Tranquillity Kings River Entitlement

Water Year Thru	Annual Entitlement			Net Annual Diversions Between Weirs			Pool Supplies Available for Channel Losses (Excluding J&T Entitlement)			Loss Impact Calculation Triggered?
	James and Tranquillity	Crescent	Stinson	Island to Crescent	Crescent to Stinson	Stinson to James	Full	Partial	None	
1967	57,000	27,000	23,000	20,000	21,000	29,000	x			no
1969	50,000	36,000	29,000	45,000	39,000	14,000	x			no
1983	42,000	36,000	28,000	48,000	35,000	0	x			no
1995	37,000	30,000	25,000	34,000	35,000	20,000	x			no
1978	35,000	28,000	24,000	13,000	20,000	38,000	x			no
1982	33,000	24,000	21,000	28,000	23,000	11,000	x			no
1980	32,000	25,000	22,000	12,000	36,000	10,000	x			no
1986	32,000	27,000	20,000	45,000	27,000	0	x			no
1998	30,000	25,000	22,000	31,000	27,000	0	x			no
1997	28,000	24,000	20,000	37,000	28,000	10,000	x			no
1993	27,000	20,000	18,000	24,000	22,000	0		x		yes
1973	24,000	17,000	12,000	12,000	9,000	1,000		x		yes
1974	18,000	13,000	12,000	13,000	13,000	14,000		x		yes
1996	18,000	15,000	13,000	34,000	30,000	6,000		x		yes
1965	14,000	14,000	12,000	14,000	11,000	1,000		x		yes
1975	14,000	9,000	5,000	11,000	10,000	1,000		x		yes
1979	14,000	10,000	10,000	14,000	25,000	1,000		x		yes
2000	13,000	10,000	9,000	16,000	5,000	0		x		yes
1984	11,000	11,000	9,000	-21,000	34,000	3,000		x		yes
2002	10,000	8,000	8,000	8,000	0	0			x	yes
2003	10,000	6,000	6,000	7,000	0	0			x	yes
1970	9,000	6,000	6,000	13,000	9,000	4,000		x		yes
1999	8,000	6,000	5,000	22,000	13,000	2,000	x			no
2001	8,000	5,000	5,000	13,000	0	0			x	yes
1991	7,000	5,000	5,000	7,000	0	0			x	yes
1981	6,000	5,000	4,000	13,000	14,000	0		x		yes
1985	6,000	5,000	4,000	6,000	13,000	1,000		x		yes
1966	4,000	4,000	4,000	7,000	5,000	0			x	yes
1971	4,000	3,000	3,000	8,000	5,000	1,000		x		yes
1964	2,000	2,000	2,000	5,000	2,000	0			x	yes
1988	1,000	1,000	1,000	1,000	1,000	0			x	yes
1994	1,000	1,000	1,000	7,000	0	0			x	yes
1968	0	0	0	8,000	6,000	0		x		no
1972	0	0	0	2,000	0	0		x		no
1976	0	0	0	7,000	1,000	0		x		no
1977	0	0	0	0	0	0			x	no
1987	0	1,000	0	12,000	8,000	1,000		x		no
1989	0	2,000	1,000	0	0	0			x	no
1990	0	0	0	0	0	0			x	no
1992	0	0	0	0	0	0			x	no

J&TPSOP SSOP data.xls *11/11/2003*

Attachment B

Assumptions Used In Calculating the Impact to Losses Resulting From the Upstream Transfer of James and Tranquillity Irrigation Districts Kings River Entitlement.

The following assumptions are utilized for the purposes of calculating the impacts to channel losses resulting from the transfer of James and Tranquillity Irrigation Districts Kings River Entitlement upstream during a specified time period.

1) The total volume of channel loss in a particular reach of the river during a specified time period remains constant irrespective of the volume of water conveyed.

2) The assumed volume of water released from Pine Flat Dam for the purpose of this calculation for the hypothetical condition without J&T transfer is the same as was actually released.

3) Transferred water bears losses from Pine Flat dam to the transfer point at the same rate as all other water delivered to that point during the specified time period.

4) The loss impact calculation addresses each lower river unit's pro rata share of impacts to losses between where the water would have been diverted and where the water was actually diverted. (For the purpose of the 2003 James and Tranquillity Rental Agreement, the point of transfer would be the end of the river in that water year, either Crescent or Stinson Weir)

Attachment C illustrates the principle of the adjustments resulting from the loss impact calculation. It assumes the James and Tranquillity Rental Agreement is in effect and follows the draft Lower River Board policy entitled River Channel Losses Related to the Agreement Entitled Rental of James and Tranquillity Irrigation Districts Kings River Water Entitlement and Storage Space.

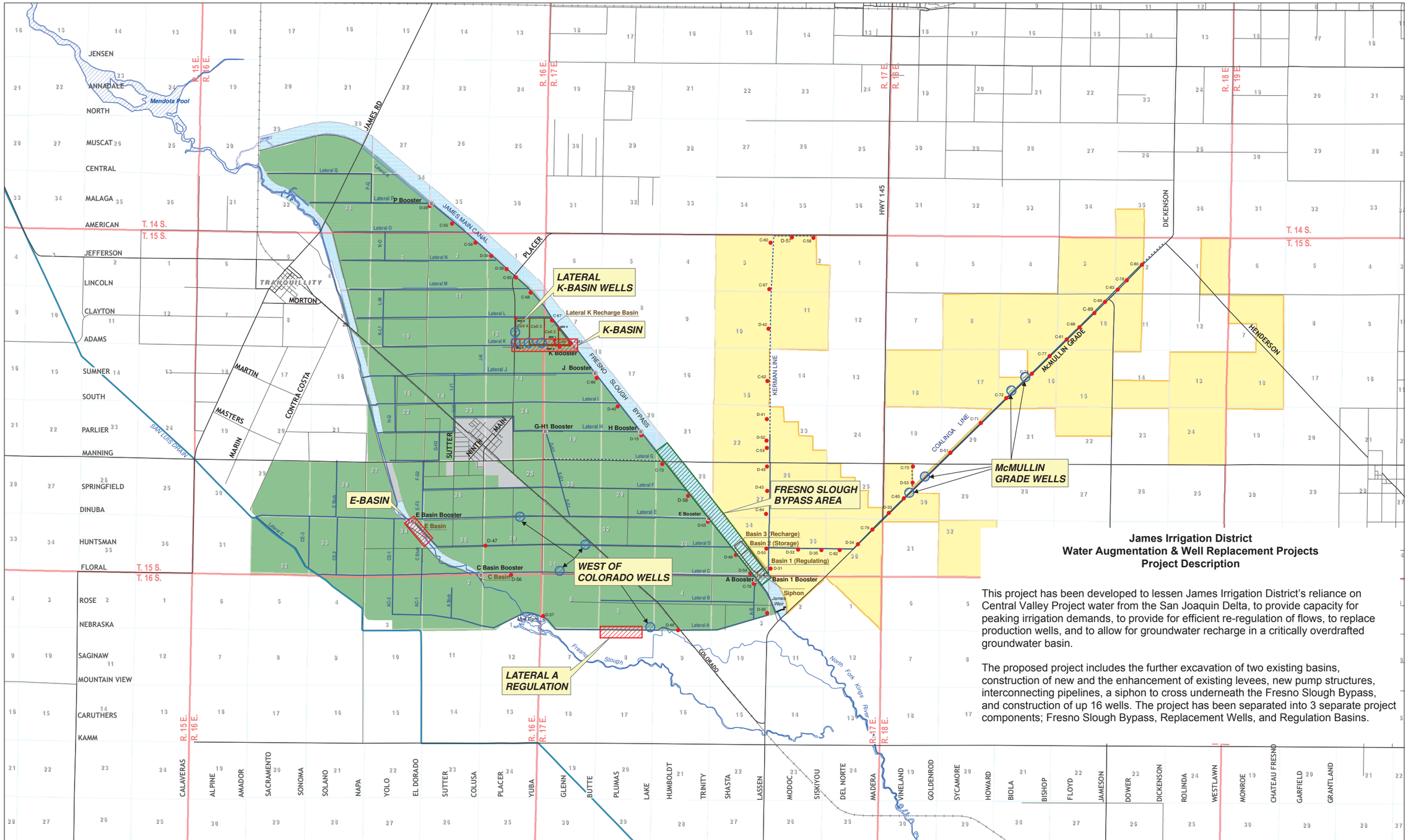
Attachment C

Estimated 2002-03 Loss Impact Adjustment Resulting From Proposed 2003 James and Tranquillity Rental Agreement.

To be distributed at a later date.

ATTACHMENT 3

Water Augmentation Project Improvements



James Irrigation District
Water Augmentation & Well Replacement Projects
Project Description

This project has been developed to lessen James Irrigation District's reliance on Central Valley Project water from the San Joaquin Delta, to provide capacity for peaking irrigation demands, to provide for efficient re-regulation of flows, to replace production wells, and to allow for groundwater recharge in a critically overdrafted groundwater basin.

The proposed project includes the further excavation of two existing basins, construction of new and the enhancement of existing levees, new pump structures, interconnecting pipelines, a siphon to cross underneath the Fresno Slough Bypass, and construction of up 16 wells. The project has been separated into 3 separate project components; Fresno Slough Bypass, Replacement Wells, and Regulation Basins.

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PROVOST & PRITCHARD
ENGINEERING GROUP
An Employee Owned Company

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Fresno, CA 93711-6162
(559) 449-2700

MAJOR ROAD
STREET
RAILROAD
TOWNSHIP/RANGE
SECTION
CITY BOUNDARY
JAMES ID
CITY OF SAN JOAQUIN/JID OVERLAP
RECLAMATION DISTRICT 1606
JAMES ID WELL FIELD
CANAL
PIPELINE
BASIN
KINGS RIVER

Boosters, Lifts, and Wells
BOOSTER
MONITOR WELL
PRODUCTION WELL

FRESNO SLOUGH BYPASS PROJECT PORTION
REGULATION BASINS PROJECT PORTION
REPLACEMENT WELLS PROJECT PORTION

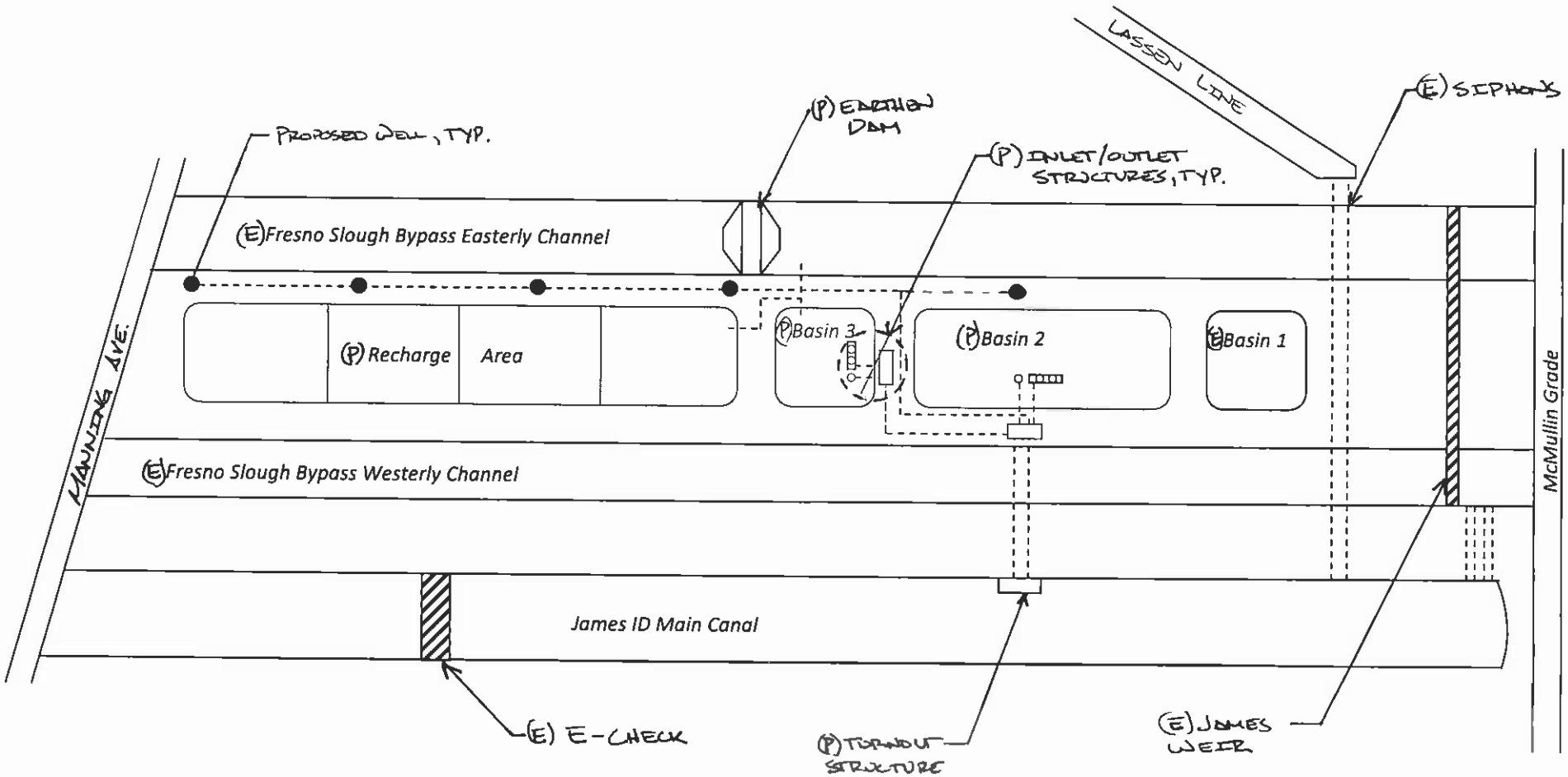
0 2,000 4,000 Feet

JAMES IRRIGATION DISTRICT
SAN JOAQUIN, CA

James Irrigation District
Fresno County, CA

September 2008

9/3/2008 \\pnefsfat\dwg_dgn\Clients\James ID-1051\Projects\-105108\02-LEG\GIS\Map\JID_projects.mxd



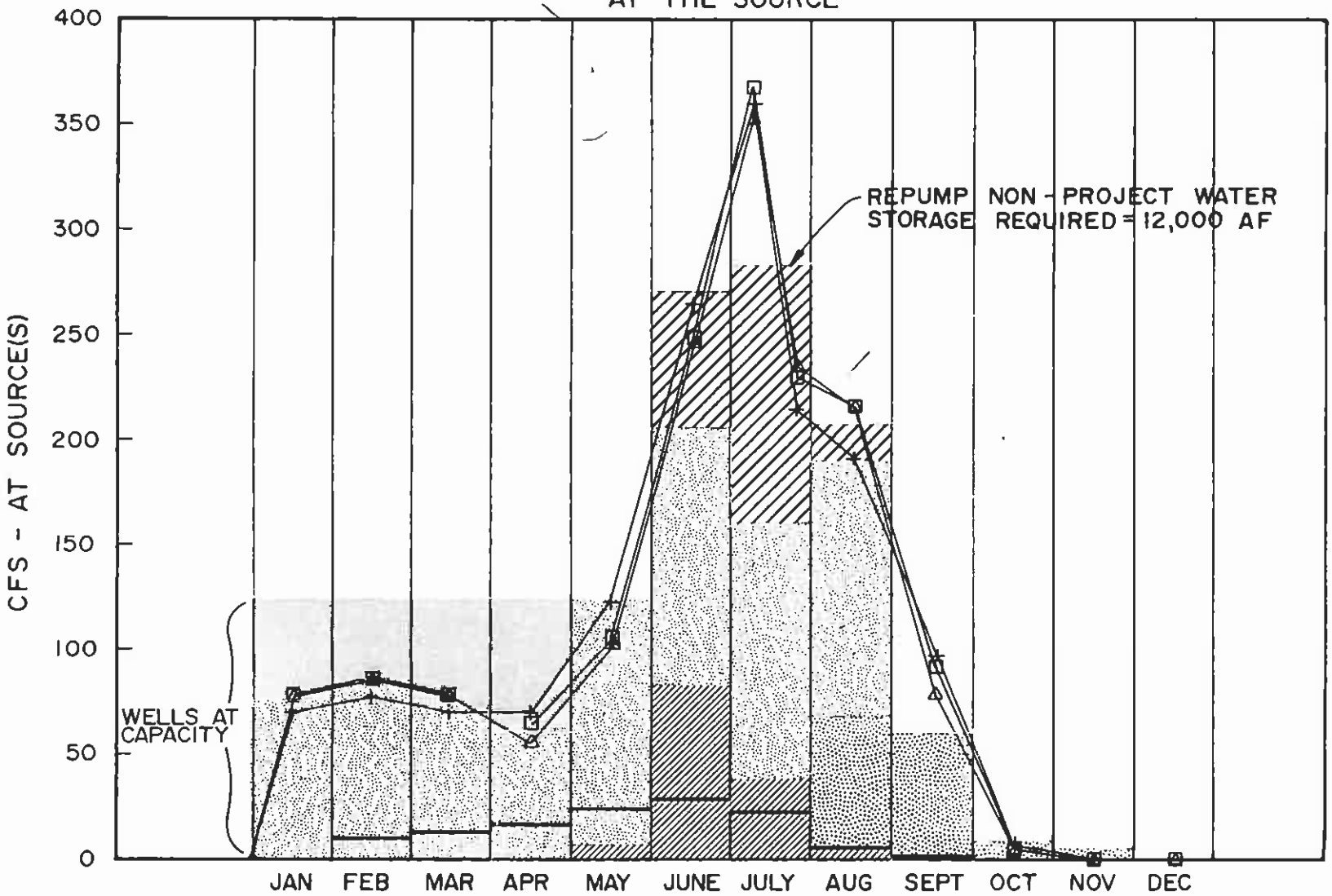
FRESNO SLOUGH BYPASS IMP.

N.T.S.

ATTACHMENT 4

Hydrographs

JAMES IRRIGATION DISTRICT
WATER DEMANDS
AT THE SOURCE

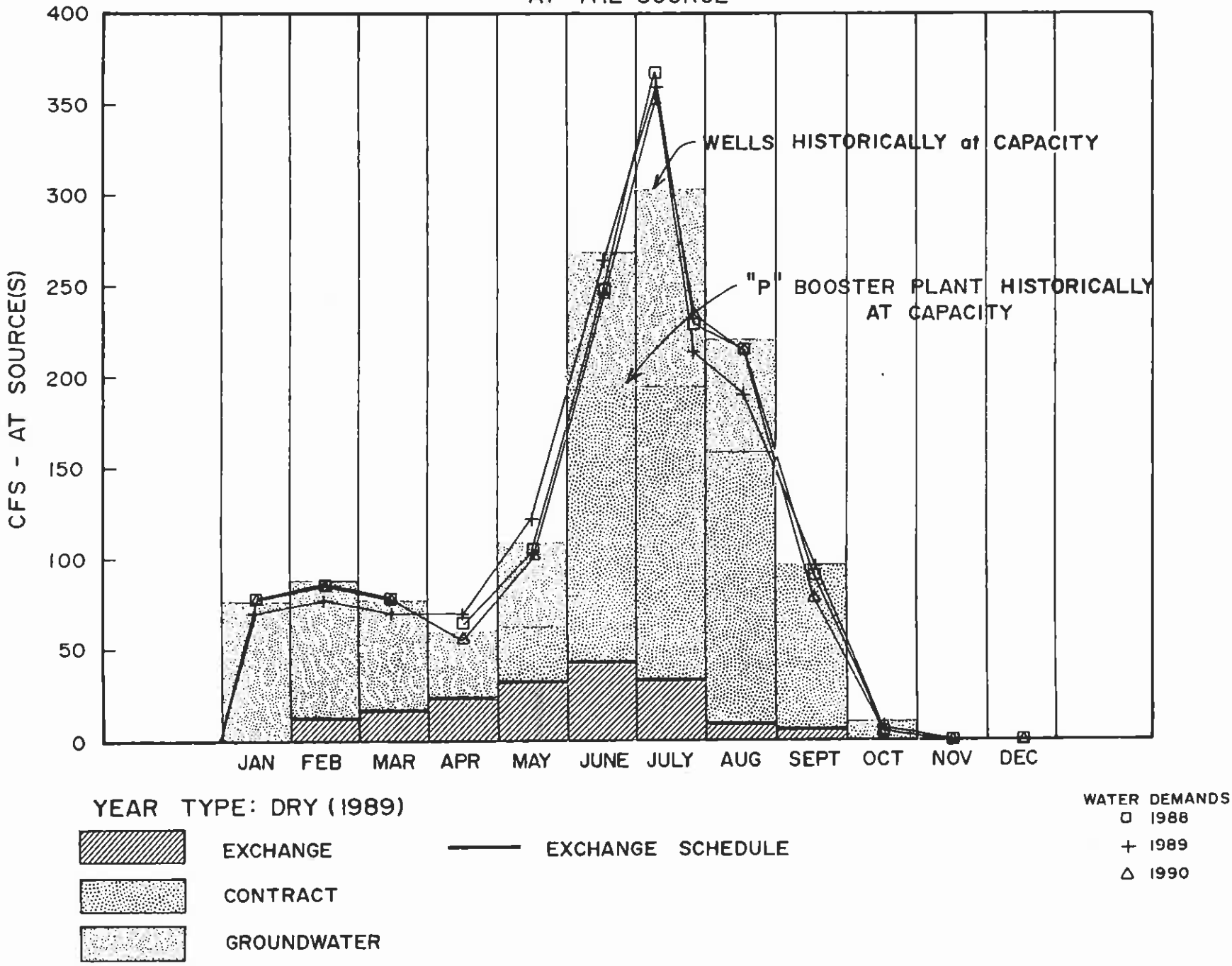


YEAR TYPE: CRITICALLY DRY (1991)

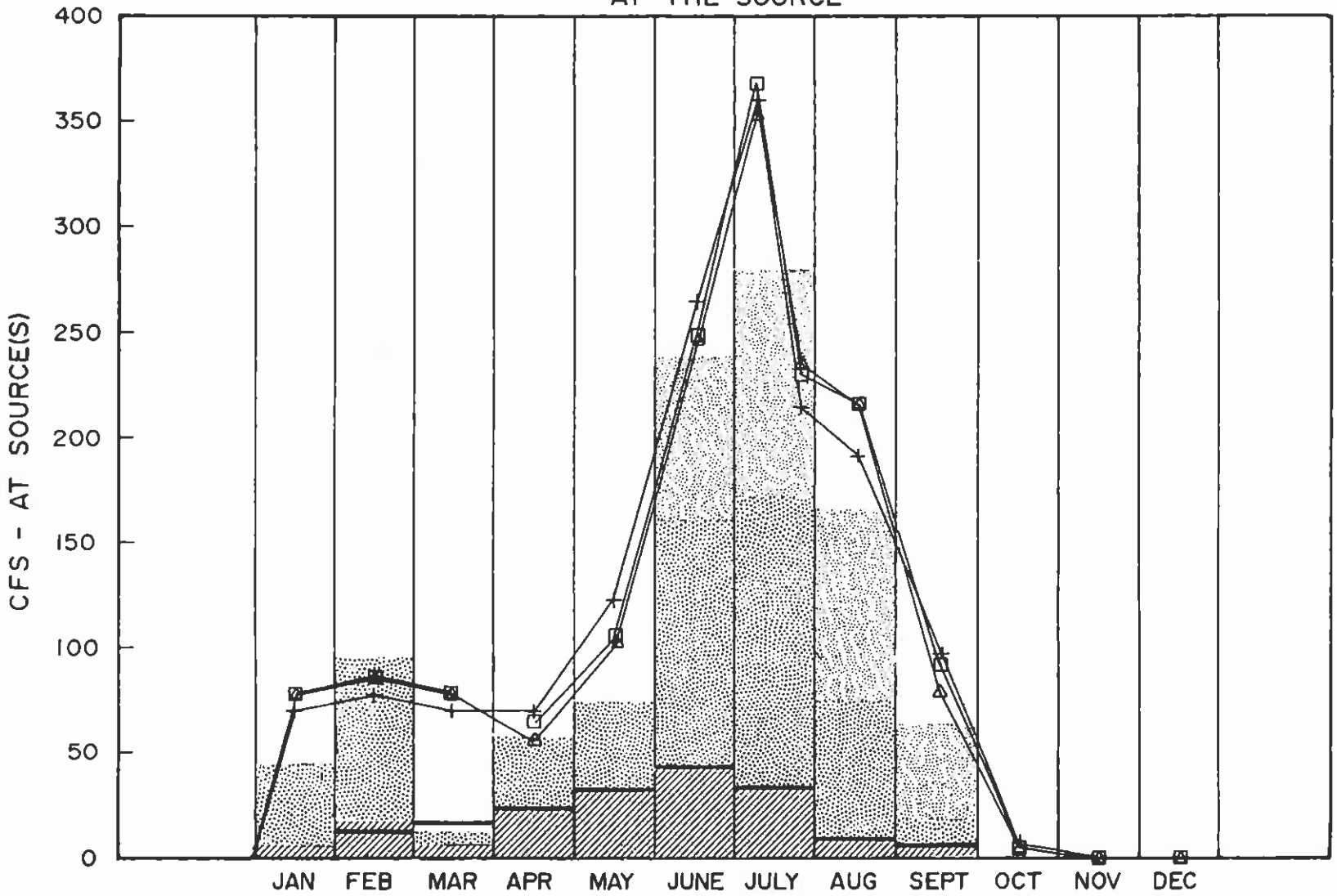
- EXCHANGE
- CONTRACT
- GROUNDWATER
- GROUNDWATER PUMPED INTO MENDOTA POOL - STORAGE
- STORED WATER PUMPED FROM POOL
- EXCHANGE SCHEDULE

WATER DEMANDS
- □ 1988
- + 1989
- △ 1990

JAMES IRRIGATION DISTRICT
WATER DEMANDS
AT THE SOURCE



JAMES IRRIGATION DISTRICT
WATER DEMANDS
AT THE SOURCE



YEAR TYPE: NORMAL (1981)

EXCHANGE

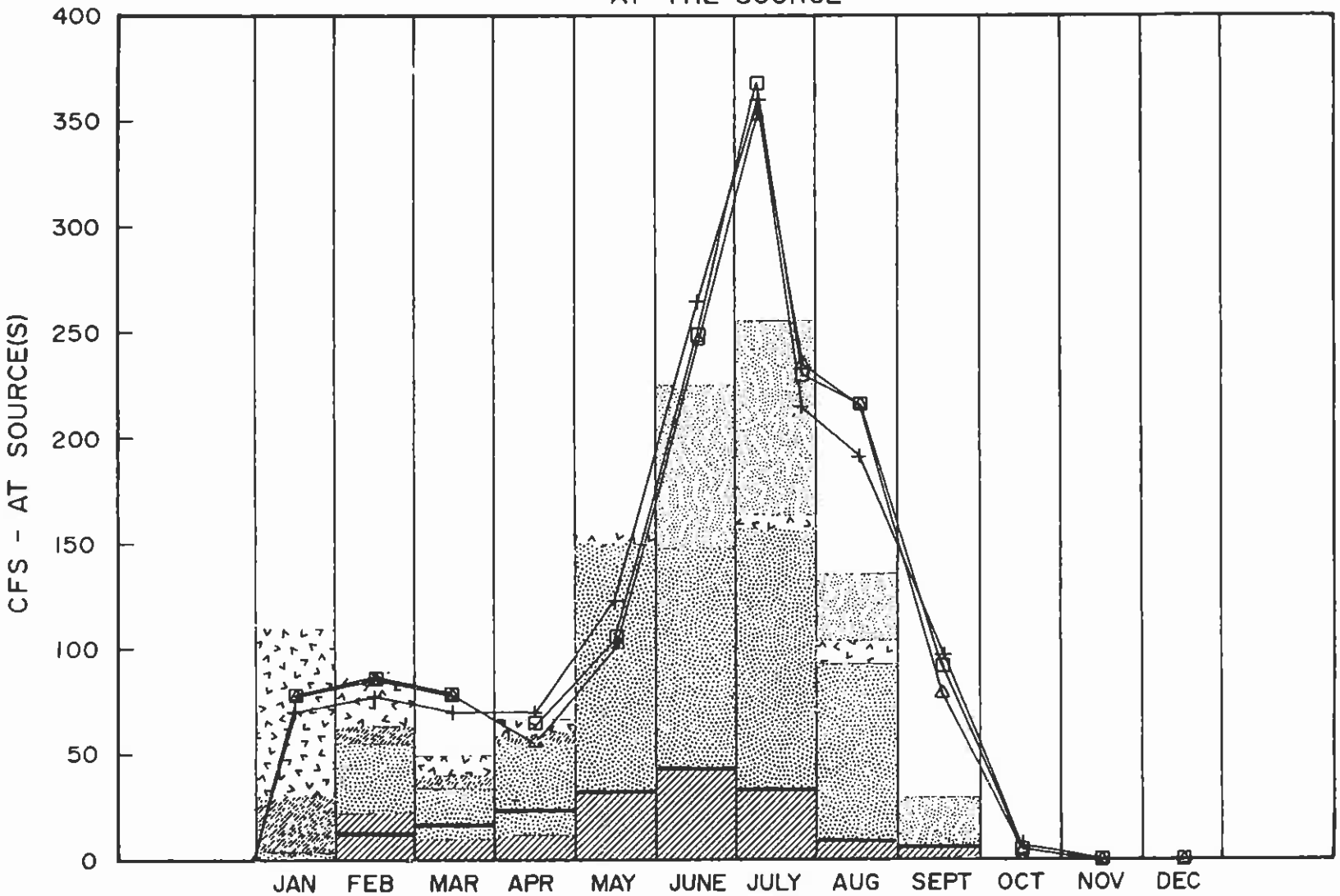
CONTRACT

GROUNDWATER

EXCHANGE SCHEDULE

WATER DEMANDS
□ 1988
+ 1989
△ 1990

JAMES IRRIGATION DISTRICT
WATER DEMANDS
AT THE SOURCE



YEAR TYPE: ABOVE NORMAL (1984)

EXCHANGE

CONTRACT

GROUNDWATER

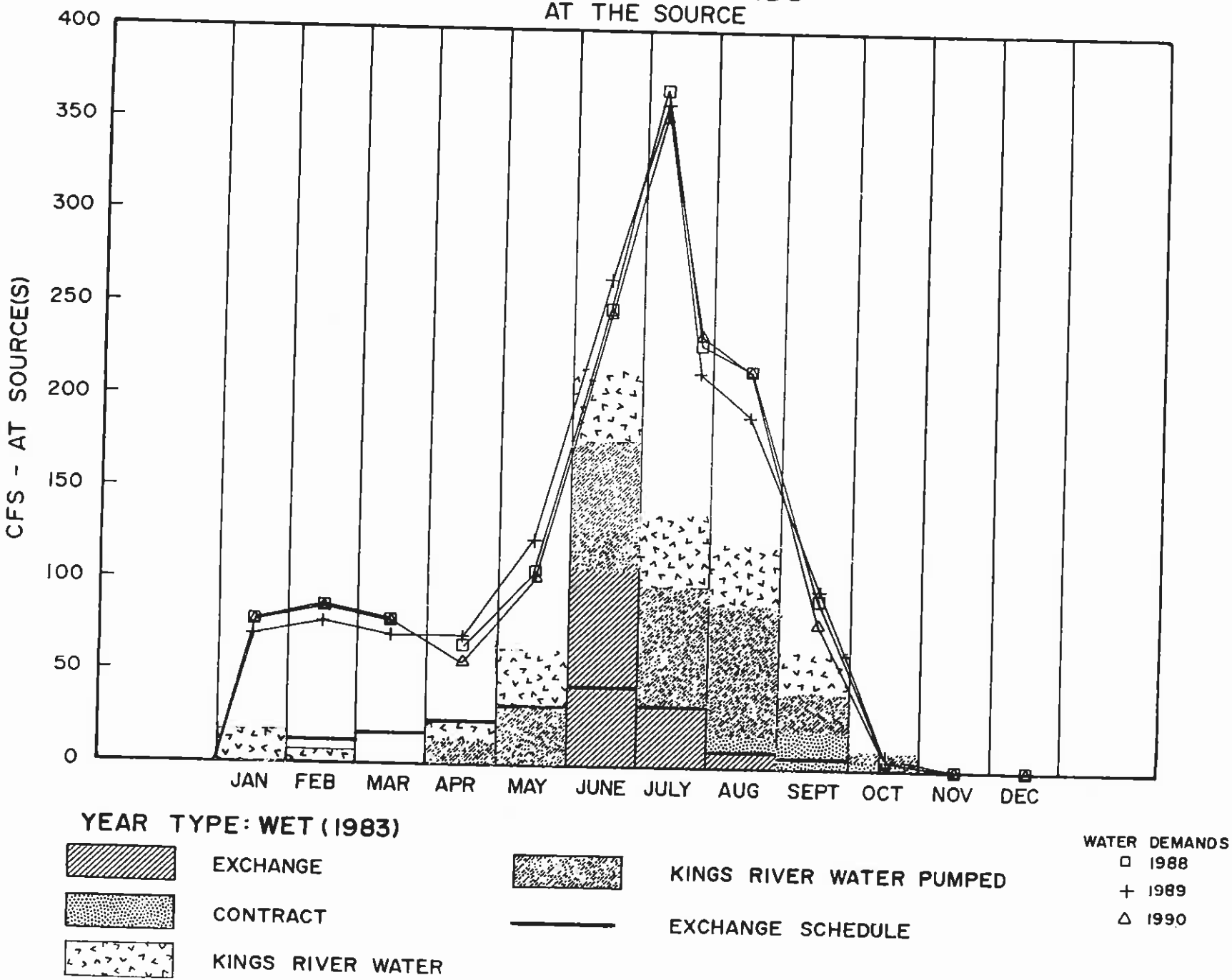
EXCHANGE SCHEDULE

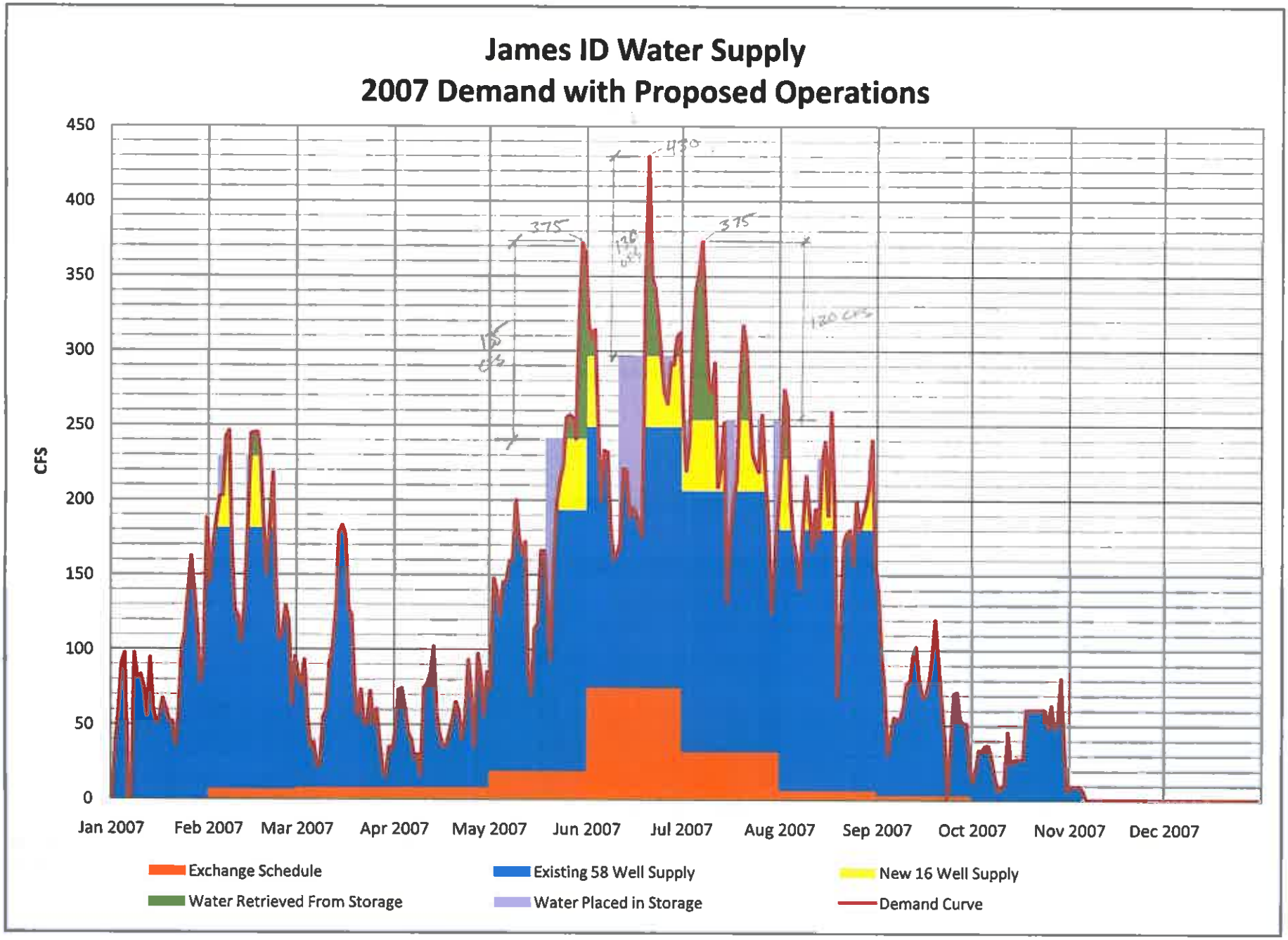
KINGS RIVER WATER

KINGS RIVER WATER PUMPED

WATER DEMANDS
□ 1988
+ 1989
△ 1990

JAMES IRRIGATION DISTRICT
WATER DEMANDS
AT THE SOURCE





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ATTACHMENT 5

Water Banking Prospectus

JAMES IRRIGATION DISTRICT

Incorporated February 16, 1920

BOARD OF DIRECTORS
Kenneth R. Hale, President
Robert Motte, Vice-President
George Ayerza, Sr.
Thomas W. Chaney
John W. Kinnunen

8749 Ninth Street
Post Office Box 757
San Joaquin, California 93660-0757

John Mallyon, Manager
Donna Hanneman, Secretary

Telephone: (559) 693-4356
Facsimile: (559) 693-4357

Water Banking Program Prospectus

Overview

The following is a solicitation of interest in purchasing a long-term water supply or water banking services from the James Irrigation District. Those interested should immediately contact Richard M. Moss, California, at (559) 636-1166. As you will read, the James Irrigation District is uniquely positioned from a geographic, hydrologic and water rights entitlement/contractual basis to offer water banking services to others as well as to offer water generated from the District's own banking program for sale on a long-term basis to willing purchasers throughout California.

Description of District

The James Irrigation District is an agricultural water purveyor located in the heart of the San Joaquin Valley near the town of San Joaquin, 25 miles southwest of Fresno in California. The District has been in formal operation since 1920 with predecessor interests dating back to the mid-1800's. The 26,000-acre (23,000 acres irrigated) district is farmed primarily to row crops, cotton, alfalfa and seed alfalfa. More recently, many acres of almonds have been planted in the District. It has a mixture of soil types ranging from light (sandy) textured soils on the eastern side of the District to very heavy clay soils for much of the central and western part of the District.

The District is underlain with a good quality groundwater aquifer with capacity to store an estimated 1.5 million acre-feet of water. The District is located near the "trough" of the San Joaquin Valley and sits between the Fresno Slough, the northern most distributary of the Kings River, and the James Bypass, the floodway that transports Kings River floodwaters to Mendota Pool and the San Joaquin River. The District can pump water from or deliver water to the Mendota Pool, an operational reservoir located on the San Joaquin River near the town of Mendota, which is also the terminus of the federal Central Valley Project (CVP) Delta-Mendota Canal and the headworks for the historic diversions from the San Joaquin River by the San Joaquin River Exchange Contractors (which hold some of the oldest and firmest water rights in the state). In some respects the Mendota Pool serves as a "switchyard" for water and water transactions with some of the most senior water rights holders in the state and some of the more junior water rights holders in the state receiving water directly or indirectly from Mendota Pool, as well having the ability to receive water from the San Joaquin River, the Kings River, the federal CVP and the California State Water Project. On the average, more than 1.5 million acre-feet of water pass through Mendota Pool every year.

The James Irrigation District has available to it several different water sources, including:

- A good quality groundwater aquifer with a dedicated well field and overlying and deeded rights to groundwater extraction within and outside of the District's boundaries. The District currently owns and operates 58 wells and deep well turbine pumps;

- Water rights to the Kings River granting it access to floodwater;

- The ability to contract for floodwater from the San Joaquin River via the CVP's Friant Division (with delivery through the Friant-Kern Canal and the Kings River) or to take San Joaquin River floodwater reaching Mendota Pool;

- The ability to contract for surplus CVP water made available from the Delta-Mendota Canal and Mendota Pool;

- A perpetual right (in settlement of water rights issues, called "Schedule 2 Water") to 9,700 acre-feet of CVP water made available from the Delta-Mendota Canal and Mendota Pool subject only to an approximately 22 percent shortage in certain (infrequent) critically dry years for the Sacramento River; and

- Contractual entitlement to 35,300 acre-feet of CVP water via a long-term water service contract subject to CVP agricultural water shortages from the CVP's Mendota Pool Unit.

It is this unique combination of access and rights to various water resources and equally unique geographical setting that allows James Irrigation District to provide water banking services using its groundwater reservoir and extraction wells and/or to make a water supply available for sale to others.

<u>How is James Irrigation District Able to Make Water Available in a Dry Year</u>?

James Irrigation District has embarked on an aggressive program of construction of direct groundwater recharge facilities (sinking basins) and groundwater wells and pumps. It intends to use these new facilities to generate new yield for use within the District by capturing available floodwater from either the Kings or San Joaquin rivers or other sources. Some of the additional yield from this new groundwater storage capability will be exchanged for the District's surface water to facilitate the sale of banked floodwater. The District has constructed a major new groundwater recharge facility and has validated on a large-scale basis the technical and policy foundation upon which the Water Sales portion of the Program is based. The balance of the needed construction of new facilities (groundwater wells) will commence with the finalization of water sales or banking agreement(s).

The third party Water Banking portion of the Program will operated by the District taking surface water deliveries from its banking customer either for direct recharge or by using

the existing distribution system to offset use by the District's water users at times they would otherwise be using their groundwater. The inverse of these operations will occur when water is to be returned to the District's Water Banking customers.

Sale of New Yield from Banking Facilities

James Irrigation District is offering a portion of the new water supplies produced through its banking program for long-term sale. This water is significantly differentiated by its relative firmness of availability. This supply is some of the most reliable water in California, and is even more reliable than Municipal and Industrial water supplies available by way of water service contract from the CVP.

Quantity - James Irrigation has available for sale up to 1,250 acre-feet per year of surface water supply produced through its banking program to be made available at O'Neill Forebay.

Term - The James Irrigation District is interested in providing a long-term program of banked water sales for the term of its CVP long-term contract water supply and renewals thereof.

Price – The price of the water is split into two components: (i) an initial one-time payment for each acre-foot of annual entitlement to be purchased of $450 per acre-foot, and (ii) an annual charge of $450 per acre-foot for each acre-foot of entitlement to be purchased (to be paid annually regardless of how much water is actually delivered). The annual charge will be adjusted annually using the All Urban Consumers, All Items Index, Western Cities with populations between 50,000 and 1,500,000 (CPI-U) as an index with the November 2007 CPI-U as its base over the term of the contract(s). Once purchased, this water supply will be available to the buyer for as long as the District retains its water service contract with the Bureau of Reclamation, up until 2054.

Other terms of sale such as build-up provisions, return of unused water, etc. of significance should be noted and flagged for negotiation early as part of the potential buyers' indication of interest.

Such supplies would be available every year, unless and to the extent the District's Schedule 2 water supply of at least 7,600 acre-feet is not made available to the District (which to date has never occurred).

Water Banking Services

James Irrigation District is also offering water banking or firming services using water supplied by banking partner(s). Much like the firm ability to provide water banked by the District itself for sale, water supplied by a partner and banked with the District can be returned in even the driest of years.

Quantity - James Irrigation District has available for return as part of its Water Banking Program up to 1,250 acre-feet per year of surface water supply to be made available at O'Neill Forebay. Water to be banked with James Irrigation District must be made

available at the District's turnout from the Mendota Pool or at other locations agreeable to the District. All costs of providing the water to be banked are to be borne by the banking partner. Water to be banked with James Irrigation District must be made available at times acceptable to the District. The original banked water quantity put with the District will be reduced by ten (10) percent to account for spreading, aquifer and any other losses and related mitigation..

Term - The James Irrigation District is interested in providing a long-term program of water banking for a term of twenty-five (25) years. The water banking program may be renewed upon terms and conditions mutually agreeable to the parties. Any water remaining in the Water Bank at the end of the term will become the asset of the James Irrigation District unless there is a renewal agreement that specifically addresses existing water supplies already in the bank.

Price - The price of the banking service is split into three (3) components: (i) an initial one-time payment of $1,750 per acre-foot of annual return capacity, (ii) a $30 per acre-foot fee when each acre-foot is actually placed into the Water Bank, and (iii) a $30 per acre-foot fee when each acre-foot is returned from the Water Bank. The placement and return charges will be adjusted annually in using the All Urban Consumers, All Items Index, Western Cities with populations between 50,000 and 1,500,000 (CPI-U) as an index with the November 2007 CPI-U as its base over the term of the contract(s). There is no limit to how much water can be placed and subsequently returned, only a limit (three times the annual return capacity purchased) that can be stored in the bank at any one time (see Banking Capacity below). It should be noted that the costs to be paid to James Irrigation District are in addition to any operation and maintenance (O&M) costs associated with operating the Water Bank including the O&M costs for a portion of the District's distribution system, groundwater recharge system and groundwater extraction system. This cost is currently estimated to be $18 per acre-foot for annual O&M plus an additional $45 per acre-foot energy charge in years when groundwater extraction occurs on behalf of the banking partner. These charges will be adjusted annually to reflect actual costs.

Banking Capacity – Three (3) acre-feet of storage capacity within the James Irrigation District's groundwater reservoir for each acre-foot of annual return capacity will be provided by the District.

<u>District Goals</u>

The District's Program has some fundamental underlying goals:

- The Program must generate significant, quantifiable benefits to the District and its landowners;

- The Program should not have any significant adverse impacts (short-term or long-term) on the District, its landowners or any third parties. This includes impacts to local groundwater supplies; and

- The Program should not have any adverse implications on the District's ability to continue to receive water (or the benefits of that water) under its existing water or contract rights.

The Program (or any portion of it) will not be pursued unless it meets those goals.

It should also be noted that James Irrigation District might pursue an expansion of this initial offering or other such programs. While the commitments made pursuant to this Program are intended to be kept, there is no intention of priority associated with this Program over other programs the District is currently involved with or may become involved with in the future.

Fresno Irrigation District &
James Irrigation District

Supplement to Reconnaissance Investigation
Possible Banking Projects / Opportunities

FINAL DRAFT

February 2013

Prepared for:

Fresno Irrigation District
James Irrigation District

Prepared by:

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Table of Contents

1 Purpose 1
2 JID Water Supply and Demand 2
2.1 USBR CVP 2
2.2 Kings River Water 3
2.3 Groundwater 7
2.4 Transfers and Spills 7
3 FID water supplIES Potentially available to JID 8
3.1 Eastside – Kings River and Local Streams 8
3.2 Westside – CVP Friant Recirculated Water 8
4 Conceptual Groundwater Banking Project and Facility Improvements 9
4.1 Existing McMullin Grade Canal 9
4.2 Improved Facilities Analysis 9
4.3 Conceptual Groundwater Banking Project 9
5 Estimated Water Supply and Cost Analysis 11
6 Benefits and Conclusions 12
6.1 Summary 12
6.2 Benefits to JID 13
6.3 Benefits to FID 13

Attachments

Attachment 1 – JID Historical Water Deliveries, Supply and Estimated Demand
Attachment 2 – JID Historical Kings River Yield and Entitlement
Attachment 3 – Kings River Floodwater
Attachment 4 – JID Facilities Map
Attachment 5 – Potential FID Water Supplies Available to JID
Attachment 6 – Conceptual Groundwater Bank & Facility Improvements
Attachment 7 – Estimated JID Water Supply and Cost Analysis

1 PURPOSE

A reconnaissance investigation was conducted in February 2011 for the Fresno Irrigation District (FID) to document general information about the James Irrigation District (JID) to assist FID with evaluating opportunities that could benefit both districts. The February 2011 reconnaissance investigation presented the following information regarding JID:

1) Background Information – including history, organizational structure, crops grown, district assessments, water supply and water rates.
2) Facilities and Capacities – including a brief description about each of the main JID facilities and the capacity of each facility.
3) Water Demand and Timing – including estimated cfs demand under different year types.
4) Project Opportunities – presented a water banking prospectus, water augmentation project and discussing potential programs or opportunities.

The reconnaissance investigation was performed to evaluate the potential for the two Districts to work collectively together on water supply subjects. Both FID and JID have expressed interest in developing a program consisting of a single or multiple projects that would be of joint benefit. The goal would be to develop a program that maximizes the resources of both agencies to first become locally water supply self sufficient and secondly provide a cash flow to help support the program.

The purpose of this Supplement to the February 2011 Reconnaissance Investigation Report is to present more current water supply information (both identification and quantification) and specifically to evaluate enlargement and interconnection of the irrigation systems as well as evaluate a specific water banking project. The main topics that are addressed in this Supplement are:

- The JID portion of J&T Water Supply and Storage
- FID water supply available to JID
- Interconnection of systems through Lower Dry Creek connection
- Conceptual Banking Program on Lower Dry Creek System
- Identification of Benefits

Section 2 (Water Supply) of the February 2011 report is revised herein in its entirety to incorporate the additional information developed during this study. This Supplement also presents estimated facility capital improvement costs for the conceptual project features and they can be found in the attachments.

2 JID WATER SUPPLY AND DEMAND

JID has several sources of water that it can utilize to meet landowner demands - primarily surface water from the Central Valley Project (CVP) and groundwater. JID has an entitlement of Kings River water that has historically been sold, however, JID does divert Kings River high flows for recharge (direct and in-lieu) in wet and above average years when floodwater is available. **Attachment 1** contains historical JID water delivery and water supply information, as well as an estimate of the JID water demand. As shown in **Attachment 1**, surface water has historically supplied approximately 57% of the total JID water supply and groundwater has supplied the remaining 43% of the water supply.

2.1 USBR CVP

2.1.1 Long Term CVP Contract

JID has a CVP contract (No. 14-06-200-700A-LTR1) for up to 35,300 acre-feet of water each year. The CVP water year is from March 1 through February 28. JID normally delivers the CVP water in the spring and summer months and the allocation varies each year based on hydrology and policies set by the United States Bureau of Reclamation (USBR). USBR does not publish information regarding the predicted reliability of CVP water supplies, but current regulatory requirements have impacted the Delta export potential to the point where at the 50% exceedance level, the South of Delta agricultural allocation would be expected to be around 45%, meaning that the average annual supply would be expected to be approximately 45% of the contract amount. CVP contract water can usually be rescheduled from one year to the next if JID demand does not warrant delivering all the water. Use of rescheduled water is limited if San Luis Reservoir is full or nearly full. The contract CVP water deliveries averaged 20,600 AF/year between 1994 and 2011 and accounted for approximately 27% of the total JID water supply during that period as shown in **Attachment 1**.

2.1.2 Schedule 2 CVP Water

Schedule 2 CVP Water (aka Riparian or Exchange Water) is delivered without charge as a settlement of the District's historic water rights claims to San Joaquin River water in Fresno Slough. During normal and wet years 9,700 AF is available, during dry years 7,600 AF is available. The contract (No. 14-06-200-700-A) requires that the District take delivery of this water according to the schedule shown in the following table. In practice, the USBR has allowed some flexibility on when this water is taken. The reliability of this water is very high.

Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Normal	0	600	800	1,300	1,900	2,500	2,000	400	200	0	0	0	9,700
Dry	0	600	800	1,000	1,500	1,900	1,400	300	100	0	0	0	7,600

2.2 Kings River Water

2.2.1 J&T Agreement

JID is a member unit of the Kings River Water Association (KRWA) and receives an entitlement of Kings River water, although since JID is at the end of the river, they are a high flow unit and do not come on schedule until natural flow of the river would have reached them. Tranquillity Irrigation District (TID) is in a similar situation. Years ago, both JID and TID did not want to take delivery of Kings River water as a result of high seepage loss and significant lag time from the dam to their canal headworks. It was proposed that if JID and TID could obtain a CVP water supply contract that the rest of the Lower KRWA units would pay for the CVP supply in exchange for using the J/T water to satisfy their conveyance losses. In 1963, the Lower Kings River Units entered into agreements with both JID and TID to lease their Kings River water and storage space for the purpose of augmenting the Primary and Secondary Storage Operation Pools. In return, the Lower Kings River Units agreed to reimburse the cost to James and Tranquillity for a set amount of USBR CVP water. These agreements were parts of a package of agreements, including the 1963 Intra-Association Agreement, which were negotiated together. The James and Tranquillity (J&T) Agreements were later negotiated independently. The Lower Kings River Units have agreements with both JID and TID to lease their water and storage space.

Stated in the "Intra-Association Agreement" of 1963 (amended in 2003) James ID is allotted 20,000 AF of storage in Pine Flat Reservoir. It is also stated that Tranquillity ID is allotted 8,000 AF. In addition, it appears that along with the storage allotment, the renter is also entitled to the District's supply downstream of Peoples Weir. It is not clear if these allotments can be rented separately. The participating percentages of each of the Lower River Units is included in this agreement. This agreement was included in the February 2011 report.

The "Agreement for Rental of James Irrigation District and Tranquillity Irrigation District Kings River Water Entitlement and Storage Space" (J&T Agreement) effective 12/23/2003, details the terms and distribution of the James and Tranquillity supplies with the Lower River Units. As part of the agreement, current charges paid by the Lower River Units is $580,000 per year, with JID receiving 66.44% or $385,352 and TID receiving 33.56% or $194,648 of the total. Based on Section 6, the agreement term is 12 years, ending 12/31/2015. On four year cycles (2007 and 2011) the agreement can be terminated by any party if a 2-year notice is provided to the other parties. With the expiration of the J&T Agreements, both of these Districts have the option of taking direct delivery of their Kings River water rather than leasing their entitlement and storage to the Lower Kings River User Units. Of note in the Agreement is the Right of First Refusal identified in Section 20 on page 7 of the Agreement; if James or Tranquillity wants to terminate and create a new agreement to the rental, use, ownership, occupancy, or transfer of Kings River water or storage to another entity, it must provide a 90-day notice to all Lower River Units to be part of the new agreement on the new terms. A copy of this agreement was also included in the February 2011 report.

There is no other program (water exchange) that can provide water and storage to the Lower River Units as good as the existing J&T program, due to the storage component

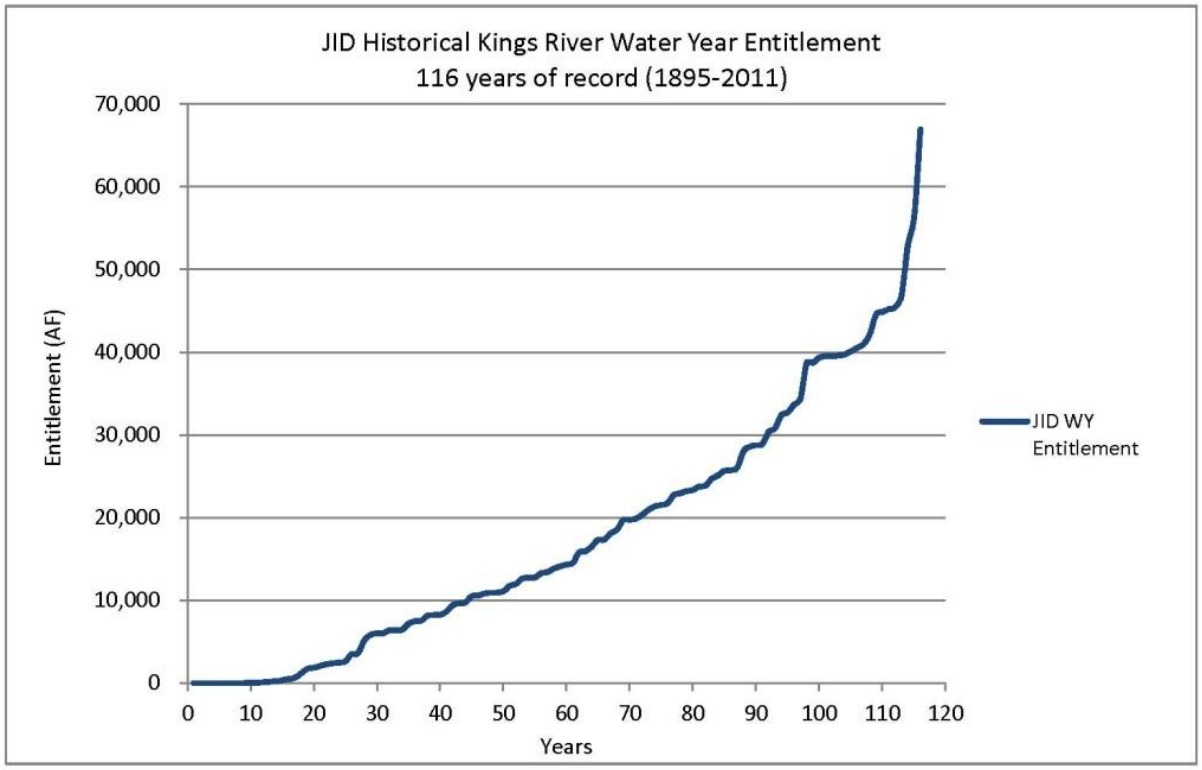
in the existing program. However, if JID did not renew the J&T Agreement with the Lower River Units, they could choose to run their water. In order to do so, the water could be run in the Kings River, incurring significant losses, or the point of diversion could be moved elsewhere on the river. If the point of diversion is moved upstream, conveyance losses must be provided to assure that the other water users are not harmed. In other words, if JID delivered their Kings River water through the river, the Lower River Units would not have to contribute as much water in conveyance losses than if JID water was delivered upstream to FID. Therefore, a like amount would have to be contributed by JID to make up the difference in loss water. If JID choose not to renew the agreement, the Lower River Units would lose the amount of entitlement developed by the schedule as well as the storage associated with the entitlement.

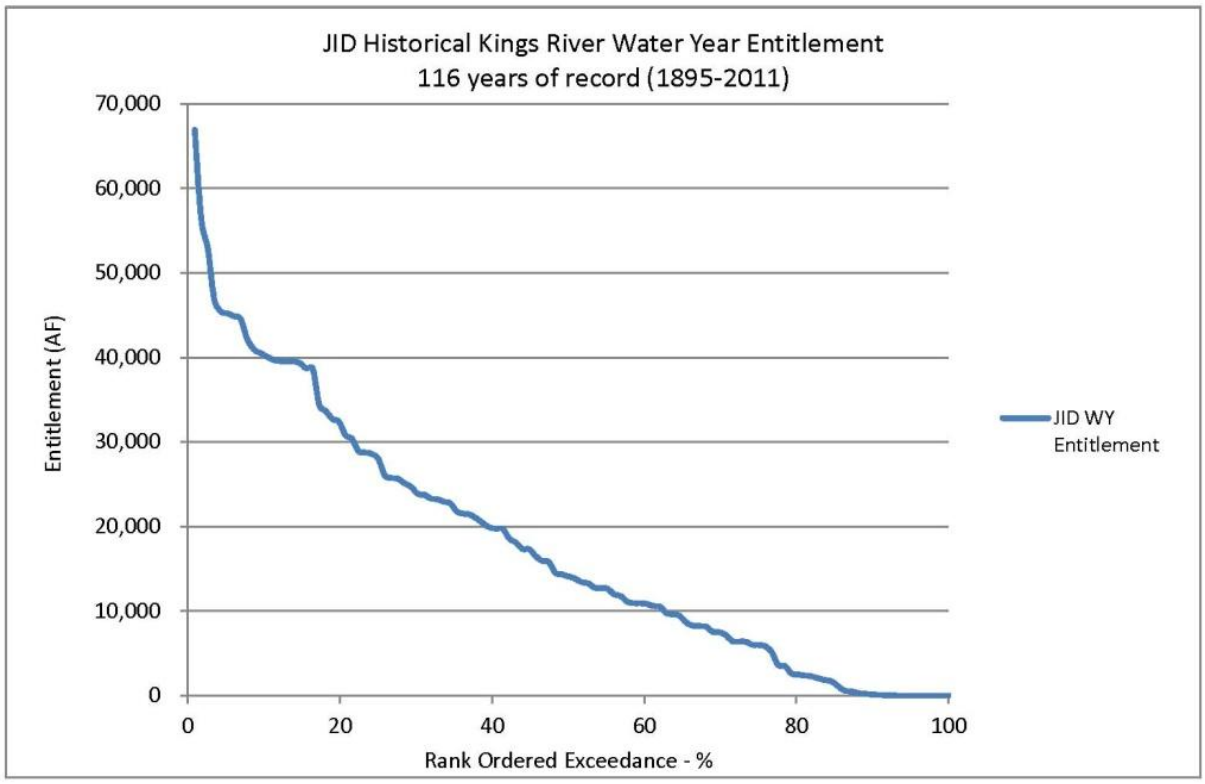
In addition to moving and diverting entitlement through FID, JID could also "contract" with FID to operate their storage any way FID chooses, with the intent to allow FID to use JID storage in Pine Flat to store FID water. It is anticipated that this would not require the approval of KRWA.

2.2.2 JID Kings River Entitlement

A review of the historical Kings River entitlement available to JID was performed to determine the average amount of Kings River water JID would be entitled to under different year types. Historical "yield" information was obtained from JID for Kings River Water Right via the James Main Canal and the Beta Main Canal. This data was compared to annual Kings River entitlement information obtained from KRWA, which compared very favorably. The term "yield" was used prior to the construction of Pine Flat Dam, while "entitlement" is the currently used term. Historical head gate diversion data is not readily available. The entitlement data from 1895/96 to 2010/11 was sorted by the Kings River water year percentage to determine an average annual entitlement under different year types. While the entitlement can be quite variable even in similar water year types, the average annual entitlement by water year type is helpful to know what the Lower River Units are receiving through the J&T agreements. This data is presented in **Attachment 2** and summarized below:

Kings River water year	Average JID WY entitlement (AFt)
< 55%	673
55% - 75%	7,124
75% - 100%	14,252
100% - 125%	22,513
> 125%	40,082


JID Historical Kings River Water Year Entitlement
116 years of record (1895-2011)
Entitlement (AF)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
10
20
30
40
50
60
70
80
90
100
110
120
Years
JID WY Entitlement


JID Historical Kings River Water Year Entitlement
116 years of record (1895-2011)
Entitlement (AF)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
20
40
60
80
100
Rank Ordered Exceedance - %
JID WY Entitlement

2.2.3 Floodwater Frequency and Quantity

High flow water from Pine Flat Reservoir (as measured at James Bypass) is available approximately 40% of the time, or once every 2.5 years. When floodwater is available, the average length of the flood release is approximately 100 days. On an average annual basis since the construction of Pine Flat, 191,480 AF/yr has left the Kings River service area through the James Bypass. **Attachment 3** contains historical information about Kings River floodwater leaving the service area through the James Bypass since the construction of Pine Flat Dam, including a graph that depicts the average annual yield with varying diversion capacity.

2.2.4 Kings River Issues

JID has not been "on the River" and taken delivery of its Kings River entitlement water for a long time. The following lists the Kings River issues that are thought to be triggered by JID deciding to run their water and the expected Watermaster interpretations.

Method for JID requesting to run water:

After the expiration of the J&T Agreement, a simple letter from JID to KRWA can be used to request to run its Kings River water, stating that under the 1927 Agreement JID water will be delivered into FID and conveyed through FID canals to JID. No water or storage rights would be transferred. The same letter should also inform the Watermaster that FID will order the JID water for delivery to the FID canals and that the Watermaster should take the required conveyance loss water as though JID was running on the river and attribute the loss to the upstream delivery.

(The above letter would get circulated to all on the river and no protests can be made.)

River Losses/Storage Operations Pools:

It is understood that JID will be required to contribute water to the storage operations pools for their contribution of loses in years when JID runs its Kings River entitlement water. Losses are expected to be proportionate to their flow in the Lower River in years when water is run. Preliminary estimates have been made later in this document as to the magnitude of these expected losses in various year types that need to be reviewed/refined with KRWA.

Fisheries Management Program:

Flows – The Lower River units do not contribute to Schedule C flows so there is no impact to JID. However, all the units contribute to Schedule D flows when they are triggered. Schedule D flow contributions are proportionate to the units entitlement in the year that Schedule D flows are triggered. A rough approximation for J/T would be about 1% or 2 cfs.

Storage - Under the Fisheries Management Plan all units provide 10% of their storage space for a "temperature control pool".

Operations and Maintenance:

JID will be required to pay 1.29% (TID 0.85%) of the total KRWA budget plus Pine Flat O&M as billed by the Corps of Engineers to KRWA. There is a significant O&M cost coming up for the slide rehabilitation below the dam, although repayment costs will likely be spread over two 5-year funding periods. For comparison, FID pays 17.97% of the total KRWA budget and Pine Flat O&M.

Power Revenue:

JID will accrue power revenue based upon the KRWA power revenue agreement.

Other Issues? There are likely other Kings River issues that will be identified in future discussions with KRWA that will need to be addressed.

2.3 Groundwater

The District has about 66 active production wells. The well locations are shown on the Facilities map in **Attachment 4**. 31 of these wells are within the District boundary and 35 are in the Districts East Side Well Field, a deeded groundwater area. The estimated capacity of all the wells is nearly 200 cfs. Most of JID's wells are between 500 and 600 feet deep, and extend to the top of the Corcoran Clay. A few of JID's older wells are 700 to 900 feet deep and penetrate the confined aquifer beneath the Corcoran Clay. Depth to water ranges from about 80 to 200 feet below ground surface. Two privately owned agricultural wells, and multiple private domestic wells for homesteads, are inside JID's boundary. Groundwater has accounted for approximately 43% of the total JID water supply during the period 1994-2011 as shown in **Attachment 1**. The power costs only for pumping groundwater are estimated to vary from $45 to $75 per acre foot for this supply source. On average the total cost of groundwater within JID is approximately $60/AF.

Location	Area	# of Wells	Capacity (cfs)
East Side Well Field	Lassen Ave	12	36.4
East Side Well Field	McMullin Grade	23	72.6
Within JID	Main Canal	18	53.7
Within JID	West of Colorado Ave	7	10.8
Within JID	Lateral K Basin	6	25.2
	Total	**66**	**198.7**

2.4 Transfers and Spills

Typically some water transfers are made with FID, TID, and San Luis WD. Inflows from FID average over 1,300 AF/year. TID can take water from JID spill points, but these transfers are sporadic. In recent years SLWD has made arrangements to bank and purchase water from JID.

3 FID WATER SUPPLIES POTENTIALLY AVAILABLE TO JID

There are several potential water supplies that FID could make available to JID in a joint program. Water provided to JID by FID could free up other JID supplies, such as the CVP contract water, that could be marketed elsewhere.

3.1 Eastside – Kings River and Local Streams

From previous work there is the potential for FID surface water supplies to be directed to the Dry Creek system for potential recharge or delivery to JID. These surface water flows include Kings River fish flows as well as flows developed from the rural streams group northeast of the District and the Cities of Fresno and Clovis. Separate quantification of each of these supplies was not regenerated here, but the estimated magnitude and availability of these supplies can be found in **Attachment 5**. These flows, if occurring at a time that the JID has demand,, would be used directly. Otherwise the flows would be recharged and later recovered for use.

3.2 Westside – CVP Friant Recirculated Water

Recently the Friant division contractors settled a lawsuit on the San Joaquin River with a number of environmental organizations herein called the San Joaquin River Restoration settlement. The settlement agreement called for additional flows to be released down the San Joaquin River to benefit wildlife and anadromous fisheries. In order for this to occur, the Friant contractors agreed to a methodology as to how to identify the contribution of each contractor, that is, how much water each contractor must give up for river restoration, which impacted the water supply of each Friant contractor. For the last several years the Bureau of Reclamation has released some additional water down the San Joaquin River on a trial basis. Since river restoration has not been completed with a connection to the Merced River some of the releases to the San Joaquin River have been recovered at Mendota Pool and have essentially been stored by the Bureau in San Luis Reservoir on the Friant contractors behalf, including water from FID. When the river restoration is complete, there is still the potential to “recirculate” the restoration water by either diverting the water from the lower reaches of the San Joaquin River or pumping it from the Delta. It is unknown exactly how the restoration program will work or how much water can be recirculated on an annual basis, but if the FID recirculated water could be stored in San Luis Reservoir, then JID could take delivery of the recirculated water on behalf of FID and an equivalent amount of the JID CVP water supply could be available for market, or other FID supplies could be freed up for recharge or other purposes. This would be a way for FID to beneficially recover its river restoration water, and perhaps the program could be expanded to include other Friant contractors.

4 CONCEPTUAL GROUNDWATER BANKING PROJECT AND FACILITY IMPROVEMENTS

4.1 Existing McMullin Grade Canal

The McMullin Grade Canal is the only facility connecting James ID to Fresno ID. FID can spill into the McMullin Grade Canal through two separate facilities; the Central Wasteway No. 33, and the Lower Dry Creek No. 77.

The Central Wasteway is documented in an agreement dated June 7, 1953 between JID and FID. The Agreement granted FID perpetual right to facilities upstream of JID's Well C-36 (SW ¼, NW ¼, Sec 2, T15S, R18E, MDB&M), in the McMullin Grade Canal. FID is allowed to, but not obligated to, discharge up to 15 cfs.

The agreement to construct, maintain, and operate the Dry Creek extension was entered into on the 6th of April, 1970. The agreement is between the County of Fresno, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District and James Irrigation District. The purpose of this agreement is to allow the Fresno Irrigation District to spill up to 56 cfs of water into the McMullin Grade canal at the quarter section of Section 16, Township 15 South, Range 18 East, just downstream of well C-74.

The McMullin Grade Canal is completely open channel and delivers groundwater from the East well field into JID; max flow rate is approximately 100 cfs. If all of the McMullin Grade wells were operating, they would utilize approximately 72 cfs. Another lateral that delivers groundwater from the East well field into JID is the Kerman line, which is piped on the upstream end and open channel downstream; max flow rate is 45 cfs. Both ditches are concrete lined and join on the east side of the Fresno Bypass. All wells that discharge into these ditches are delivered to the Main Canal first through a common ditch (145 cfs capacity) then into two parallel siphons with a combined capacity of 170 cfs.

4.2 Improved Facilities Analysis

An analysis was performed to conceptually determine the facility improvements that would be required to be able to deliver recharge water to a proposed 160-acre groundwater bank in the FID Flood Rights area and deliver 100 cfs from FID to JID through an improved McMullin Grade Canal. A conceptual layout of the improvements is shown in **Attachment 6**, along with an estimated cost of the capital improvements to the FID system ($5,600,000) as well as the capital improvements to the JID McMullin Grade Canal ($2,700,000).

4.3 Conceptual Groundwater Banking Project

A 160-acre groundwater bank in the FID Flood Rights area was conceptually developed to estimate the capital improvements that would be needed. The exact location of the proposed basin was not identified, but was envisioned to be adjacent to the Lower Dry Creek canal, just upstream of the Lower Dry Creek spill. The cost of constructing a groundwater basin, including land acquisition, was estimated to be $6,100,000. An

estimate was also made of the annual cost of recovered banked water if Kings River floodwater was the only source of recharge water, assuming a recharge rate of 0.50 feet/day. The resultant annualized cost of the recovered water using this facility was $185/AF, assuming a 5% interest rate and a 30 year project life. If other sources of water were used for recharge in addition to Kings River floodwater, such as east side stream group water, the unit cost of recovered water would be considerably lower.

With estimated surveying, engineering and construction management, along with a 25% contingency, the total probable cost of constructing the FID system improvements, the JID system improvements and the groundwater bank was estimated to be $20,300,000 as shown in **Attachment 6**.

5 ESTIMATED WATER SUPPLY AND COST ANALYSIS

An estimate was made of the Kings River water supply that would be available in different year types to estimate the amount of conveyance water that would be required to be contributed to the Lower River Units and the resultant amount of water that would potentially be available at James Weir. The conveyance loss, and corresponding delivery percentage, to various points along the river is highly variable and doesn't strictly follow the water year type since JID is at the end of the river and how long the water is run as well as carryover water from the prior year can impact delivery amounts, but an estimate was made of the anticipated "order of magnitude" delivery percentages to various points on the river. The estimated delivery percentage is a "best guess" at this point since water hasn't been delivered to JID down the river in many years other than flood water. This estimated water supply is shown in **Attachment 7**, along with a Kings River facilities map to provide a general reference for the location of the various points on the river. Also included in **Attachment 7** is a preliminary cost analysis to meet JID water demands under different water supply scenarios and different water year types. This analysis is very preliminary, but the methodology could be helpful for further analysis in determining which water supplies to use.

6 BENEFITS AND CONCLUSIONS

6.1 Summary

In summary it is clear that FID and JID have the resources to develop a program that could benefit both agencies. JID is geographically located so that it is in close proximity to FID, has existing conveyance facilities that can be expanded to develop expanded programs, is located on the Mendota Pool and has a CVP contract for water supply that can be transferred throughout the CVP service area. The JID also has entitlement and storage on the Kings River that in the past the District has been unable to utilize directly. FID has access to surface supplies that can be managed and directed to JID so that JID can make use of the supplies to meet irrigation demand. When the delivery of supplies is in excess of demand, there are opportunities to recharge surface supplies in existing JID recharge areas as well as opportunity to construct new sites.

The following lists the major topics identified previously, and summarized in section 1, with a potential action, expected result along with times that need to be discussed.

Purchase J&T storage and entitlement –

- Action - Per the discussion in Section 2, the option under this part would be for JID to terminate the agreement and run the water, although running water down the river could be prohibitive from the water loss standpoint. It would be suggested that JID move its point of diversion to FID and allow FID to use unused space in JID storage account.
- Expected result – JID runs water in years greater than 75%. Contribution to conveyance losses expect to be from 0 to 7,500 AF in any given year. In water years less than 75%, water would be left in storage for use the following year.
- Issues to be discussed - method and means of transport. Reregulation of supply, cost for delivery, costs for use of storage space, assurance for JID of purchase of additional surface supplies

Pursue expanded Interconnection –

- Action – Jointly submit application for funding under Proposition 84 to the Upper Kings forum for funding the improvements
- Expected result – Application cost of $30,000 due by beginning of year 2013. If selected and funded, expected construction could commence in approximately 1 ½ to 2 years.
- Issues to be discussed – Agree to funding split

Participate in Banking –

- Action – Jointly submit application for funding under Proposition 84 to the Upper Kings forum for funding the improvements
- Expected result – Application cost of $30,000 due by beginning of year 2013. If selected and funded, expected construction could commence in approximately 1 ½ to 2 years.
- Issues to be discussed – Who and how property owners are approached. Acquire property, identify how the project is operated. Does flood water go here before JID facilities? Will the account be kept so that FID and JID both account for water in and out separately or will the operations be communal and the cost and operations are proportionate to each?

FID to deliver surface water to JID –

- Action – To set expectations, it would be assumed that under various year types there is some quantity of water that would be available to JID.
- Expected result – would free up some of the JID water, either reducing the amount of groundwater pumping required or freeing up CVP water that could be marketed.
- Issues to be discussed – Expectations of surface water and costs. Do the Districts want to pay for costs directly or exchange storage for supply as an example?

6.2 Benefits to JID

Identified benefits to JID of a joint program with FID include:

- A firm local water supply since the CVP supply has become less reliable
- Improve water quality
- Lower annual operating costs
- Recharge surface supplies to stabilize groundwater levels
- Be less dependent on groundwater
- Use existing infrastructure to allow for groundwater banking

6.3 Benefits to FID

Identified benefits to FID of a joint program with JID include:

- Increase Pine Flat storage
- Allow for marketing of water to other CVP Districts
- Ability to recapture “recirculated” San Joaquin River water
- Increase groundwater banking opportunities and stormwater control
- Develop income stream to lessen cost increases

ATTACHMENT 1

JID Historical Water Deliveries and Water Supply
Estimated JID Water Demand

ATTACHMENT 2

JID Historical Kings River Yield and Entitlement

ATTACHMENT 3

Kings River Floodwater

ATTACHMENT 4

JID Facilities Map

ATTACHMENT 5

FID Water Supplies Potentially Available to JID

ATTACHMENT 6

Conceptual Groundwater Bank & Facility Improvements

ATTACHMENT 7

Estimated JID Water Supply & Cost Analysis

FRESNO IRRIGATION DISTRICT

FRESNO COUNTY, CA

SOUTHWEST GROUNDWATER BANKING PROJECT

FID JOB NO. ____

ABBREVIATIONS

AGG	AGGREGATE
AP	ANGLE POINT
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY FOR TESTING & MATERIALS
BC	BEGIN CURVE
BTM	BOTTOM
BW	BACK OF WALL
CFS	CUBIC FEET PER SECOND
℄	CENTERLINE
CLF	CHAIN LINK FENCE
CMLC	CEMENT MORTAR LINED & COATED
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
CONT	CONTINUOUS
CY	CUBIC YARD
DEMO	DEMOLISH
DIA OR ø	DIAMETER
DIM	DIMENSION
D/S	DOWNSTREAM
EA	EACH
EC	END OF CURVE
EF	EACH FACE
EG	EXISTING GRADE
EL	ELEVATION
ELC	EPOXY LINED & COATED
ELL	ELBOW
EM	EMERGENCY
EP	EDGE OF PAVEMENT
EW	EACH WAY
(E) OR EX	EXISTING
F&I	FURNISH & INSTALL
FF	FINISHED FLOOR
FG	FINISHED GRADE
FL	FLOW LINE
FT	FOOT/FEET
FW	FACE OF WALL
GA	GAUGE
GALV	GALVANIZED
GB	GRADE BREAK
GPM	GALLONS PER MINUTE
HGL	HYDRAULIC GRADE LINE
HORIZ	HORIZONTAL
HWL	HIGH WATER LEVEL
ID	INSIDE DIAMETER
IN	INCH
INV	INVERT
IP	IRON PIPE
IRR	IRRIGATION

ABBREVIATIONS (CONT)

LCW	LONG CRESTED WEIR
LCD	LOWER DRY CREEK CANAL
LF	LINEAR FEET
LT	LEFT
MAX	MAXIMUM
MIN	MINIMUM
NAVD	NORTH AMERICAN VERTICAL DATUM
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OH	OVERHEAD
OP	OPERATING
O&M	OPERATIONS & MAINTENANCE
PIP	PLASTIC IRRIGATION PIPE
PL	PROPERTY LINE
POC	POINT ON CURVE
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
R	RADIUS
RCP	REINFORCED CONCRETE PIPE
REQD	REQUIRED
RGRCP	RUBBER GASKETED REINFORCED CONCRETE PIPE
RGS	RIGID GALVANIZED STEEL
RT	RIGHT
R/W	RIGHT OF WAY
SCH	SCHEDULE
SS	STAINLESS STEEL
STA	STATION
SW	SWALE
T&B	TOP & BOTTOM
TB	TOP OF BANK
TBM	TEMPORARY BENCHMARK
TC	TOP OF CURB
TF	TOP OF FOOTING
TL	TOP OF LINING
TOE	TOE OF SLOPE
TOP	TOP OF SLOPE
TP	TOP OF PAVEMENT
TS	TOP OF STRUCTURE
TYP	TYPICAL
TW	TOP OF WALL
UG	UNDERGROUND
U/S	UPSTREAM
VERT	VERTICAL
WL	WATER LEVEL
W/	WITH
W/O	WITHOUT

LEGEND

EXISTING | PROPOSED

- TOP OF BANK
- TOE OF BANK
- GRADE BREAK
- OVERHEAD ELECTRIC LINE (E / OH ELECTRIC)
- UNDERGROUND ELECTRIC LINE (E / UG ELECTRIC)
- CENTERLINE
- MAJOR CONTOUR (208)
- DRAINAGE SWALE
- PROPERTY LINE
- REVISION CLOUD
- UTILITY POLE
- GATE VALVE HANDLE
- GATE POST
- FENCE GATE
- SLOPE LINE
- DETAIL NUMBER (X) / SHEET NUMBER (XX)
- CONCRETE LINING
- DEMOLITION

TOPOGRAPHY NOTE

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PROJECT BENCHMARK

PRIMARY BENCHMARK: ALL ELEVATIONS SHOWN HEREON ARE BASED ON CONTROL POINT WALDRON POND 1 (WP-1), FOUND ALUMINUM DISK. ELEVATION = 249.98'. DATUM IS NAVD 1988 AS DETERMINED FROM THE VALUES PUBLISHED BY THE NATIONAL GEODETIC SURVEY (NGS) AND MEASURED BY GPS OBSERVATIONS. NO BENCHMARKS HAVE BEEN SET ON-SITE AT THIS TIME.

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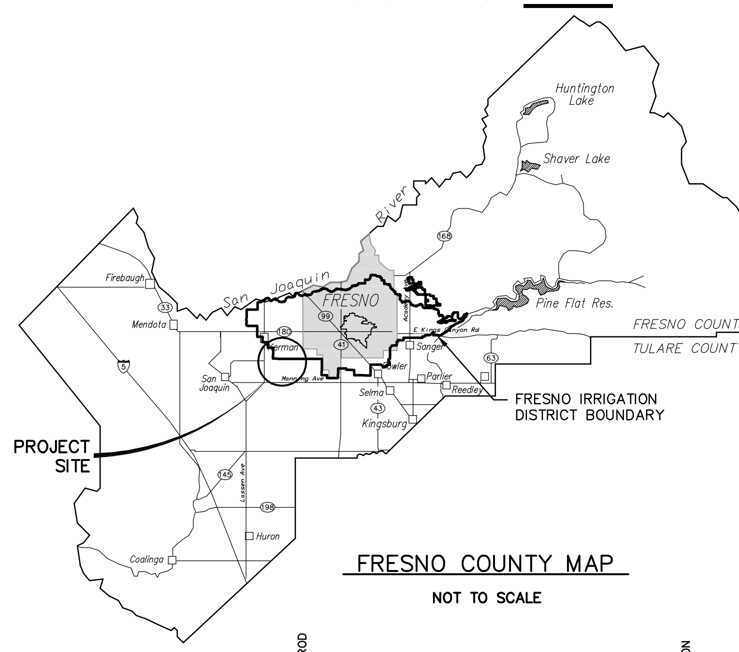
CONSTRUCTION CONTRACTOR AGREES THAT IN ACCORDANCE WITH GENERALLY ACCEPTED CONSTRUCTION PRACTICES, CONSTRUCTION CONTRACTOR WILL BE REQUIRED TO ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THE PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY, THAT THIS REQUIREMENT SHALL BE MADE TO APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS, AND CONSTRUCTION CONTRACTOR FURTHER AGREES TO DEFEND, INDEMNIFY AND HOLD DESIGN PROFESSIONAL HARMLESS FROM ANY AND ALL LIABILITY, REAL AND ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPTING LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF DESIGN PROFESSIONAL.

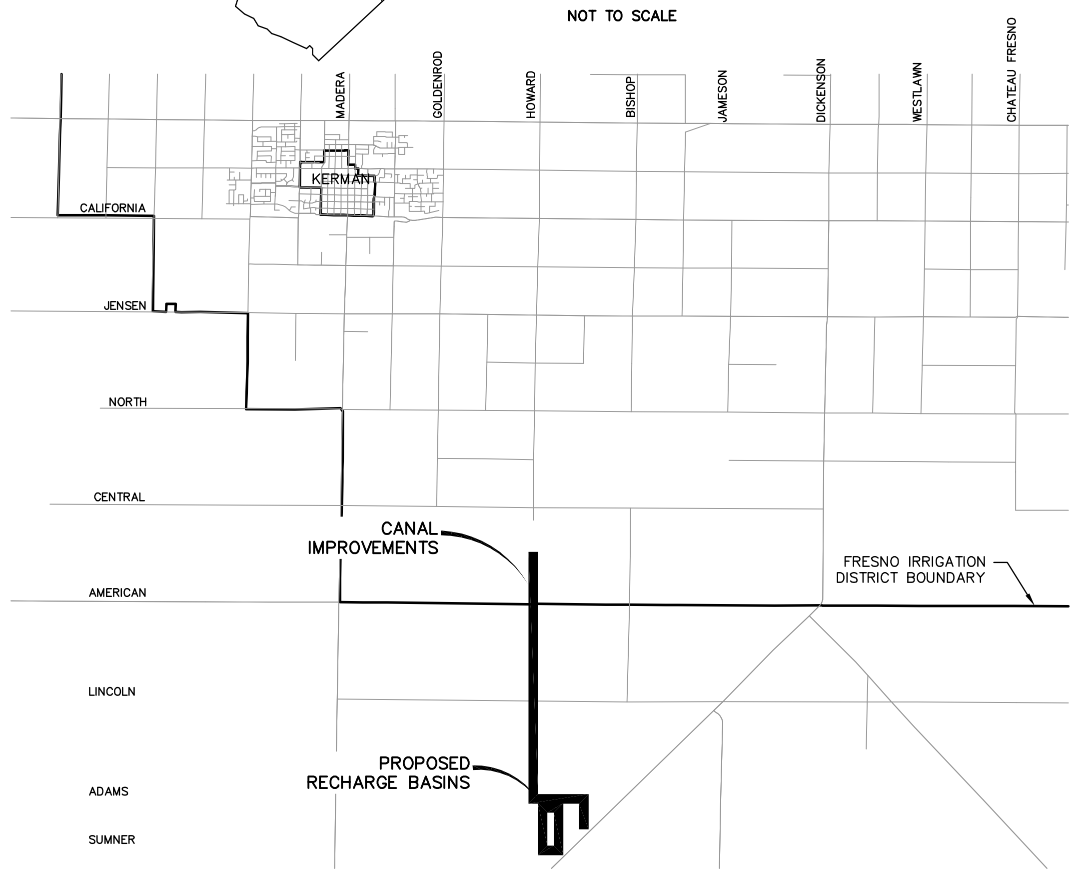
SPECIAL NOTE

WHERE UNDERGROUND AND SURFACE STRUCTURES ARE SHOWN ON THE PLANS, THE LOCATIONS, DEPTH AND DIMENSIONS OF STRUCTURES ARE BELIEVED TO BE REASONABLY CORRECT, BUT ARE NOT GUARANTEED. SUCH STRUCTURES ARE SHOWN FOR THE INFORMATION OF THE CONTRACTOR, BUT INFORMATION SO GIVEN IS NOT TO BE CONSTRUED AS A REPRESENTATION THAT SUCH STRUCTURES WILL, IN ALL CASES, BE FOUND WHERE SHOWN, OR THAT THEY REPRESENT ALL OF THE STRUCTURES WHICH MAY BE ENCOUNTERED.



FRESNO COUNTY MAP

NOT TO SCALE



VICINITY MAP

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FRESNO IRRIGATION DISTRICT NOTES

1. ALL WORK SHALL CONFORM TO THE STANDARDS AND REQUIREMENTS AS SHOWN IN THE FRESNO IRRIGATION DISTRICT'S ENGINEERING HANDBOOK OF SPECIFICATIONS.
2. ALL REINFORCED CONCRETE PIPE SHALL BE RUBBER GASKETED AND CONFORM TO ASTM STANDARD C-361. ANY OTHER TYPE OR CLASS PIPE SHALL REQUIRE DISTRICT APPROVAL.
3. ALL DISTURBED SOIL SHALL BE COMPACTED TO A MINIMUM 90% COMPACTION. COMPACTION TESTS SHALL BE MADE AVAILABLE TO THE DISTRICT'S ENGINEER.
4. ALL EXCESS MATERIAL AND/OR DEBRIS SHALL BE REMOVED UPON COMPLETION OF THE INSTALLATION.
5. CONSTRUCTION SHALL NOT INTERFERE WITH THE FLOW OR DISTRIBUTION OF WATER AS REQUIRED BY THE DISTRICT. ANY CANAL OR PIPELINE DESIGNATED AS A FLOOD CHANNEL SHALL BE CONSTRUCTED IN A MANNER TO ALLOW FLOOD FLOWS TO PASS AT ALL TIMES.
6. THE DISTRICT WILL NOT BE RESPONSIBLE FOR ANY WATER THAT MAY FLOW IN THE IRRIGATION FACILITY OR AREA OF CONSTRUCTION DURING THE TIME OF INSTALLATION.
7. FRESNO IRRIGATION DISTRICT'S ENGINEERING DEPARTMENT, 233-7161, SHALL BE NOTIFIED 48 HOURS PRIOR TO CONSTRUCTION.
8. ALL WORK SHALL BE COMPLETED BY THE DATE SPECIFIED IN THE CONTRACT AND THE AREA RESTORED TO ITS ORIGINAL CONDITION. ANY WORK REQUIRED AFTER THE COMPLETION DATE SHALL BE APPROVED BY DISTRICT'S ENGINEER PRIOR TO COMMENCEMENT OF WORK.
9. ALL IRRIGATION PIPE INSTALLED SHALL BE INSPECTED AND APPROVED BY DISTRICT'S FIELD INSPECTOR BEFORE BACKFILLING MAY OCCUR.
10. ALL PIPE CONNECTIONS SHALL BE WATER TIGHT.

GENERAL NOTES

1. FRESNO IRRIGATION DISTRICT SHALL INSPECT ALL WORK PHASES ON IRRIGATION FACILITIES FOR CONFORMANCE TO DISTRICT SPECIFICATIONS. REINFORCING SHALL NOT BE ENCASED IN CONCRETE WITHOUT PRIOR DISTRICT INSPECTIONS. LIKEWISE CONCRETE SHALL NOT BE COVERED WITH EARTH PRIOR TO DISTRICT INSPECTION.
2. ALL CONSTRUCTION SHALL BE IN CONFORMANCE WITH THESE PLANS, PROJECT SPECIFICATIONS AND DISTRICT SPECIFICATIONS.
3. USED MATERIAL, REJECTS, MISFITS, OR SECONDS, ETC. ARE NOT ACCEPTABLE FOR USE ON DISTRICT FACILITIES.
4. CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR OF ALL DAMAGE TO FACILITIES WHICH OCCURS DURING CONSTRUCTION OF IMPROVEMENTS AFFECTING EXISTING FACILITIES.
5. CONTRACTOR SHALL FIELD VERIFY THE HORIZONTAL AND VERTICAL LOCATIONS OF ALL EXISTING FACILITIES PRIOR TO COMMENCING WORK. CALL UNDERGROUND SERVICE ALERT (USA) AT 811. CONTRACTOR SHALL MAKE ENGINEER AWARE OF ANY DISCREPANCIES.
6. CONTRACTOR SHALL SALVAGE & RETURN ANY EXISTING EQUIPMENT TO THE DISTRICT AT THE DISTRICT'S OPTION.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ADEQUATE DUST CONTROL AT ALL TIMES.
8. ALL EXPOSED STEEL SHALL BE HOT-DIP GALVANIZED IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
9. ALL NUTS, BOLTS, AND WASHERS USED TO SECURE UNDERGROUND FITTINGS SHALL BE STAINLESS STEEL. AFTER INSTALLATION, ALL STEEL HARDWARE SHALL BE COATED WITH A RUST PREVENTATIVE, WRAPPED WITH 4 MIL POLYETHYLENE SHEETING, AND SECURED WITH PVC TAPE.
10. ALL CONSTRUCTION SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE HEALTH AND SAFETY LAWS OF THE STATE OF CALIFORNIA AND CAL/OSHA STANDARDS. SPECIAL SAFETY PRECAUTIONS SHALL BE TAKEN WHEN WORKING IN THE VICINITY OF GAS, OIL, OR ELECTRICAL LINES.
11. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING WATER NECESSARY FOR CONSTRUCTION AND DUST CONTROL PURPOSES.
12. CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS REQUIRED FOR CONSTRUCTION

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Sheet Number	Sheet Title
1	COVER SHEET
2	SHEET INDEX
3	TYPICAL CROSS SECTIONS
4	PLAN AND PROFLIE
5	PLAN AND PROFILE
6	PLAN AND PROFILE
7	PLAN AND PROFILE
8	RECHARGE BASINS SITE PLAN
9	DISTRIBUTION STRUCTURE
10	CONSTRUCTION DETAILS
11	TYPICAL MONITORING WELL

APPROVAL

FRESNO IRRIGATION DISTRICT

WILLIAM R. STRETCH, CHIEF ENGINEER

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REGISTERED PROFESSIONAL ENGINEER RANDY S. HOPKINS No. 63538 Civil STATE OF CALIFORNIA — NOT FOR CONSTRUCTION

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SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

COVER SHEET

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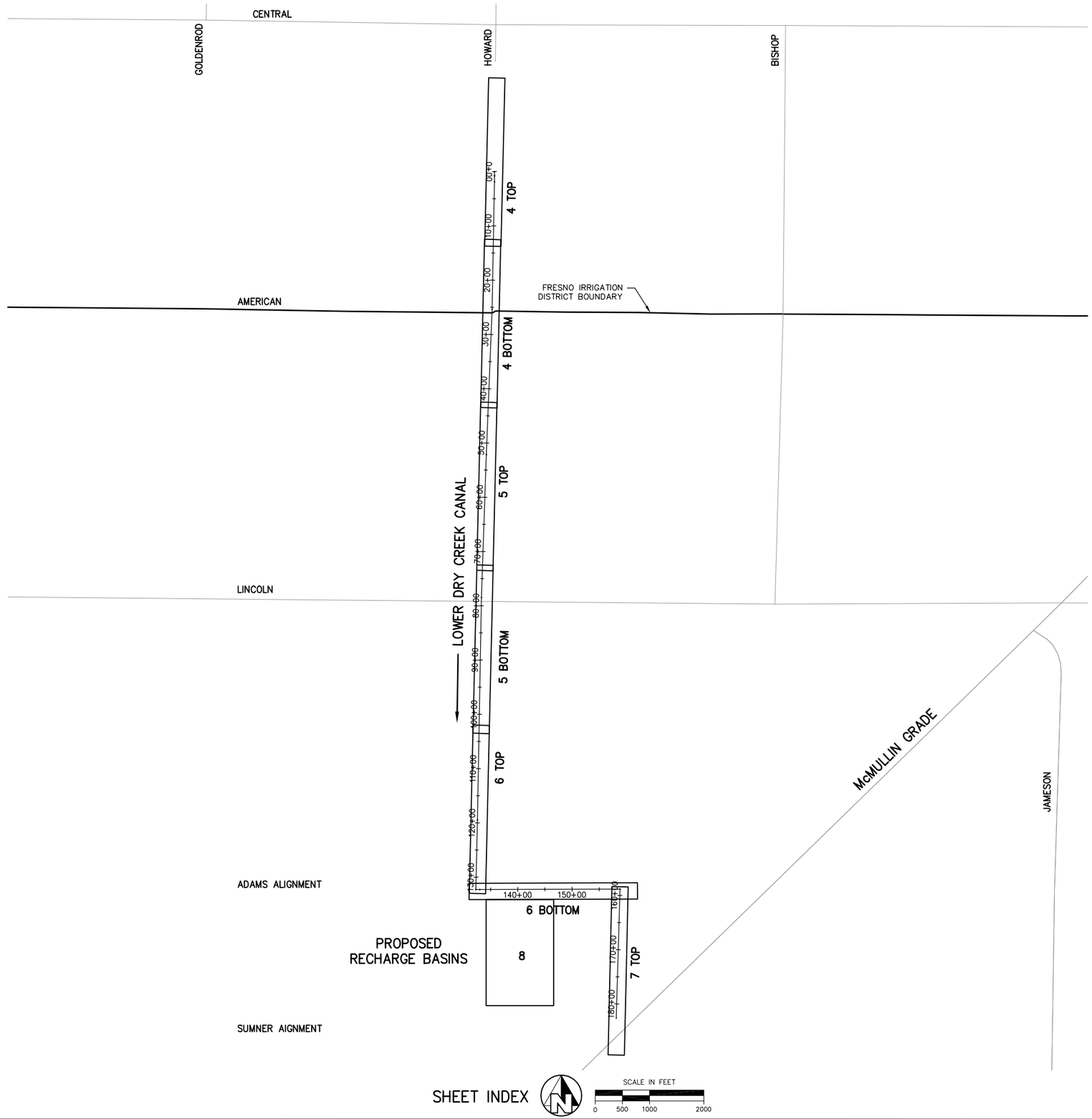

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CIVIL
STATE OF CALIFORNIA

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FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

SHEET INDEX

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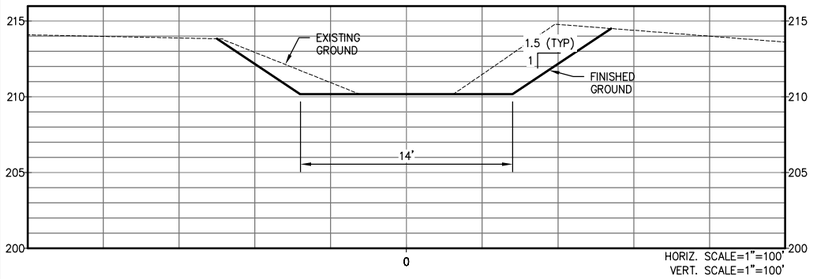

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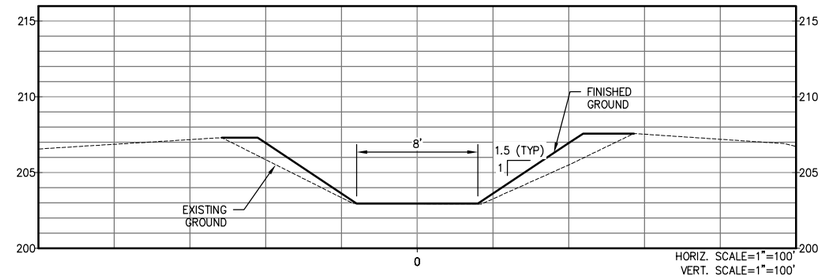

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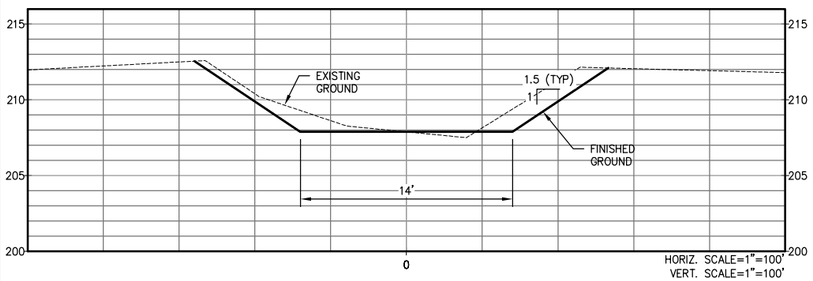

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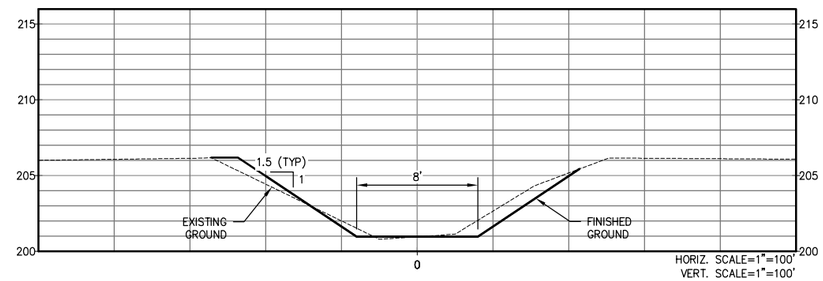

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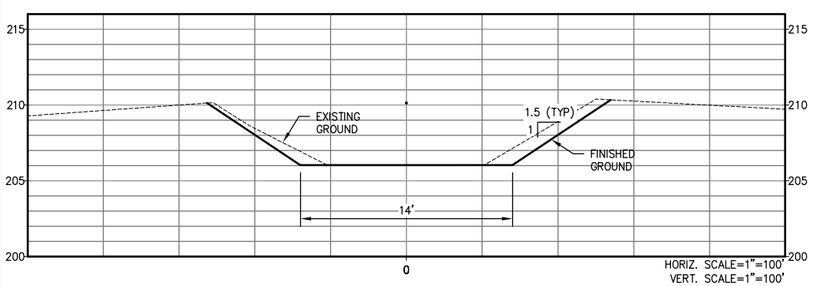

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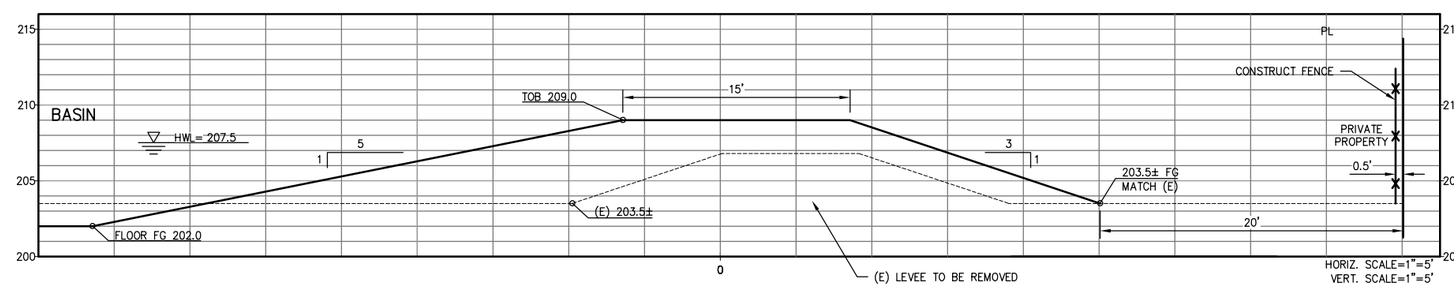

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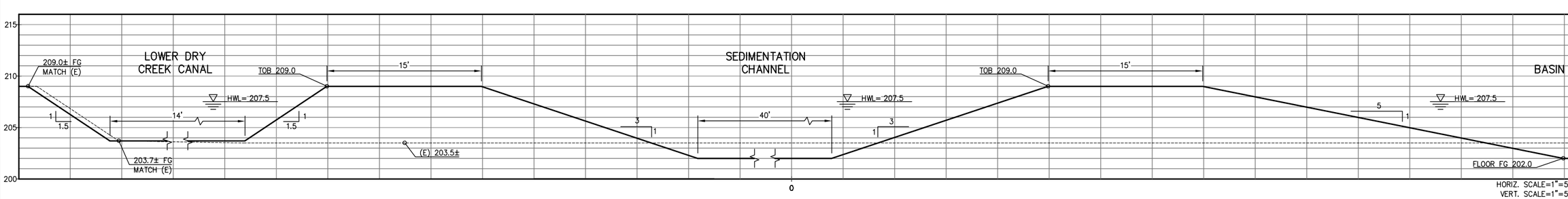

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No. 63538
CIVIL
STATE OF CALIFORNIA

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FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

TYPICAL CROSS SECTIONS

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LOWER DRY CREEK CANAL NO. 77 STATION 0 THRU 29+00

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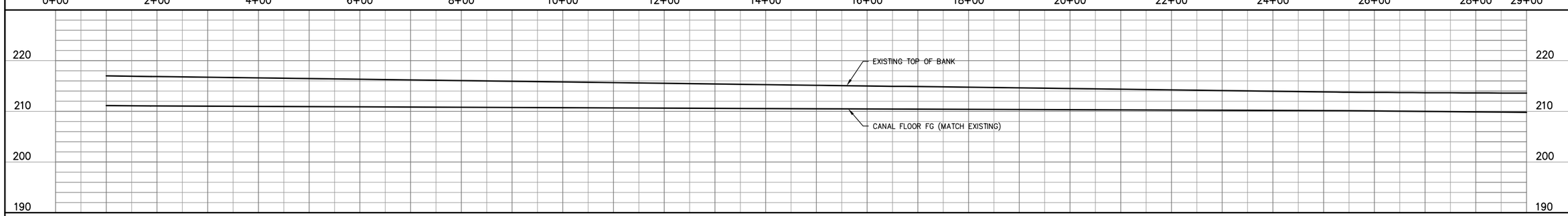
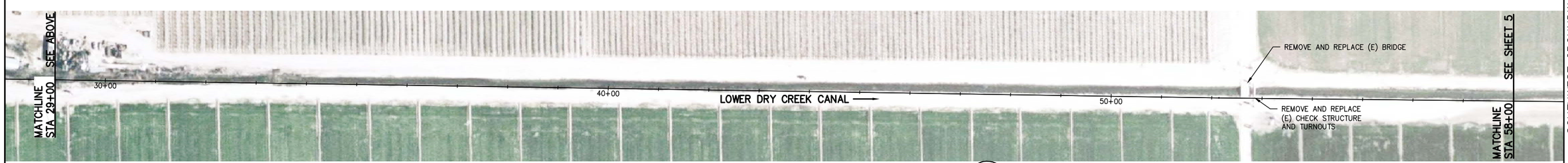
SCALE: HORIZ=1"=100' VERT=1"=10'

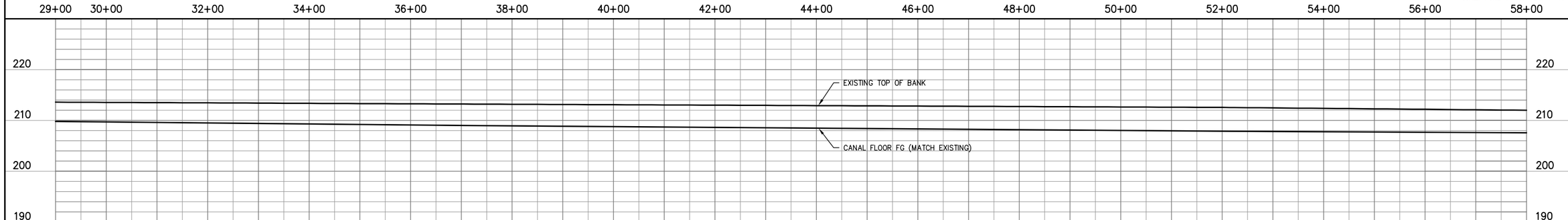




LOWER DRY CREEK CANAL NO. 77 STATION 29+00 THRU 58+00

SCALE IN FEET 0 50 100 200

SCALE: HORIZ=1"=100' VERT=1"=10'



WARNING
POWER LINES OVERHEAD

811 Know what's **below.** **Call** before you dig.

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No.	REVISION	BY	DATE

PRELIMINARY PLANS

REGISTERED PROFESSIONAL ENGINEER 63538 CALIFORNIA CIVIL RANDY S. HOPKINS

DATE SIGNED:

SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

PLAN AND PROFILE

PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company
286 W. CUTLER AVENUE
CLOVIS, CALIFORNIA 93611-9166
559/326-1100 FAX 559/326-1090
www.ppeng.com

DESIGN ENGINEER: RANDY HOPKINS

LICENSE NO: 63538

DRAFTED BY: STG | CHECKED BY: RSH

DATE: 3-27-2013

JOB NO: 103812C3

0 1
ORIGINAL SCALE SHOWN IS IN INCHES. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.

SHEET 4 OF 11

3/27/2013 11:33 AM G:\Clients\Fresno ID - 103812\103812C3-ID Rankins Project\DWG\SHEET\4 PLAN AND PROFILE.dwg -David Sorrick

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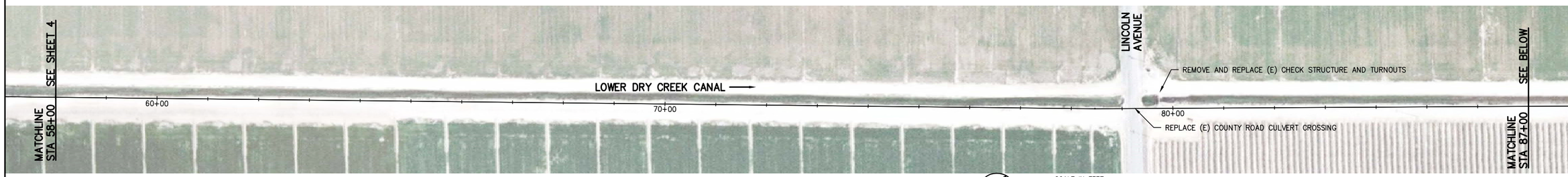
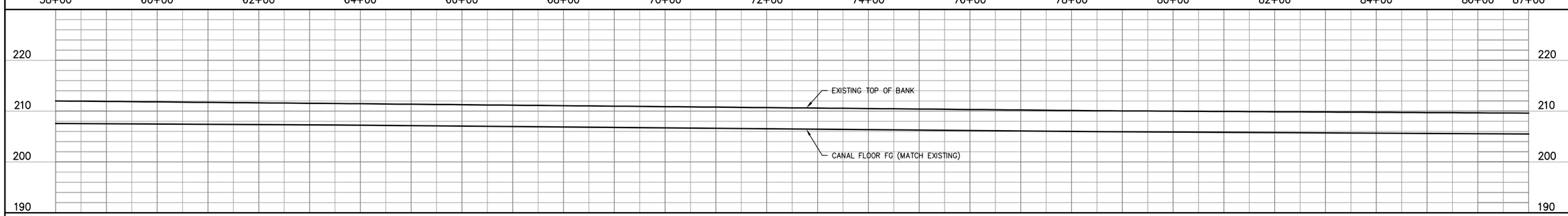
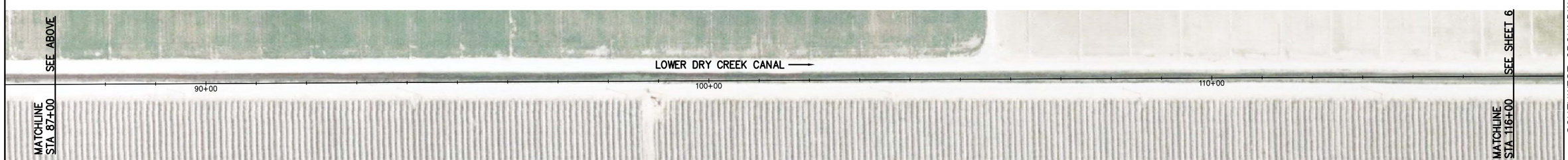


LOWER DRY CREEK CANAL NO. 77 STATION 58+00 THRU 87+00

SCALE IN FEET 0 50 100 200

SCALE: HORIZ=1"=100' VERT=1"=10'

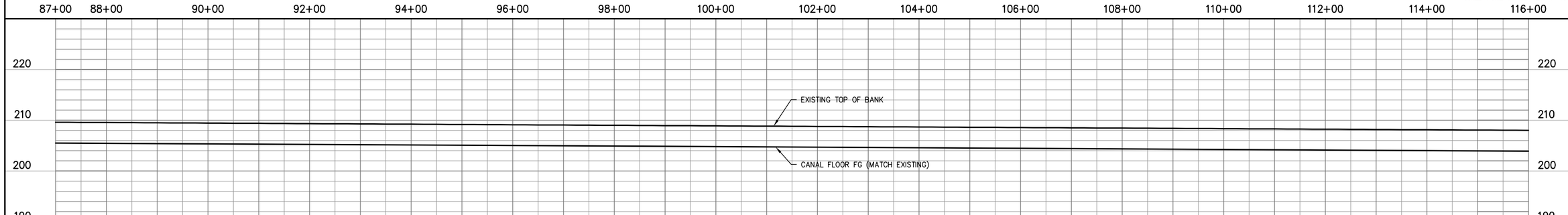




LOWER DRY CREEK CANAL NO. 77 STATION 87+00 THRU 116+00

SCALE IN FEET 0 50 100 200

SCALE: HORIZ=1"=100' VERT=1"=10'



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PRELIMINARY PLANS

No.	REVISION	BY	DATE

REGISTERED PROFESSIONAL ENGINEER RANDY SHEA HOPKINS No. 63538 CIVIL STATE OF CALIFORNIA

DATE SIGNED: _____

SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

PLAN AND PROFILE

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www.ppeng.com

DESIGN ENGINEER: RANDY HOPKINS
LICENSE NO: 63538
DRAFTED BY: STG
CHECKED BY: RSH
DATE: 3-27-2013
JOB NO: 103812C3
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ORIGINAL SCALE SHOWN IS IN INCHES. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.
SHEET 5 OF 11

3/27/2013 11:34 AM G:\Clients\Fresno ID - 1038\103812C3-ID Rankin Project\DWG\SHEET\5 PLAN AND PROFILE.dwg -David Sorrick

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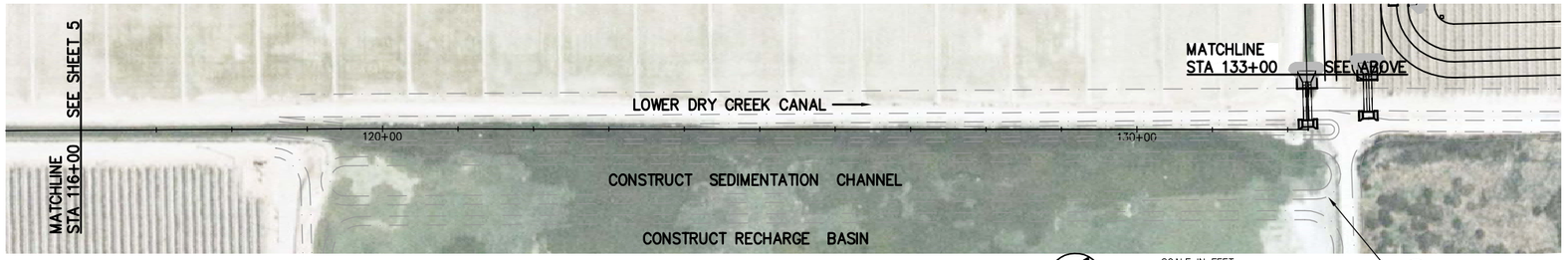
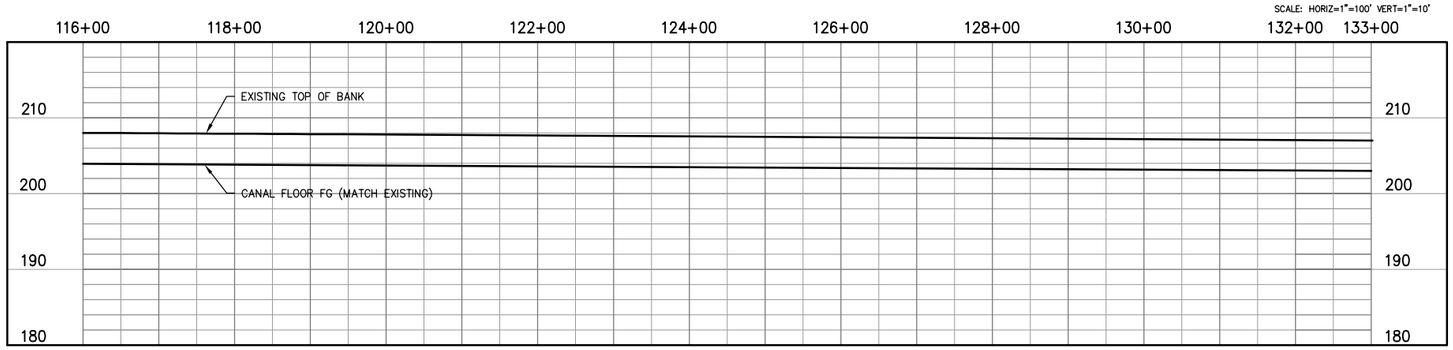
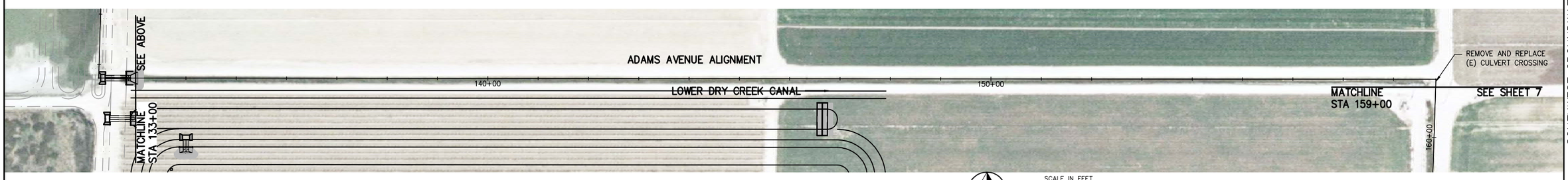


LOWER DRY CREEK CANAL NO. 77 STATION 116+00 THRU 133+00

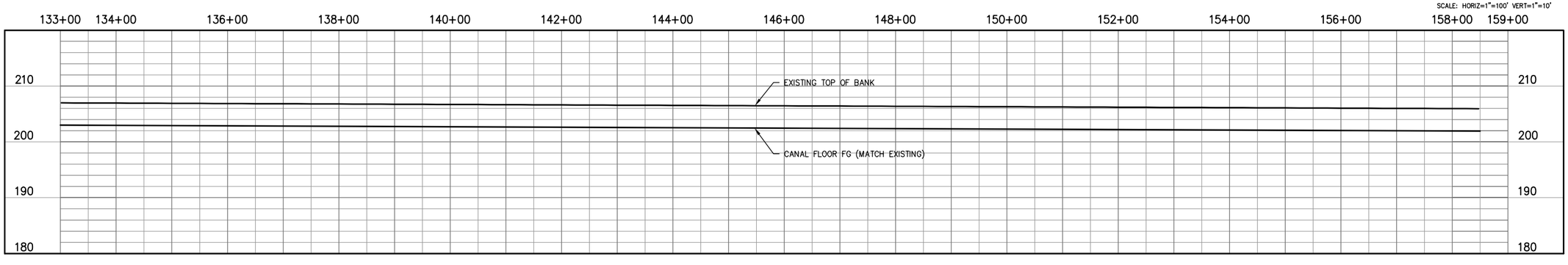
SCALE: HORIZ=1"=100' VERT=1"=10'





LOWER DRY CREEK CANAL NO. 77 STATION 133+00 THRU 159+00

SCALE: HORIZ=1"=100' VERT=1"=10'



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PRELIMINARY PLANS

REGISTERED PROFESSIONAL ENGINEER
RANDY S. HOPKINS
No. 63538
CIVIL
STATE OF CALIFORNIA

DATE SIGNED: _____

SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

PLAN AND PROFILE

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CONSULTING GROUP
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559/326-1100 FAX 559/326-1090
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LICENSE NO: 63538
DRAFTED BY: STG
CHECKED BY: RSH
DATE: 3-27-2013
JOB NO: 103812C3

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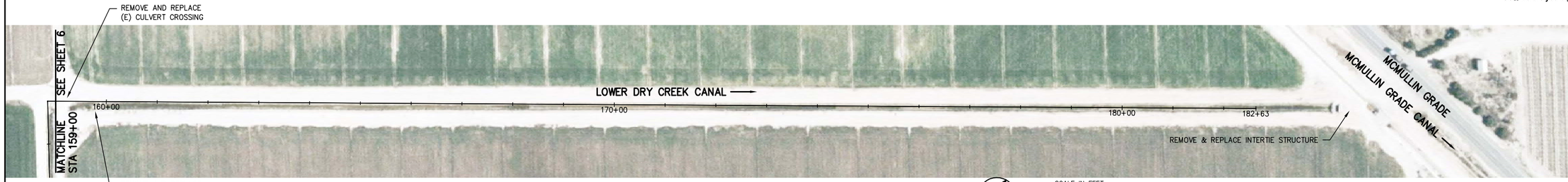
ORIGINAL SCALE SHOWN IS IN INCHES. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.

SHEET 6 OF 11

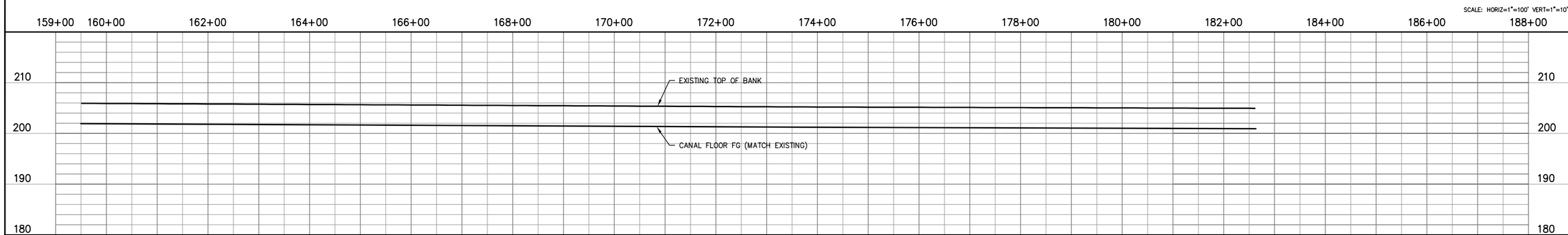
3/27/2013 11:34 AM G:\Clients\Fresno ID - 1038\103812C3-JD Rankins Project\DWG\SHEETS\6 PLAN AND PROFILE.dwg -David Sorrick



LOWER DRY CREEK CANAL NO. 77 STATION 159+00 THRU 183+00±

SCALE IN FEET
0 50 100 200

SCALE: HORIZ=1"=100' VERT=1"=10'



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PRELIMINARY PLANS

No.	REVISION	BY	DATE

REGISTERED PROFESSIONAL ENGINEER
RANDY HOPKINS
No. 63538
STATE OF CALIFORNIA
CIVIL

DATE SIGNED: _____

SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

PLAN AND PROFILE

EST. 1968
PROVOST & PRITCHARD
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DRAFTED BY: STG
CHECKED BY: RSH
DATE: 3-27-2013
JOB NO: 103812C3

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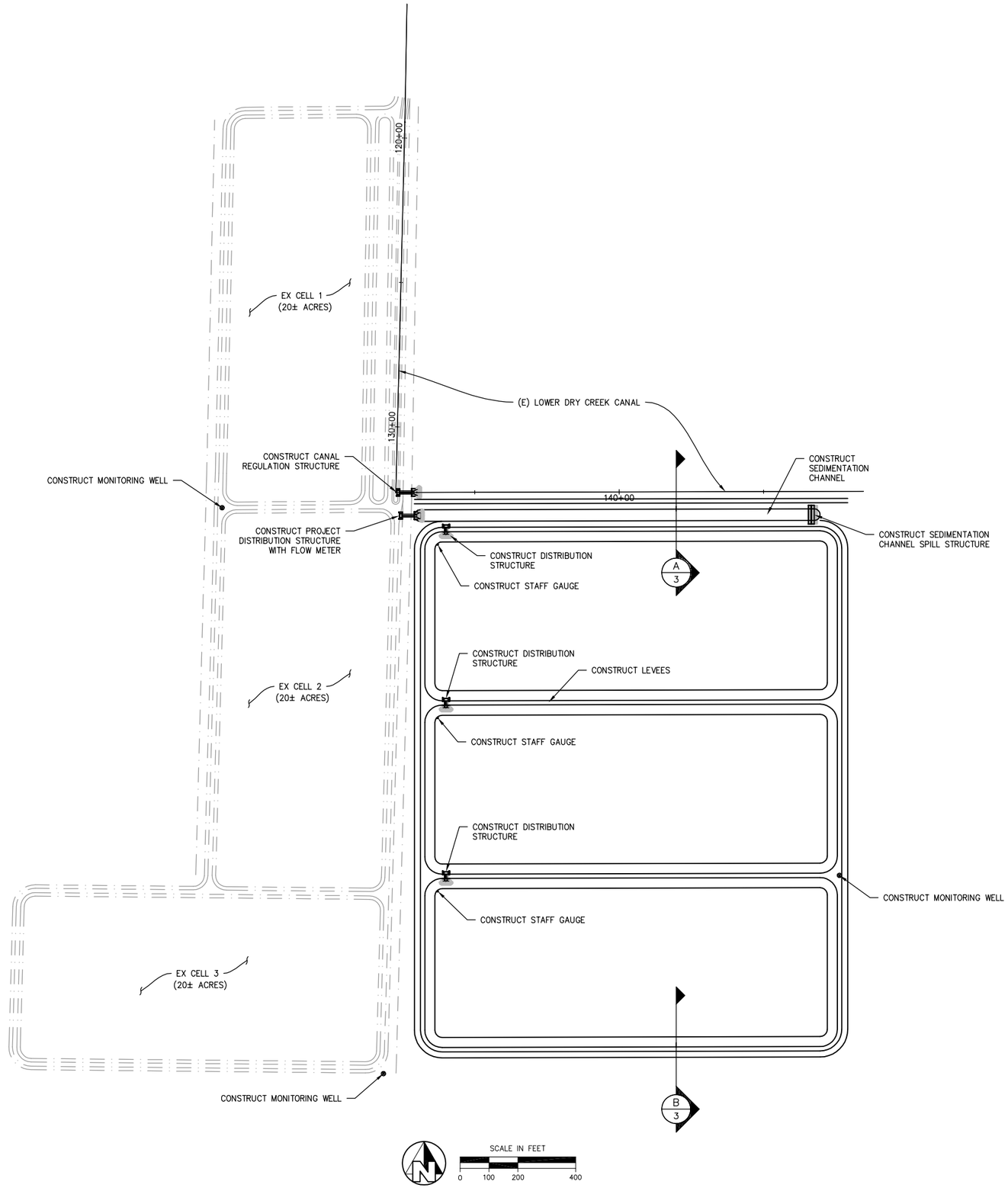
ORIGINAL SCALE SHOWN IS IN INCHES. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.

SHEET 7 OF 11

3/27/2013 11:34 AM G:\Clients\Fresno ID - 103812\103812C3-JID Banking Project\DWG\SHEET\7 PLAN AND PROFILE.dwg -Rovid, Sorrick



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RANDY HOPKINS
No. 63538
Exp. 12/31/13
CIVIL
STATE OF CALIFORNIA

DATE SIGNED: _____

SOUTHWEST GROUNDWATER
BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

RECHARGE BASINS SITE PLAN

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CLOVIS, CALIFORNIA 93611-9166
559/326-1100 FAX 559/326-1090
www.ppeng.com

DESIGN ENGINEER:
RANDY HOPKINS

LICENSE NO:
63538

DRAFTED BY:	CHECKED BY:
STG	RSH

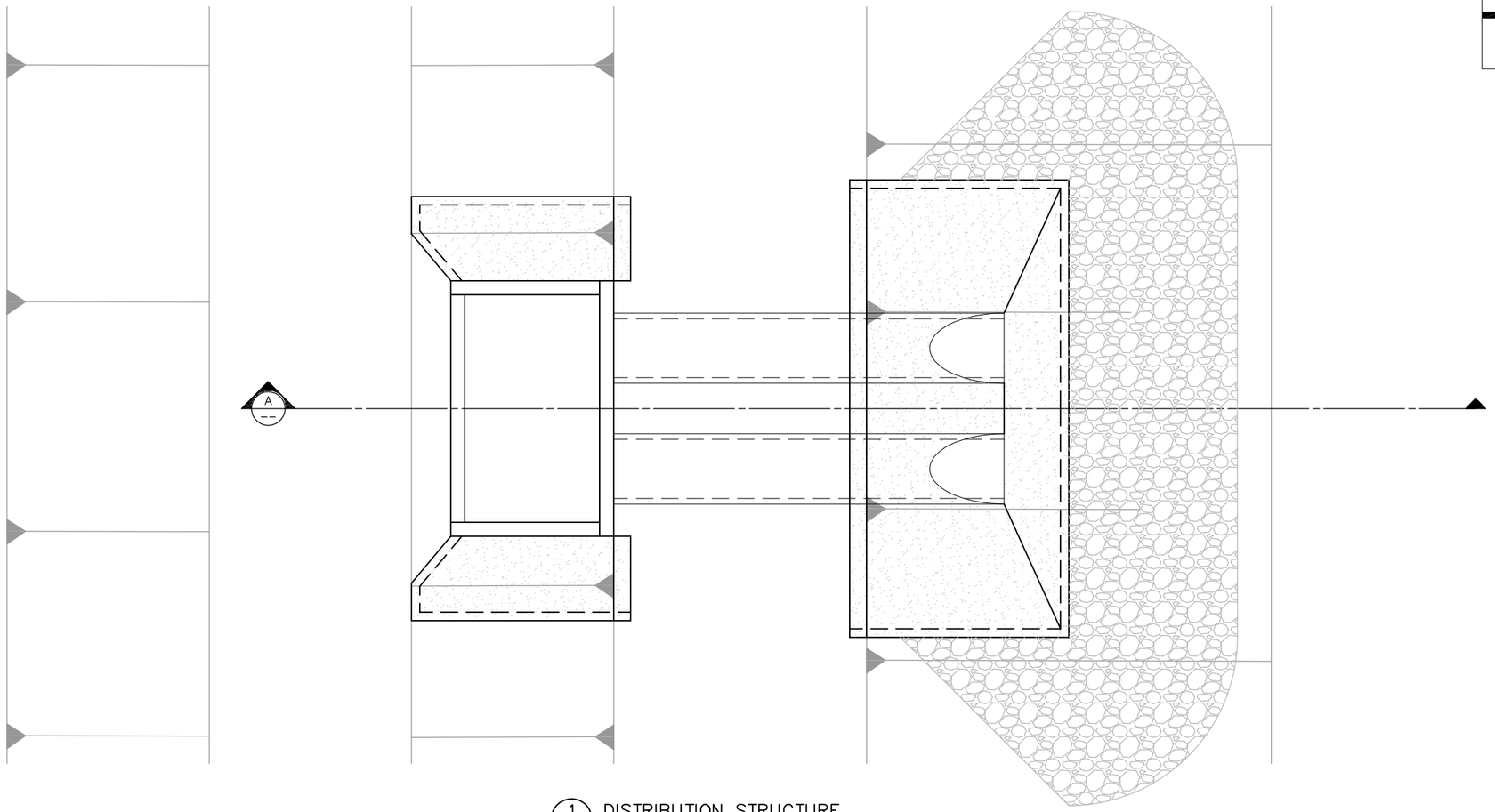
DATE: 3-27-2013

JOB NO: 103812C3

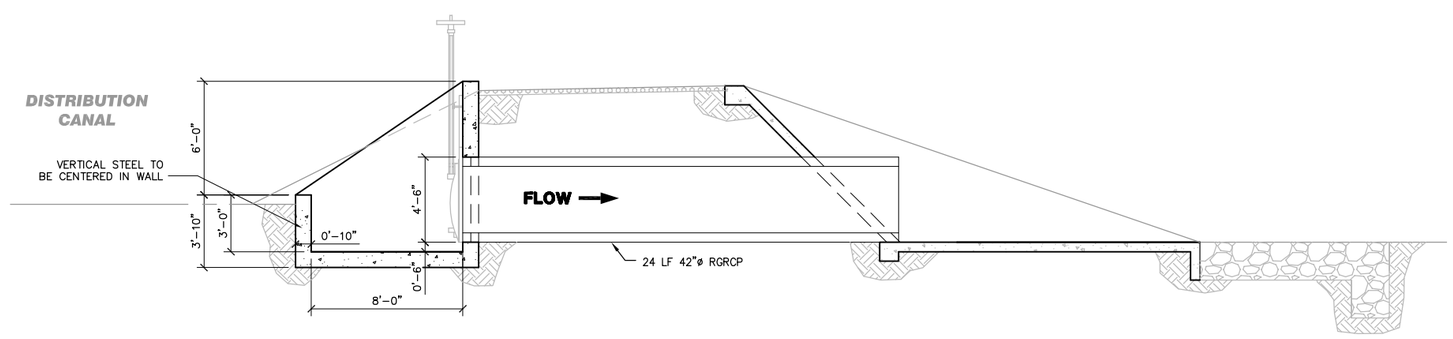
0 ____ 1
ORIGINAL SCALE SHOWN IS IN INCHES. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.

SHEET
8 OF 11

3/27/2013 11:35 AM G:\Clients\Fresno ID - 103812C3-JD Rankin Project\DWG\SHEET\7 POND.dwg -David Sorrick



1 / C18 DISTRIBUTION STRUCTURE
SCALE: 1/4"=1'-0"



A / – SECTION
SCALE: 1/4"=1'-0"

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PRELIMINARY PLANS

No.	REVISION	BY	DATE

REGISTERED PROFESSIONAL ENGINEER
RANDY HOPKINS
No. 63538
CIVIL
STATE OF CALIFORNIA

DATE SIGNED: _____

SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

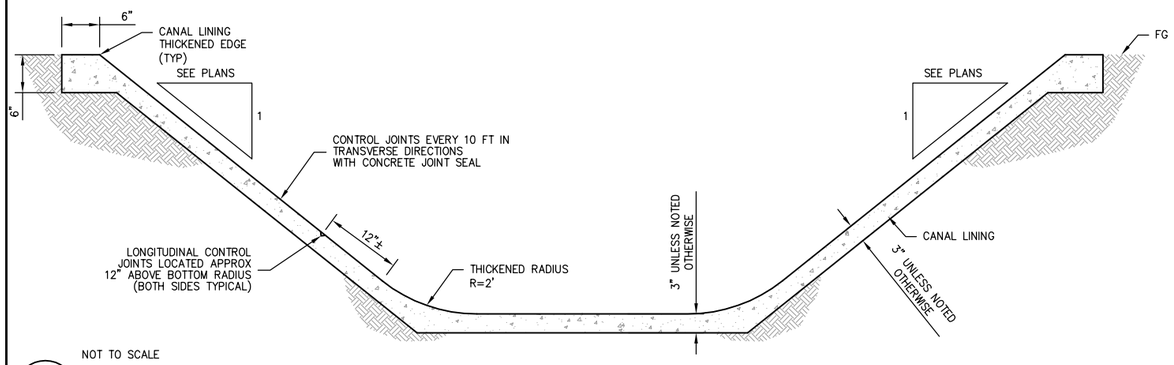
DISTRIBUTION STRUCTURE

FGT 21661
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company
420 EMERALD AVENUE, SUITE 205
CLOVIS, CALIFORNIA 93611-9166
559/326-1100 FAX 559/326-1090
www.ppeng.com

DESIGN ENGINEER: RANDY HOPKINS	
LICENSE NO: 63538	
DRAFTED BY: STG	CHECKED BY: RSH
SCALE: AS SHOWN	
DATE: 3-27-2013	
JOB NO: 103812C3	
DWG. NO:	
SHEET 9 OF 11	

3/27/2013 11:35 AM G:\Clients\Fresno ID - 103812C3-JID Rankins Project\DWG\SHEET\9 DISTRIBUTION STRUCTURE.dwg -David Sorick

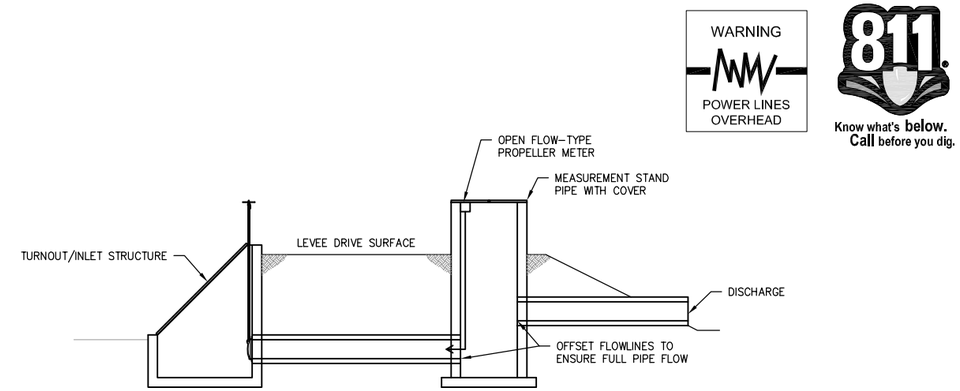
PC-0243



NOT TO SCALE

1/10

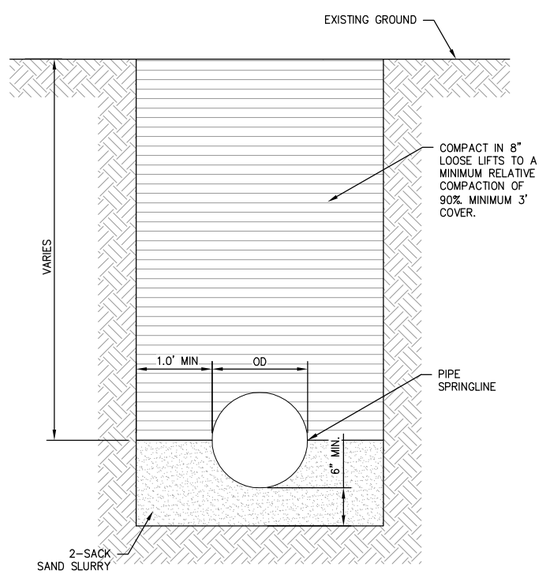
CANAL LINING



2/10

TYPICAL OPEN FLOW PROPELLER METER STAND

WT-0332

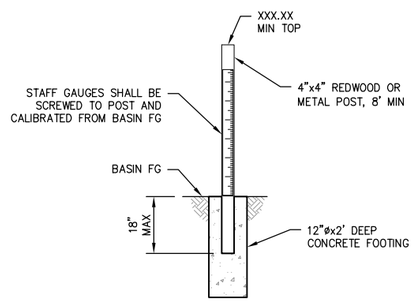


NOT TO SCALE

3/10

SLURRY MORE THAN 3' COVER

PC-0521



NOTES:

1. STAFF GAUGE SHALL BE TWO 3.33 FOOT SECTIONS, WATERMARK STREAM GAUGE STYLE "C" BY FORESTRY SUPPLIERS. ITEM NUMBERS 39732 AND 39733, OR ENGINEER APPROVED EQUIVALENT.
2. PLACE STAFF GAUGE NEAR BASIN DELIVERY STRUCTURES AT TOE OF EMBANKMENT SLOPE AND BEYOND AREA OF TURBULENCE AT PIPE OUTLET

NOT TO SCALE

4/10

BASIN STAFF GAUGE

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PRELIMINARY PLANS

No.	REVISION	BY	DATE

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SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

CONSTRUCTION DETAILS

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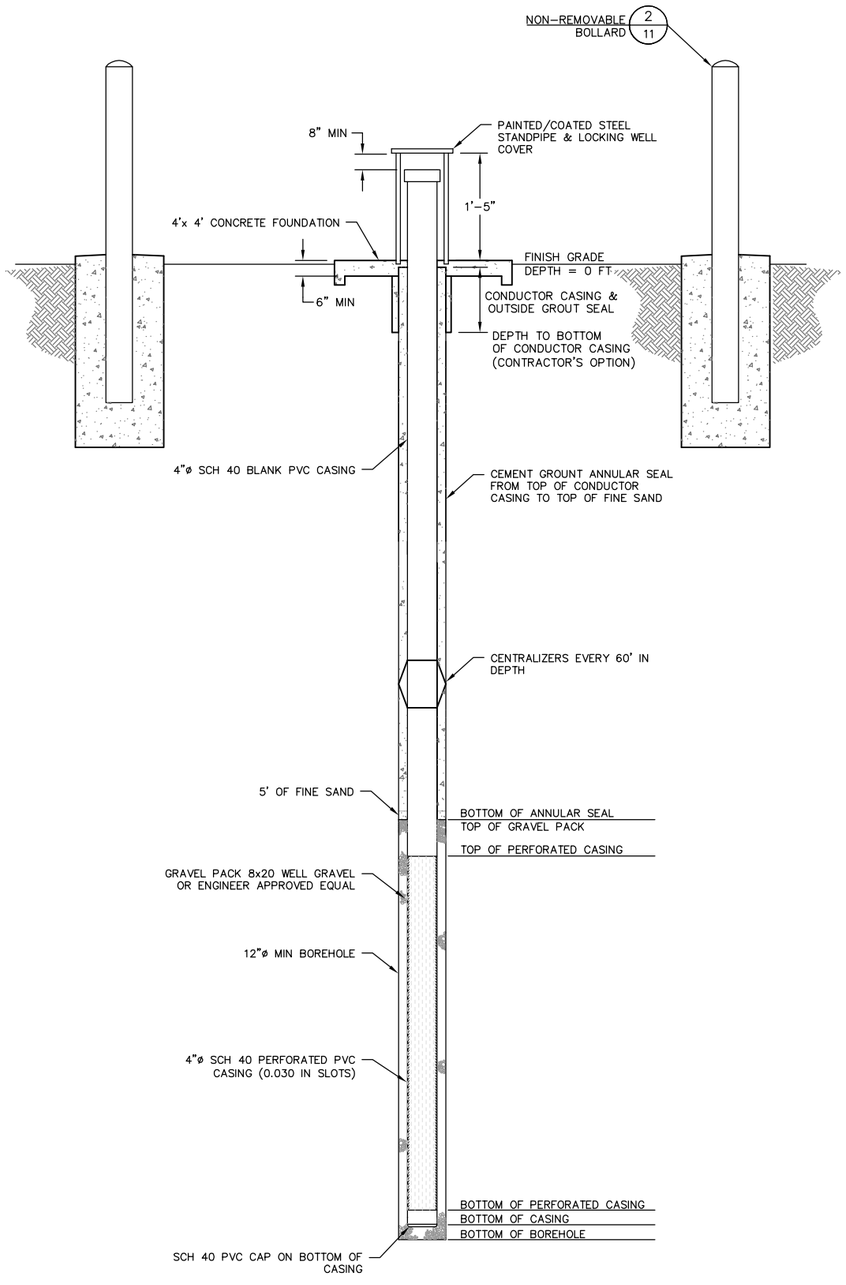
DESIGN ENGINEER: RANDY HOPKINS
LICENSE NO: 63538
DRAFTED BY: STG
CHECKED BY: RSH
DATE: 3-27-2013
JOB NO: 103812C3

0 1
ORIGINAL SCALE SHOWN IS IN INCHES. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.

SHEET 10 OF 11

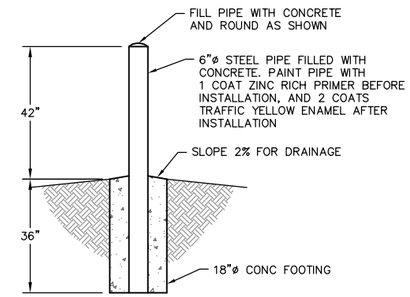
3/27/2013 11:35 AM G:\Clients\Fresno ID - 103812\103812C3-ID Banking Project\DWG\SHEET\10 CONSTRUCTION DETAILS.dwg -David Sorrick



1/11

MONITORING WELL DETAIL

SCALE = NTS



2/11

NON-REMOVABLE BOLLARD

SCALE = NTS

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No.	REVISION	BY	DATE

PRELIMINARY PLANS

REGISTERED PROFESSIONAL ENGINEER
RANDY HOPKINS
No. 63538
STATE OF CALIFORNIA

DATE SIGNED: _____

SOUTHWEST GROUNDWATER BANKING PROJECT
FRESNO IRRIGATION DISTRICT
FRESNO COUNTY, CA

TYPICAL MONITORING WELL

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CONSULTING GROUP
An Employee Owned Company
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CLOVIS, CALIFORNIA 93611-9166
559/326-1100 FAX 559/326-1090
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DESIGN ENGINEER: RANDY HOPKINS
LICENSE NO: 63538
DRAFTED BY: STG
CHECKED BY: RSH
DATE: 3-27-2013
JOB NO: 103812C3

0 _____ 1
ORIGINAL SCALE SHOWN IS IN INCHES. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.

SHEET 11 OF 11

3/27/2013 11:35 AM G:\Clients\Fresno ID - 103812C3-JD Rankin Project\DWG\SHEET\11 TYPICAL MONITORING WELL.dwg -David Sorrick

YOUR MOST VALUABLE RESOURCE - WATER

OFFICE OF
FRESNO IRRIGATION DISTRICT

TELEPHONE (559) 233-7161
FAX (559) 233-8227
2907 S. MAPLE AVENUE
FRESNO, CALIFORNIA 93725-2208

March 28, 2013

Mr. Dan Habib, Trustee
7025 South McMullin Grade
Fresno, CA 93706-9372

Re: Letter of Intent for Acquisition of Property

Dear Mr. Habib:

Set forth below is an outline of the terms and conditions under which the Fresno Irrigation District ("FID") would be willing to pursue the purchase of real property you own consisting of approximately 60 acres identified as Fresno County APN 035-060-77s (the "Property"):

1. Escrow. The purchase and sale transaction would be accomplished via an escrow to be established at First American Title Company in Fresno upon execution of a formal Purchase and Sale Agreement by the parties (the "Purchase Agreement").

2. Purchase Price for Property. The total purchase price for the Property would be $900,000, based on an assumed acreage included in the Property of 60 acres and a per acre price of $15,000. The total purchase price would be adjusted proportionately (up or down) if it is determined that the Property consists of more or less than 60 acres.

3. Payment of Purchase Price. The purchase price would be paid in cash at the closing of the transaction.

4. Closing Date. The closing would occur on a date mutually acceptable to both parties, but no later than 30 days after the later of (i) the satisfaction of all conditions and (ii) the end of the Due Diligence Period.

5. Title. Title to the Property would be conveyed at the closing subject only to liens or encumbrances approved by FID during the Due Diligence Period. At the closing, FID would receive an ALTA owner's policy showing title to the Property vested in FID.

6. Possession. FID would take possession of the Property at the close of escrow.

BOARD OF DIRECTORS President RYAN JACOBSEN, Vice-President STEVEN BALLS
JEFFERY NEELY, GEORGE PORTER, GREGORY BEBERIAN, General Manager GARY R. SERRATO

7. Due Diligence/Inspection Period. FID would have 120 days after the execution of the Purchase Agreement (the "Due Diligence Period") to review and approve all title matters and to conduct all inspections, tests, investigations and studies regarding the Property it deemed appropriate. Such inspections might include, without limitation, preparation of a Phase I environmental report, physical inspection and testing of the Property, and engineering tests. In the event that FID determined during the Due Diligence Period that the Property is unsuitable for FID's intended use, FID would have the right in its sole and absolute discretion to terminate the Purchase Agreement without liability by providing written notice thereof to Seller on or before the expiration of the Due Diligence Period. FID would indemnify the Seller from and against any and all loss, cost, damage, expense, claim or liability including personal injury, loss of life and/or property damage that result from the acts or omissions of FID or its agents in performing or preparing for any inspection and/or testing activity on or about the Property (but not for conditions or information discovered in the course of such inspections or testing).

8. CEQA Compliance. As a public agency, FID is required to evaluate the proposed acquisition of the Property and its subsequent intended use thereof pursuant to the California Environmental Quality Act ("CEQA") and other environmental laws. If this letter of intent is acceptable to you, FID will undertake the necessary environmental review and compliance before the Purchase Agreement is developed. No Purchase Agreement would be developed, and no party will be bound to proceed with the transaction described herein until the parties have negotiated, executed and delivered mutually acceptable agreements based upon information produced from the CEQA environmental review process and on other public review and hearing processes and subject to all governmental approvals. FID will not be pre-committed to any approvals until all environmental work has been completed and FID has made findings to proceed, which are conditions to FID's obligations to pursue the proposed project and the acquisition of the Property. Accordingly, FID retains the absolute sole discretion to (i) modify the terms above as may, in its sole discretion, be necessary to comply with CEQA, (ii) select other feasible alternatives to avoid significant environmental impacts, (iii) balance the benefits of the proposed project against any significant environmental impacts prior to taking final action if such significant environmental impacts cannot otherwise be avoided, and/or (iv) determine not to proceed with the proposed project. If, upon completion of the environmental review, FID finds one or more significant, unmitigated environmental impacts resulting from the proposed project and cannot make a finding that the benefits of the proposed project outweigh the impact(s), or that the impact(s) can be mitigated to a level below significance, then no party shall have any further obligation or liability with respect to the proposed project. Neither the execution of this letter of intent, nor any preliminary steps taken to implement this letter of intent, will be taken into account in determining whether mitigating or avoiding any significant impact is feasible.

9. Other Conditions. FID's obligations under the Purchase Agreement would be conditioned upon (i) FID obtaining funding for the acquisition of the Property and its proposed use thereof on terms acceptable to FID in FID's sole and absolute discretion, (ii) the absence of any litigation, administrative proceedings or other matters that would prevent FID's intended use of the Property and (iii) the satisfactory completion of the Due Diligence Period.

10. Prorations and Closing Costs. Real estate taxes and assessments would be prorated as of the closing date. Seller would pay for the title insurance policy, documentary transfer tax and all other customary seller's charges. FID would be responsible for all recording fees and all other customary buyer's charges. Escrow fees would be split one-half to FID and one-half to Seller and would be paid at the close of escrow.

11. Like-Kind Exchange. If you wish to sell the Property by means of a like-kind exchange qualifying for tax-free treatment pursuant to Internal Revenue Code Section 1031 (an "Exchange"), FID would cooperate in effecting an Exchange provided that you (i) bear and pay for all additional transaction costs attributable to the Exchange and (ii) indemnify FID against any and all losses and liabilities FID incurs in connection with the Exchange. No Exchange would be permitted to delay the closing or alter any terms of the Purchase Agreement.

12. Other Provisions. The Purchase Agreement would contain other standard terms, including typical representations and warranties and provisions dealing with the establishment of an escrow, as well as terms determined to be necessary by FID as a result of its CEQA review. This letter is intended only to outline general terms and conditions upon which FID would pursue a Purchase Agreement, it being expressly understood that by necessity, such agreement would include terms and conditions which would require further negotiation by the parties.

This letter is not intended to be a binding agreement between the parties, but is instead intended to simply present FID's initial proposal for the purchase of the Property. Neither party will be bound until all conditions described above have been satisfied and a final Purchase Agreement has been prepared and executed by all parties. It is expressly understood that no liability, obligation or commitment of resources of any nature is created as a result of this letter.

If you are interested in pursuing the transaction as presented above, please execute a copy of this letter and return it to FID on or before March 29, 2013.

Should you have any questions, please do not hesitate to contact the undersigned.

Very truly yours,

Gary R. Serrato

Gary R. Serrato
General Manager

The above terms are acceptable to Seller.

Dan Habib

Dan Habib, Trustee

Groundwater Recharge Feasibilty Study

Prepared For: Raisin City Water District

Prepared by: WRIME

August, 2012

TABLE OF CONTENTS

TABLE OF CONTENTS ..... **I**

SECTION 1 INTRODUCTION **1-1**

1.1 Goals and Objectives of the Study 1-1
1.2 Purpose of the Project 1-2
1.3 Scope of Project 1-2
1.4 Organization of the Report 1-3

SECTION 2 RECHARGE SITE FEASIBILITY INVESTIGATION **2-1**

2.1 Land Suitability Analysis 2-1
2.1.1 Data Sets 2-1
2.2 Preliminary Site Selection 2-3
2.3 Environmental Impacts Assessment 2-3
2.3.1 Minimizing the Environmental Impacts 2-3
2.3.2 Areas of Groundwater Contamination 2-3
2.3.3 Limiting the Land Subsidence Potential 2-4
2.4 Site Visits 2-4
2.4.1 FID Flood Easement Site 2-4
2.4.2 RCWD Vacant Land 2-5
2.4.3 CID Goldie Pond 2-5
2.4.4 CID Marks Pond 2-5

SECTION 3 CONVEYANCE ALTERNATIVE ANALYSIS **3-1**

3.1 Estimated Recharge Volumes 3-1
3.2 Existing Canal Inventory 3-1
3.2 Improvements / New Conveyance Feasibility 3-2
3.2.1 Existing Facilities Improvements 3-2
3.2.2 New Conveyance Facilities 3-3

SECTION 4 WATER AVAILABILITY **4-1**

4.1 Sources of Water Supply 4-1
4.1.1 Flood Flows from the Kings River 4-1

4.1.2 Section 215 Water 4-1
4.1.3 Reclaimed Water from Fresno-Clovis Regional Treatment Plant 4-2
4.1.4 Stormwater from City of Fresno 4-2
4.2. Frequency Analysis of Water Supply Sources 4-3
4.2.1 Flood Flows from the Kings River 4-3
4.2.2 Section 215 Water 4-3
4.3. Purchase and Delivery Costs 4-4
4.3.1 Flood Flows from the Kings River 4-4
4.3.2 Section 215 Water 4-4

SECTION 5 SITE CHARACTERIZATION 5-1

5.1 Regional Setting 5-1
5.2 CPT Methods 5-1
5.3 CPT and Boring Log Locations 5-2
5.4 Analysis of Boring Logs 5-2
5.5 Analysis of CPT Logs 5-3
RCWD Vacant Land Site 5-3
CID Goldie Pond Site 5-3
CID Marks Pond Site 5-4
5.6 Recommendations Based on CPT Results 5-4

SECTION 6 OVERVIEW OF KINGS IGSM 6-1

6.1 Model Area 6-1
6.2 Model Grid and Subregions 6-1
6.3 Calibration Period 6-1
6.4 Existing Conditions Baseline 6-2

SECTION 7 RECHARGE RATES AND SCHEDULES 7-1

SECTION 8 PROJECT IMPACTS AND BENEFITS 8-1

8.1 Recharge Scenarios 8-1
8.2 Recharge at RCWD Pond 8-2
8.3 Recharge at Dry Creek Pond 8-2
8.4 Recharge at Goldie Pond 8-3
8.5 Recharge at Marks Pond 8-4

8.6 Recharge at All Ponds 8-4

SECTION 9 PROJECT PRIORITIZATION AND PREFERRED PROJECT 9-1

SECTION 10 SUMMARY 10-1

SECTION 11 REFERENCES 11-1

TABLES

FIGURES

APPENDIX A TEXTURAL SUMMARY OF BORING LOGS

APPENDIX B CPT RESULTS

SECTION 1 INTRODUCTION

The Kings Basin is in critical overdraft and a groundwater cone of depression has been developed in the central and western parts of the Basin and is centered near the southwestern boundaries of the Raisin City Water District (RCWD). Overdraft increases the competition for available groundwater supply between geographic areas within the region. Declining groundwater levels and groundwater migration across jurisdictional boundaries are also potential sources of increased concern. In addition, site-specific issues associated with groundwater quality, groundwater recharge, and the need for water and wastewater management facilities to address the overdraft have been identified as high priority issues.

RCWD is actively participating in the Kings River Conservation District (KRCD) Coordinated Groundwater Management Plan (GWMP) and the Upper Kings Basin Integrated Regional Water Management Plan (IRWMP) to help address the groundwater overdraft. The groundwater recharge elements of the regional plans support the development of recharge basins to store surface water and replenish the groundwater supply, which will help secure the reliability of the primary source of water supply in the region.

RCWD has conducted a groundwater recharge feasibility study, funded through the Local Groundwater Assistance Grant (AB303 Program) from California Department of Water Resources, to identify required land, water, and conveyance structures and determine efficient, cost effective methods to replenish the groundwater supply through recharge projects. The groundwater recharge feasibility study contributes to the attainment of groundwater stability. The study covers areas within RCWD and at its boundaries with Fresno Irrigation District (FID) and Consolidated Irrigation District (CID). A map of the project area is presented in Figure 1.1.

The purpose of this report is to present the details of the data collected, work completed, and results of the recharge feasibility study. The results of field exploration work are presented in Section 5 and appendices.

1.1 GOALS AND OBJECTIVES OF THE STUDY

The goals of the feasibility study are to enhance the knowledge of groundwater basin recharge capacity, establish a groundwater recharge project to aid in the planning process, and evaluate the benefits that could be realized through the recharge of the groundwater basin. The project supports the goals and objective of the GWMP. The key goal is to stabilize and reverse overdraft and create a balance between groundwater demand and supply, ensuring that the resource will be available in the future. The groundwater recharge feasibility study is an integral part of achieving this goal. Producing a reliable, consistent source of groundwater information will provide new knowledge and a better understanding of the current conditions of the basin.

1.2 PURPOSE OF THE PROJECT

The purpose of this project is to collect and assess the data required to support the regional efforts by the GWMP stakeholders and participants to protect the groundwater basin as a source of water for agriculture and municipal use. A summary of data used in this analysis is listed in Table 1.1.

The groundwater recharge feasibility study supports the primary Basin Management Objective (BMO) of the GWMP to:

> *"Identify and build near-term groundwater recharge projects within each Water Management Area (WMA) to capture flood flows; begin to stabilize the basin; and demonstrate project feasibility, benefits, and cost effectiveness."*

This project also supports the goals and objectives of the IRWMP. The goals and objective of the IRWMP, as related to this project and the GWMP, are:

- Halt, and ultimately reverse, the current overdraft and provide for sustainable management of surface and groundwater;
- Increase the water supply reliability, enhance operational flexibility, and reduce system constraints;
- Define local and regional opportunities for groundwater recharge, water reuse/reclamation, and drinking water treatment;
- Develop large scale regional conjunctive use projects and artificial recharge facilities to:
  - Improve the ability to store available sources of surface water in the groundwater basin;
  - Capture storm water and flood water currently lost in the region;
  - Provide multipurpose groundwater recharge facilities that provide flood control, recreation, and ecosystem benefits; and
  - Promote 'in-lieu' groundwater recharge to reduce reliance on groundwater.

1.3 SCOPE OF PROJECT

The major project components consist of background investigation of existing conditions related to water supply and conveyance system, characterization of land use for potential project sites, and assessment of project impacts and benefits. A summary of the project tasks are as follows:

- Task 1 – Recharge Site Feasibility Investigation
- Task 2 – Water Availability Study
- Task 3 – Conveyance Alternative Analysis
- Task 4 – Drilling and Site Characterization
- Task 5 – Projects Impacts and Benefits Assessment Study

- Task 6 – Final Report
- Task 7 – Public Outreach
- Task 8 – Project Management

This report presents the work performed for and the results of Tasks 1, 2, 3, 4, 5 and 6.

1.4 ORGANIZATION OF THE REPORT

This report is organized as follows:

- **Section 1 – Introduction**: This section.
- **Section 2 – Recharge Site Feasibility Investigation**: presents the evaluation of recharge capacity of potential recharge sites within the boundaries of and in the vicinity of RCWD. These activities were performed as part of activities of Task 1.
- **Section 3 – Conveyance Alternative Analysis**: presents the existing canal inventory and proposed improvements to the existing conveyance facilities and infrastructure. These analyses were performed as part of activities of Task 3.
- **Section 4 – Water Availability:** identifies the source of water and availability for recharge as a part of Task 2 activities.
- **Section 5 –Site Characterization:** presents the exploratory program for potential recharge facilities. This program was designed and applied as a part of activities of Tasks 1 and 4.
- **Section 6 – Overview of Kings IGSM:** presents an overview of the Kings Basin Integrated Groundwater and Surface Water Model (Kings IGSM) and Kings IGSM Existing Conditions Baseline scenario. This overview was provided as a part of activities of Task 5.
- **Section 7 – Recharge Rates and Schedules:** summarizes the volume and timing of surface water availability for the activities of Task 5.
- **Section 8 – Project Impacts and Benefits:** lists the updates to Kings IGSM model to develop recharge scenarios as a part of the activities of Task 5. It also summarizes impacts and benefits of the recharge operations at the potential recharge sites as part of the activities of Task 5.
- **Section 9 – Project Prioritization and Preferred Project:** summarizes the results of the analysis completed in Task 1 to 5 and presents the project prioritization and preferred project.
- **Section 10 – Summary:** provides a summary of the work performed and results of the project.

- **Section 11 – References:** lists the documents cited in this report.
- **Tables:** lists the tables used in Sections 1 to 10.
- **Figures:** lists the figures used in Sections 1 to 10.
- **Appendix A – Textural Summary of Boring Logs:** presents the textural summary of the USGS boring logs in the immediate vicinity of the project area.
- **Appendix B – CPT Results:** presents the additional data for the CPT logs.

SECTION 2 RECHARGE SITE FEASIBILITY INVESTIGATION

The performance of conjunctive use projects is enhanced through direct recharge, spreading, and groundwater banking of available allocated and unallocated flood waters. The recharge capacity of recharge ponds is dependent on site conditions and significantly influenced by soil conditions, depth to groundwater, and permeability of aquifer material. This section presents the evaluation of recharge capacity of potential recharge sites within the boundaries and in the vicinity of RCWD.

2.1 LAND SUITABILITY ANALYSIS

Site conditions have a significant impact on the success of recharge operations through recharge ponds or surface spreading. Properties of near surface soils directly affect the ability of water to infiltrate the ground, and subsurface aquifer conditions directly affect the quantity of water that can be stored in the subsurface. A good understanding of the properties of soils in the region provides valuable information for land acquisition opportunity, when a property comes into market.

This section describes the processes used to evaluate the suitability of lands in and around RCWD for recharge at a regional scale, based on the physical properties of the soil conditions and the economic feasibility of the land.

2.1.1 DATA SETS

Five different digital maps and data sets were collected and used to identify suitable lands in the region. These maps and data sets, all available as GIS shapefiles, include:

1. Land use
2. Hydrologic soils
3. A- and E-clay
4. Specific yield
5. Depth to groundwater water

The land use data were used to identify economically feasible lands in the region. Data items 2 and 3 were used to assess the infiltration ability and permeability of the regional lands. Data items 4 and 5 were used to evaluate the aquifer storage capacity. An index ranking system was developed, on a scale from 1 to 5, for different features of each of the data sets. A lower index value was assigned to less suitable land. An index value of zero was given for situations that would preclude a successful project. The ranking factors and quantification methods are shown in Table 2.1.

Land Use

Land use maps were used to screen out areas (e.g., urbanized areas) that are not economically feasible for spreading basins or are inappropriate for developing large scale recharge facilities. Areas in the urban spheres of influence may be excluded from conjunctive use sites; however, spheres of influence were not used as a criterion in this analysis. Idle and vacant lands are given higher rankings than cropped lands, and annually cropped lands are given higher rankings than the more permanently cropped lands. The ranking index for land use is shown in Figure 2.1 and Table 2.1.

Surface and Subsurface Conditions

Soils maps from the United States Department of Agriculture, Natural Resources Conservation Service present classifications of the Hydrologic Soil Groups were used to assess groundwater recharge feasibility. The soils map and the map of A-clay and/or E-clay formations were used to define areas that would allow for high rates of recharge and be favorable for downward flow of water to the aquifer. Areas identified as having the smallest runoff potential (Type A) are ranked highest, and areas identified as having the greatest runoff potential (Type D) are ranked lowest. Runoff potential is inversely proportional to infiltration rates (i.e., low runoff potential means high infiltration rates). Maps of the ranking index for Hydrologic Soil Groups and the presence of A-clay and/or E-clay are shown in Figures 2.2 and 2.3, respectively.

Available Storage

Available groundwater storage is a function of (1) the distance between the water table and the root zone of nearby crops, and (2) the ability of the geologic materials to transmit and store water, or the specific yield of the formation. Ranking criteria are based on both of these factors. Areas with a larger unsaturated zone and with higher specific yield are ranked higher. To be conservative, a Spring 2003 water levels map was used to calculate the depth to ground water. This was a year that followed a number of wet years and had relatively higher water table elevations. Maps of the ranking index for depth to water and specific yield are shown in Figures 2.4 and 2.5, respectively.

Weighting of Ranking Indices

To keep the analysis simple and straightforward, the resulting rankings were calculated with all factors evenly weighted. All of the five data coverages were overlaid in the GIS and the ranking indexes were applied to develop a composite score. A maximum possible value of 25 would represent land most suitable for recharge, and a minimum possible value of 3.92 would represent land least suitable for recharge. The distribution of the composite index is shown in Figure 2.6.

The composite index was then reclassified to produce a more general recharge potential map. Figure 2.7 simplifies the recharge potential into four categories, identifying areas as having very high, high, medium, or low potential for implementation of a successful direct recharge project.

2.2 PRELIMINARY SITE SELECTION

In addition to the data sets described in the previous sub-section, land availability, landowner cooperation, maximizing use of existing infrastructure, utilizing existing right-of-way to expand or extend conveyance facilities, and ensuring consistency with long-term land uses and water rights agreements were also considered and used as screening criteria during the selection process for the sites.

After compiling all the necessary information to identify suitable lands in the project area and consultation with RCWD, four site locations were selected, as shown in Figure 2.8 and Figures 2.9.a – 2.9.d. Two sites are within CID service area, one is within FID service area, and one is within RCWD service area. Table 2.2 summarizes some of the main characteristics of the proposed recharge sites.

Figure 2.10 shows the recharge potential of the proposed recharge sites. Similarly, site conditions relative to land use, soil permeability, E-clay, depth to groundwater, and relative specific capacity are shown in Table 2.3, with ranking indexes for each site and category. Table 2.3 shows that CID Marks Pond and CID Goldie Pond have higher recharge potential than FID Lower Dry Creek Pond and RCWD Vacant Land.

2.3 ENVIRONMENTAL IMPACTS ASSESSMENT

2.3.1 MINIMIZING THE ENVIRONMENTAL IMPACTS

The California Natural Diversity Database (CNDDB) holds data on the status and locations of rare and endangered plant, animal, and vegetation types—information maintained by the Habitat Conservation Division of the California Department of Fish and Game (CDFG). The CNDDB 2011 GIS layers were overlaid on top of the project sites, as shown in Figure 2.11.a and 2.11.b, to examine if the project sites are within any of the areas specified by the CNDDB federal and California lists for rare and endangered plant, animal, and vegetation types. Figure 2.11.a and 2.11.b show that the projects sites are out of the areas specified by the CNDDB federal and California lists.

2.3.2 AREAS OF GROUNDWATER CONTAMINATION

A detailed description of the groundwater quality around the project area is presented in WRIME (2002a,b). Primary groundwater quality concerns in the area are pesticides and nitrates. In general, groundwater in the area is suitable for intended agricultural use. The quality of water available for recharge (from Friant Kern Canal as Section 215 water or flood water from Kings River) at the project site will likely be higher than that of the underlying groundwater.

GeoTracker GAMA is an online groundwater information system from the California Department of Water Resources (DWR) that gives access to water quality data from 200,000

discrete well locations throughout the state. The database integrates groundwater quality data from multiple sources, which are searchable by chemical or location. The locations of the project sites were compared with wells with any chemical comparison concentration within the area. There are a few wells with high nitrate levels within RCWD, but they are not near any of the proposed project sites.

Water quality has not been an issue at nearby recharge basins and is not expected to be an issue for this project, based on the findings from reports created by WRIME (2002a,b) and GeoTracker GAMA database.

2.3.3 LIMITING THE LAND SUBSIDENCE POTENTIAL

Land subsidence results from extensive groundwater pumping beneath laterally extensive confining layers. The removal of groundwater causes increased pressure on fine grained deposits below the confining layer, which results in compaction of the fine grained layers at depth and is evident at the ground surface as land subsidence. While there has been subsidence in the areas of Western San Joaquin Valley (such as in the Westland Water District and the Pleasant Valley Water District), there is no regionally extensive land subsidence within RCWD (Ireland et al. 1980). Faunt ed. 2009 estimates around one foot of land subsidence around RCWD from the distribution of land subsidence estimated from 1961 to 1977 extensometer data. The same report estimates a few feet of total simulated subsidence from water years 1962 through 2003 around RCWD.

2.4 SITE VISITS

The purpose of the site visit was to identify any fatal flaws, review the location for access, and evaluate conditions for selection of the final exploration and monitoring well locations. Four sites were selected based on land availability, preliminary groundwater recharge potential, maximizing use of existing infrastructure, and land owner cooperation. Two sites are currently used as groundwater recharge ponds near the western boundary of CID Goldie Pond and Marks Pond. The third site is vacant land owned by RCWD. The fourth site is near the boundary of RCWD and FID. FID holds a flood easement and has two canals in place to deliver water for recharge.

2.4.1 FID FLOOD EASEMENT SITE

The Fresno Irrigation District recharge pond is located between McMullin Grade and Lincoln Avenue and between Highway 145 and Jameson Avenue (Figure 2.9.a). The pond is approximately 60 acres and has flood easement rights (shown in Figure 2.8) to the surrounding 1,600 acres. The site has access from McMullin Grade along a canal connecting the pond and James Irrigation District's McMullin Grade canal. The source of water comes from FID's Lower

Dry Creek Canal, with a capacity of approximately 100 cfs. The surrounding land is currently being farmed and is available for the spreading of flood water under FID's flood easement. The existing pond would be under consideration for future expansion to 80 acres for surface water retention and groundwater recharge and banking.

2.4.2 RCWD VACANT LAND

The project site (Figure 2.9.b) within RCWD is located on the northeast corner of Chateau Fresno Avenue and Manning Avenue, in Fresno County. RCWD purchased this land as a potential groundwater recharge basin because it was available and anecdotal information from neighboring landowners indicated that the site would make a good site for groundwater recharge. There are two constraints to overcome for this project site. First, there are no existing canals that can deliver water to the site and any infrastructure to convey water would have to be through a buried pipeline. Neighboring landowners are in-favor of the project but do not want to have canals running through their farmland. Second, the site is outside of the Kings River Water Association (KRWA) service area and may have to rely on short-term contracts for Kings River water or other sources of water.

2.4.3 CID GOLDIE POND

Goldie Pond (Figure 2.9.c) is owned and operated by CID and is located on Marks Avenue, north of Manning Avenue, in Fresno County. The pond is currently used for groundwater recharge and is approximately 40 acres. Wristen Ditch is an existing CID canal and has a capacity at the headgate of 100 cfs. The canal size has a 45 cfs capacity, which feeds Goldie Pond through a pipeline with a capacity of 25 cfs. Canal and pipeline improvements are needed to increase capacity to 50 cfs into the recharge pond. Goldie Pond has the potential to recharge surface water from the Kings River and other sources. The site has street access along Marks Avenue for site drilling and soil testing.

2.4.4 CID MARKS POND

Marks Pond (Figure 2.9.d) is owned and operated by CID and is located south of Flora Avenue and west of Marks Avenue, in Fresno County. The pond is currently used for groundwater recharge and is approximately 40 acres. Marks Pond receives surface water from the Kings River during flood events and is delivered by two canals, Wristen Ditch with a capacity of 45 cfs from the north, and a second canal with approximately 40 – 50 cfs from the south. The pond does not have direct street access, and drilling rigs approaching from Flora Avenue may find access difficult. Access from Mark Avenue may be possible, but the canal bank is steeper on the east.

SECTION 3 CONVEYANCE ALTERNATIVE ANALYSIS

This section presents the existing canal inventory to determine whether existing conveyance facilities are adequate for transferring water from the selected sources to the selected recharge locations. It also presents the proposed improvements to the existing conveyance facilities and infrastructure needed to convey the selected quantities of recharge water to the selected recharge sites.

3.1 ESTIMATED RECHARGE VOLUMES

The capacities of the conveyance systems and recharge basins are generally the limiting factors for the volume of water that can be recharged. The existing canals were examined to determine if they have enough capacity to convey the total amount of water needed for recharge operations. Table 3.1 shows how much water can be recharged for an estimated minimum and maximum recharge rate for each site and the corresponding design flows. The numbers from Table 3.1 can help assess if any improvements to the existing conveyance facilities, any additional new conveyance facilities, or any new infrastructure are necessary.

3.2 EXISTING CANAL INVENTORY

Existing canal locations and capacity data were obtained from FID, CID, KRCD, and personal communications with local authorities. Based on the available data, canal capacities for the major FID and CID canals are shown in Figures 3.1 and 3.2, respectively. Also, canal capacity data for the major FID and CID canals and Friant-Kern Canal is summarized in Table 3.2.

Frequency analysis of the daily diversion potentials and canal capacity was conducted to determine the availability of excess canal capacity above other demands, at the time when recharge water is available. The frequency analysis was also used to determine the timing of canal capacity availability. Headgate diversion records of the CID's Consolidated Canal and FID's Fresno Canal and Gould Canal were obtained from KRWA. Friant-Kern Canal flow data was obtained from U.S. Geological Survey (USGS). Available canal capacities were determined by evaluating the daily differences between canal capacity and headgate diversions from 1964 to 2011. Table 3.3 shows what percent of the time the available canal capacities were more than 75 cfs, 100 cfs, 150 cfs, 200cfs, and 250 cfs on daily basis. Available canal capacities greater than 200 cfs for Friant-Kern Canal, Consolidated Canal and Fresno-Gould Canals are 100%, 100% and 95% of the days from 1964 to 2011, respectively. The combined design flow for all of the proposed recharge ponds is 160 cfs (Table 3.1) for the estimated maximum recharge rates. The availability of all three canal capacities becomes 100% when the same analysis is done just for the flood dates. As a result, canal capacity for the three major canals should not be a limiting factor to divert water to proposed recharge ponds.

Figure 3.3 shows the CID and FID tail-end canals close to the proposed recharge sites. Table 3.4 also summarizes the canal capacity for Wristen Ditch and Dan Smith Ditch, which are the tail-end canals for CID recharge sites, and the Central Wasteway, McMullin Grade, and Lower Dry Creek Canals, which are the tail-end canals for the FID recharge site. Since flood water from Kings River and Friant-Kern Canal will be only available during the flood seasons when there is almost no irrigation, we can assume that canal capacity for the tail-end canals would be available at almost 100%.

Design flow for the CID Goldie Pond is 40 cfs at the maximum estimated recharge rate. Wristen Ditch has enough capacity to provide this flow during the flood releases. The remaining capacity of Wristen Ditch combined with Harlan Stevens Ditch would have enough capacity to provide 40 cfs of design flow to CID Marks Pond at the maximum estimated recharge rate. Both Central Wasteway and McMullin Grade have capacities bigger than 40 cfs, which is the design flow for the RCWD recharge site at maximum estimated recharge rates. Additional conveyance facilities should be added to convey water from the Central Wasteway or McMullin Grade to the RCWD recharge site. The capacity of the Lower Dry Creek is large enough to convey 40 cfs of water, which is the design flow for the Lower Dry Creek Pond at maximum estimated recharge rate.

3.2 IMPROVEMENTS / NEW CONVEYANCE FEASIBILITY

FID and CID operate extensive canal systems that carry water from Friant-Kern Canal and Kings River to their respective service areas. The existing canal systems can transfer water all the way to the boundary of RCWD. The existing canals can be used to convey water for the proposed recharge sites within the CID and FID service areas with minimum improvements. However, more improvements and new facilities would be necessary to carry the water to the RCWD recharge site.

The intent is to utilize existing canals, available land, and recharge facilities to maximize the opportunity to recharge groundwater. The selected recharge ponds are underutilized because of initial design constraints of the canal system. The canals were designed to deliver surface water from the river at the headgate to the farm land, thus requiring large capacities near the river and less at the end of the canal. The headgate capacity of the main canal in CID is 2,100 cfs, while the canals at the end of the system may only require 15 cfs.

This section outlines improvements to existing facilities and the development of a new conveyance system to optimize movement of surface water for direct groundwater recharge.

3.2.1 EXISTING FACILITIES IMPROVEMENTS

The CID Goldie Pond's primary source of water is delivered through Wristen Ditch. Wristen Ditch has a headgate capacity of 100 cfs and tapers down to approximately 45 cfs. The water is

diverted into the pond through a buried, 24-inch pipeline, approximately 200 yards in length. The recommended improvements are to increase the canal capacity and diversion pipeline (Figure 3.4). The soil in the general area is sandy. Enlarging the canal to 100 cfs may require reinforcement of the levies to protect neighboring landowners from flooding. The canal should be enlarged from CID Goldie Pond to Highway 41, approximately 5.25 miles. The underpass at Highway 41 constrains the water flow to an unknown capacity. The rebuilding of the underpass may allow 100 cfs flow of water through Wristen Ditch.

Enhancement to Wristen Ditch to deliver additional water to the CID Marks Pond requires increasing capacity of two segments of pipeline and two segments of canals, as shown in Figure 16. Downstream of the Goldie Pond, Wristen Ditch flows through a buried pipeline, 1.75 miles in length, resurfaces to a canal of approximately 45 cfs for 0.5 mile, and flows into another buried pipeline for another 0.5 mile. The pipeline discharges into a canal for 0.5 mile leading to the CID Marks Pond. The sizes of the buried pipes and canal are unknown, but are estimated to allow up to 45 cfs flow of gravity fed water. Increasing the capacity of the segments of pipe and canal will allow additional intake of water to the CID Marks Pond and future pond development between the CID Goldie and Marks Ponds.

The Lower Dry Creek Pond and surrounding flood easement land is capable of receiving water through the Lower Dry Creek Canal, which has a 100 cfs capacity. The pond site is currently only 60 acres and receives water during flood seasons. Increasing the capacity of the pond to 80 acres when land becomes available is recommended. The pond can be used for groundwater recharge or as a holding/regulation basin to optimize conveyance operations. The pond is located along the McMullin Grade and it can allow for possible future water banking or exchange projects with James Irrigation District. Exchanging surface water to reduce or eliminate pumping along McMullin Grade would help restore the groundwater basin.

3.2.2 New Conveyance Facilities

The vacant land owned by RCWD, located near Manning Avenue, is 80 acres. Delivering water to the RCWD pond will require development of new canals or pipelines. There are a few canals within the district for on-farm use. Landowners are supportive of having recharge basins developed within the district, but do not want canals interrupting access to their farmland, impeding operations, or causing a loss of available farmland. The alternative is to use a buried pipeline to convey water. A series of pipeline options that connect CID and FID conveyance systems to the proposed RCWD pond are described below.

There are two options to connect the CID conveyance system to the proposed RCWD pond. These options are labeled as CID Intertie Options 1 and 2 in Figure 3.5. CID Intertie Option 1 diverts water from Wristen Ditch downstream of CID Goldie Pond through a 3.9-mile pipeline along Manning Avenue. CID Intertie Option 2 diverts water from Wristen Ditch near CID Marks Pond through a pipeline, 5.25 miles along Henderson Road, with a turnout at Manning

Avenue to the RCWD pond. Figure 17 shows the option labeled as FID Intertie to connect the FID conveyance system to the proposed RCWD pond. FID Intertie diverts water from Central Wasteway through a pipeline, 4.6 miles along S. Grantland Avenue, with a turnout at Manning Avenue to the RCWD pond. 48 inch diameter pipes would be used for the proposed buried pipelines that would allow 50 cfs gravity flow.

SECTION 4 WATER AVAILABILITY

The availability of surface water for infiltration at the potential recharge sites needs to be assessed for source, volume, and timing of excess surface water availability standpoint. This section discusses the recharge water availability.

4.1 SOURCES OF WATER SUPPLY

The sources of surface water potentially available in this region include the Kings River (flood flows, entitlement flows, and conserved releases), Section 215 flood water releases from Millerton Lake to Friant-Kern Canal, and excess storm flow and treated wastewater from the City of Fresno.

4.1.1 FLOOD FLOWS FROM THE KINGS RIVER

Kings River is a fully appropriated stream. This means that water rights have been granted for the entire year round flow of the Kings River. Even with the full appropriation of surface water supplies, there are times when Pine Flat Reservoir and existing facilities cannot store or manage all of the available water in the Kings River. Flood flows not stored behind the Pine Flat Dam or currently being diverted into irrigation districts' canals run down the Kings River to the Lower Basin, where they may be directed to either the North Fork of the Kings River and the James Bypass flood channel, or to the South Fork of the Kings River and Tulare Lake Basin. The flood flows could be captured and used as a water supply for the groundwater recharge project.

The Kings River flood water has been a reliable source for groundwater recharge. However, there are institutional constraints for the use of Kings River water. The Kings River is managed by the 28-member KRWA. Water from the Kings River can only be used within the KRWA service area that includes the individual district members' boundaries. The RCWD proposed sites are outside the KRWA service area and not eligible to receive water from the Kings River. The KRWA has made exceptions for recharging groundwater if there will be benefits to the KRWA service area through a short-term, annual-renewable contract for use of the Kings River flood water. Use of Kings River water may be available, but since long-term agreements cannot be made, it is assumed that water from sources other than the Kings River will be used for recharge at the RCWD project site.

4.1.2 SECTION 215 WATER

Pursuant to Section 215 of the Reclamation Reform Act of 1982 (RRA) (Public Law 97-293), the Secretary of the Interior is authorized to contract for temporary supplies of water, resulting from an unusually large water supply not otherwise storable for project purposes, or from infrequent and otherwise unmanaged flood flows of short duration, provided such temporary

water supplies do not adversely affect other authorized project purposes. These temporary water supplies are commonly referred to as Section 215 water or surplus water.

The U.S. Bureau of Reclamation (Reclamation) has determined that unusually large water supplies may result from winter hydrology in some years such that future restricted storage capacity in Millerton Lake may create a non-storable supply of water, pursuant to Section 215 of the RRA (Section 215 water). This water supply may be offered to non-Central Valley Project (CVP) contractors via temporary water service contracts. Friant Division and Cross Valley CVP long-term contractors have first priority in the offering and conveyance of the Section 215 water. Non-CVP contractors have a lower priority in the offering and conveyance of Section 215 water.

4.1.3 Reclaimed Water from Fresno-Clovis Regional Treatment Plant

Municipal wastewater from the Cities of Fresno and Clovis and industrial wastewater from some of the food processing plants in the Fresno Metropolitan Area at a rate of about 80,000 AF/year are treated at the Fresno-Clovis Regional Wastewater Treatment Facility. The treated wastewater from this plant is directed mostly to percolation ponds where it percolates down into the aquifer. There are several reclamation wells at this facility that pump out groundwater to control the mound underneath the ponds. The reclaimed water is pumped into FID canals. These canals transfer the reclaimed water downstream for agricultural use. About 5% to 10% of treated wastewater is directly used for agricultural land at and in the vicinity of the facility. It will be assumed that any potential water from the Fresno-Clovis Regional Wastewater Treatment Plant will not be a reliable source of recharge water for the purposes of this project, because FID is developing a strategic plan to optimize its existing recharge facilities to utilize the extra water from this plant.

4.1.4 Stormwater from City of Fresno

Management of stormwater collection and ponding is performed by cooperation between the Fresno Metropolitan Flood Control District (FMFCD), the Cities of Fresno and Clovis, and FID. A cooperative groundwater recharge program was developed among these partnering agencies to capture approximately 90% of urban runoff in stormwater basins for groundwater recharge. The stormwater basins are used by FID and the cities during the dry seasons as groundwater recharge basins. FMFCD and FID are currently developing a strategic plan to optimize the capture and recharge (in-lieu or direct) of stormwater. It will be assumed that any potential water from urban runoff will not be a reliable source of recharge water for the purposes of this project.

4.2. FREQUENCY ANALYSIS OF WATER SUPPLY SOURCES

4.2.1 FLOOD FLOWS FROM THE KINGS RIVER

Kings River flood flows are highly variable from year to year, as shown in Figure 4.1, which presents the daily flows at the James Bypass gaging station for the period of record. Table 4.1 shows the frequency, duration, and episodic nature of the flow events from 1964 to 2009. Also shown are the daily minimum, maximum, averages, and annul sum of the quantities of water within the combined Upper Districts' entitlements, which have been lost to the Upper Basin during these flood events. It is these quantities of water may be the sources of water for RCWD's recharge projects.

Daily analysis of flow and frequency of occurrence help to quantify diversion and recharge opportunities. Figure 4.2 shows a frequency analysis including the flows at the James Bypass. It shows that measured flows at the James Bypass occurred less than 15% of the time from 1964 to 2009. As shown in Figure 4.1, these flows typically occur at high rates over relatively short periods of time. Table 4.2 shows the frequency of measured flows at the James Bypass during flood events exceeds 50 cfs, 75cfs, 100, cfs, 150 cfs, 250 cfs, and 300 cfs, respectively. Either 150 cfs or greater amounts of water were lost through the James Bypass 92% of the time. This could provide more than enough water for all the proposed recharge ponds, except the RCWD site, when they are all recharging water at their estimated maximum rate. Either 300 cfs or greater amounts of water were lost through the James Bypass 89% of the time. This could provide for all the proposed recharge ponds plus 300 acres of additional ponds that can recharge one foot of water per day.

4.2.2 SECTION 215 WATER

Section 215 water is non-storable Millerton Lake water due to flood space requirements. It can be used by non-Friant contractors. It is usually declared as it flows into Millerton Lake during winter rain floods or spring snowmelt floods, and is often declared to quickly evacuate water stored in the flood control storage pool. Figure 4.3 shows the monthly deliveries of Section 215 water to various districts, cities and agencies from 1982 to 2006. Additional Section 215 water declaration and availability data could not be obtained.

Table 4.3 shows the comparison of the duration and timing of the flood events at the James Bypass and Section 215 water releases from water year 1983 to water year 2006. Although the long term average duration of the events is almost the same, occasionally the timing and duration of the events differs. As a result, Section 215 water can be used as a supplement to the flood flows from Kings River for recharge operations for CID and FID recharge ponds, and it can be the source of water for the RCWD recharge pond, which does not have any water rights from the Kings River. Also, Section 215 water can extend the duration of the water availability

for CID and FID recharge ponds, when it starts earlier or ends later than the Kings River flood flows.

Table 4.4 shows the frequency, duration, and amount of delivered water events from water year 1983 to water year 2006. There is no data available on how much more water was available on top of the amount of water delivered. The RCWD recharge pond would require around 2400 acre-feet of water per month if a maximum recharge rate of one foot per day is assumed. The average amount of water delivered as Section 215 water was around 27,000 acre-feet per month when it was available. This is almost 11 times more water than what is needed for the RCWD recharge pond. The average amount of water delivered as Section 215 water (27,000 acre-feet per month) is almost 1/12th of the average Kings River flood water measured at the James Bypass during the flood events. It would be safe to assume that there was more Section 215 water available during flood releases than what was delivered. As a result, it can be assumed that there should be at least enough Section 215 water available for use for the RCWD recharge pond.

4.3. PURCHASE AND DELIVERY COSTS

4.3.1 FLOOD FLOWS FROM THE KINGS RIVER

Kings River water is managed by the KRWA using a scheduled of water rights based on river water storage and flows. During flood events, river water is available to all of the KRWA member agencies. According to KRWA, every drop of water from the Kings River has a name associated with it, meaning all of the water is purchased and owned by the members of KRWA. The Kings River supplies the member agencies with low cost water. Landowners served by FID with Kings River water, on average, pay approximately $9 per acre-foot. During flood events, water has already been paid for by the member agencies' standard rates and they will not be charged for additional flood water delivered. In essence, this makes flood water very inexpensive, or free, if a member agency has the capacity to take additional water.

4.3.2 SECTION 215 WATER

Historically, Section 215 water was nearly free and generally used for early season irrigation or groundwater recharge. However, Reclamation started charging for Section 215 water in 1986, when legislation led to new operation and maintenance costs assessed to irrigators. This resulted in a fourfold increase in prices in 1989 (Moss 1998). However, the greatest impact on Friant water costs has been the passing of the Central Valley Project Improvement Act (CVPIA) in 1992. The CVPIA mandated a Friant Surcharge and a Restoration Fund Charge added to regular water assessments, which resulted in a $14 increase per acre-foot delivered for Class 1 (the first 800,000 acre-feet available water at Millerton Lake, which is considered the firm yield of the Friant project), Class 2 (the next 1,400,000 acre-feet, which is only declared when inflow

forecasts indicate that all Class 1 demands can be met), and Section 215 water. Section 215 flood water prices are currently on the order of Class 2 prices (Leu, 2001). But, Section 215 water prices can decrease to encourage the evacuation of flood water from Millerton Lake.

Table 4.5 summarizes the breakdown of the water rates for irrigation and M&I Section 215 water from 2004 to 2011, published by United States Bureau of Reclamation (USBR).

SECTION 5 SITE CHARACTERIZATION

The subsurface investigation focused on the upper portions of the aquifer, to identify potential low conductivity layers that could slow recharge or contribute to seepage problems on nearby properties. By focusing on performing Cone Penetrometer Tests (CPT) in the upper portions of the aquifer to approximately 100 feet, detailed data was obtained for the shallow subsurface while relying on data on deeper materials from boring logs available from DWR logs.

As per the recommendations of Technical Memorandum No. 1, the subsurface investigation was revised to make better use of existing boring log data and focus the site characterization efforts to the upper portions of the aquifer to identify potential low conductivity layers that could slow recharge or contribute to seepage problems on nearby properties. An analysis of boring logs from DWR and USGS showed that numerous boring logs are available in the area of the proposed basins to a depth of approximately 200 to 500 feet below ground surface. Boring logs such as these are typically more accurate at depth ranges near the anticipated or final screened interval and areas near the surface are often logged with less precision. By focusing CPT to maximum depth of 100 feet, more data were obtained for the shallow subsurface while extensive data on deeper materials were obtained from the well logs.

5.1 REGIONAL SETTING

Surficial geology in the area indicates the prevalence of quaternary age sand dunes for the three sites where field work was performed. The fourth site, FID Lower Dry Creek Pond, is in an area of quaternary older alluvium. Major features at depth in the region are the A-, C-, and E- Clays. The sites are located slightly to the northeast of the extent of the A-Clay and the C-Clay, regionally extensive clays at depths of approximately 100 ft below ground surface (bgs) and 200 ft bgs, respectively. The E-Clay (or Corcoran Clay) is present in the area. The E-Clay is typically at a depth of approximately 600 ft bgs. The depths of wells included in this study ranged from 185 to 555 feet deep, with an average depth of 315 feet. These depths suggest that the ability to recover recharged water would not be significantly impacted by the E-Clay.

5.2 CPT METHODS

Prior to the field work program, permits were obtained from Fresno County and utilities were cleared by a private utility surveyor and by Underground Services Alert.

CPT Testing was performed by Gregg Drilling under contract to WRIME. The CPTs were performed using an integrated electronic cone system (See Figure 5.1). The soundings were conducted using a 20 ton capacity cone with a tip area of 15 cm^2 and a friction sleeve area of 225 cm^2. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.80.

The cone takes measurements of cone bearing (q_c), sleeve friction (f_s) and penetration pore water pressure (u_2) at 5- cm intervals during penetration to provide a nearly continuous log. CPT data reduction and interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored electronically for further analysis and reference. All CPT soundings were performed in accordance with revised (2007) ASTM standards (D 5778-07).

The cone also contains a porous filter element located directly behind the cone tip (u_2). It consists of porous plastic and is 5.0mm thick. The filter element is used to obtain penetration pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT's) during appropriate pauses in penetration. Prior to penetration, the element is fully saturated with oil under vacuum pressure to ensure accurate and fast dissipation. The cone has the following accuracy: 1 tsf for q_c, 0.02 tsf for f_s and 0.5 psi for u_2.

When the soundings are complete, the test holes were grouted to the surface, per Fresno County regulations. The grouting procedures consisted of pushing a hollow tremie pipe with a "knock out" plug to the termination depth of the CPT hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

CPT operations generated no cuttings or liquid waste.

5.3 CPT AND BORING LOG LOCATIONS

The CPT field program and analysis of available boring logs occurred at three of the four proposed sites: RCWD Vacant Land, CID Marks Pond, and CID Goldie Pond. The FID Lower Dry Creek Pond was partially flooded at the time of field work and was removed from the field program. Additional CPT borings were performed at the remaining three locations. The locations of the CPT borings and available boring logs from DWR are shown in Figure 5.2, with additional detail provided in Figures 5.3, 5.4, and 5.5.

5.4 ANALYSIS OF BORING LOGS

Between four to six boring logs in the immediate area of each proposed location were obtained and reviewed to identify subsurface materials, focusing on the prevalence of coarse (sands) and fine (clays) grained materials and on the thickness and lateral extent of fine grained materials. Data was obtained from a USGS database which classified textural categories for specified depth intervals from available driller's logs. It should be noted that the locations of the borings are approximate given the limitation of the original data sources and to maintain confidentiality of the data source. Appendix A contains the complete details from the USGS database, but the actual boring logs are not provided due to confidentiality. The boring logs may be obtained from DWR by agencies if needed for specific and appropriate usage.

Figures 5.3, 5.4, and 5.5 were developed to show the location of the CPT and boring logs as well as to summarize the information collected.

5.5 ANALYSIS OF CPT LOGS

CPT logs are included in the figure with the Soil Behavior Type (SBT) and penetration pore pressure, measured behind the cone (u_2). Additional data not displayed due to space limitations on the figure are included in Appendix B.

The SBT is based on the work of Lunne et al. (1997) and utilizes data collected by the CPT to categorize subsurface materials into the types listed in Table 5.1.

Pore pressure can be used to assist in identification of soil type, adding to other data collected through the CPT (e.g., tip resistance and sleeve friction). In soft clay and silt the penetration pore pressures can be very large, whereas, in stiff heavily over-consolidated clays or dense silts and silty sands the penetration pore pressures can be small and sometimes negative relative to the equilibrium pore pressures. (Gregg Drilling, 2010)

A summary of the results from the three sites is provided in the following subsections.

RCWD VACANT LAND SITE

Data for the RCWD Vacant Land Site includes six new CPT locations and six existing boring logs. These data are summarized in Figure 5.3. The CPT results show details of the shallow subsurface (upper 100 feet). The shallow subsurface is characterized by primarily "sand & silty sand" (yellow) and "silty sand and sandy silt" (green). Few clays (blue) are present, but there are several intervals of over-consolidated or cemented materials (finer grained: light grey, coarser grained, dark gray). These over-consolidated materials could slow the downward migration of recharge water and could result in a perched aquifer and lateral movement of water. These materials are generally located in two depth ranges, the shallower range between 20 and 40 feet bgs and the deeper range between 85 and 100 feet bgs. There is variability across the site, with 2CPT4 (southwest corner) showing significantly less over-consolidated or cemented materials and 2CPT6 (southeast corner) showing significantly more. No correlation between the CPT logs and the boring logs could be discerned, although the logs show more fine grained materials than coarse grained materials.

CID GOLDIE POND SITE

Data for the CID Goldie Pond Site includes four new CPT locations and four existing boring logs. These data are summarized in Figure 5.4. The CPT results show details of the shallow subsurface (upper 100 feet). The shallow subsurface is characterized by primarily "sand & silty sand" (yellow) and "sand" (orange). Few clays (blue) are present, with one notable exception of clays at approximately 30 to 40 feet bgs. There are also several intervals of over-consolidated or

cemented materials (finer grained: light grey, coarser grained, dark gray). Along with the clays, these over-consolidated materials could slow the downward migration of recharge water and could result in a perched aquifer and lateral movement of water. These materials are generally located at depths below 30 feet bgs. There is variability across the site, with 3CPT4 (southwest corner) showing significantly more clays below 50 feet and the other locations showing more over-consolidated or cemented materials. No correlation between the CPT logs and the boring logs could be discerned, although the logs show similar amounts of coarse grained and fine grained materials.

CID MARKS POND SITE

Data for the CID Marks Pond Site includes five new CPT locations and four existing boring logs. These data are summarized in Figure 5.5. The CPT results show details of the shallow subsurface (upper 100 feet). The shallow subsurface is characterized by primarily "sand & silty sand" (yellow) and "sand" (orange). Few clays (blue) are present, but there are a few intervals of over-consolidated or cemented materials (finer grained: light grey, coarser grained, dark gray). These over-consolidated materials could slow the downward migration of recharge water and could result in a perched aquifer and lateral movement of water. These materials are generally located in one depth ranges: between 60 and 90 feet bgs. There is variability across the site, with 4CPT5 (southwest corner) showing significantly less over-consolidated or cemented materials and 2CPT1 (southeast corner) showing significantly more. No correlation between the CPT logs and the boring logs could be discerned, although the logs show more coarse grained materials than fine grained materials.

5.6 RECOMMENDATIONS BASED ON CPT RESULTS

Of the three ponds where CPT was performed, the CID Marks Pond Site appears best suited for recharge activities. Both the CPT results and the existing boring logs show coarser materials than present, on average, at the other sites. The RCWD Vacant Land Site contains generally finer grained materials and the Goldie Pond Site contains more extensive over-consolidated or cemented materials. It is recommended that efforts proceed with developing a recharge program for the CID Marks Pond Site, with additional work at the RCWD Vacant Land and Goldie Pond Site on hold until details on pilot testing or full scale recharge activities is available from the CID Marks Pond Site. If Marks Pond is successful, additional work may be warranted at the less suitable sites.

SECTION 6 OVERVIEW OF KINGS IGSM

The Kings Basin Integrated Groundwater and Surface water Model (Kings IGSM) was used to evaluate the impacts and prioritize project alternatives of the RCWD recharge project. The Kings IGSM is a regional integrated water resources model that covers the entire Kings Basin and incorporates forty one years of hydrogeologic conditions, land use, crop pattern, diversions of Kings River and major canals in the Kings Region to simulate the surface water and groundwater systems of Kings Basin.

6.1 MODEL AREA

The Kings IGSM, as shown in Figure 6.1, covers the Kings Groundwater Basin area plus the Mendota Pool area, Tranquility Irrigation District, and urban and agricultural areas in the foothills. The model area extends about 50 miles from west to east and about 35 miles from north to south. The model area includes the Fresno-Clovis metropolitan and other urban areas, two major rivers (Kings River and San Joaquin River), major canals, and several small creeks.

6.2 MODEL GRID AND SUBREGIONS

Water and land use management in the model area is represented in the Kings IGSM by subdividing the model area into 32 management areas called subregions (Figures 6.1 and 6.2). The subregions are used for independent analysis of water budgets and hydrologic conditions for each management area. Subregions represent urban areas sphere of influence, individual water districts, irrigation districts, or other organized and/or unorganized areas within the model. Figure 6.2 shows the Subregion 21 that represents the Raisin City Water District service area.

6.3 CALIBRATION PERIOD

The IGSM is a dynamic simulation model that simulates groundwater flow and stream flow for a continuous period of time. The time period of 1964-2004 was selected for calibration of Kings IGSM. This period contains an array of representative wet and dry periods and includes the operations of Pine Flat Reservoir under the final agreements. It also follows importation of Friant-Kern water to Kings Basin. Figure 6.3 shows the annual rainfall total at Hanford, California for the 1927-2004 hydrologic period. This figure indicates that the 77-year average annual rainfall (1927-2004) is 8.1 inches in the valley floor. The calibration period of 1964-2004 has an average annual rainfall of 8.4 inches.

6.4 EXISTING CONDITIONS BASELINE

The Kings IGSM model was used to evaluate the scenarios for the recharge project based on the 2005-Existing Conditions land and water use conditions. The model input files for the Existing Conditions (EC) Baseline were developed using the assumptions listed in Table 6.1. The results of the recharge scenarios were compared with those of EC Baseline Scenario.

The Kings IGSM model uses the hydrology and surface water deliveries that occurred during the calibration period, from 1964 to 2004, to represent future hydrological conditions. It is assumed that the hydrologic conditions observed over the past 40 years for Kings River and San Joaquin streamflows and diversions would occur over the next forty years. The 1964 to 2004 period contained both wet and dry periods and appropriate hydrologic variability to represent a range of conditions.

Simulated groundwater levels for EC Baseline Scenario under wet and average hydrologic conditions of 1983 and 2004 are shown in Figures 6.4 and 6.5, respectively. The contour maps show that the groundwater decline in RCWD area continues into the future. Long-term annual average water budget for RCWD subregion is shown in Figure 6.6. The annual average outflow from the RCWD subregion is by 201,400 acre-feet/year of groundwater pumping. The annual average inflow to the RCWD subregion is compensated by 143,300 acre-feet/year of subsurface inflow from the surrounding subregions and 44,600 acre-feet/year of deep percolation from rain and irrigation. Groundwater pumping is greater than inflow to subregion and groundwater storage is depleted by 13,500 acre-feet/year. Simulation of recharge scenarios, presented in the following sections, show how the groundwater levels and water budget components of RCWD subregion changes as a result of the recharge operations.

SECTION 7 RECHARGE RATES AND SCHEDULES

The availability of surface water for recharge at the potential recharge sites was assessed in Sections 3 and 4 for source, volume, and timing of surface water availability. The sources of surface water available for recharge at the proposed recharge ponds include the Kings River streamflows, Section 215 flood water releases from Millerton Lake to Friant-Kern Canal. The estimated daily recharge rates shown in Table 3.1 were used to estimate the monthly low and high recharge rates for each recharge site (Table 7.1). It is assumed that capacity of the existing and proposed conveyance facilities would be sufficient to convey water for the proposed monthly recharge rates.

Flood flows of Kings River will be recharged at the proposed recharge ponds within the Kings River Water Association (KRWA) service area located in FID and CID. The proposed site outside of the KRWA service area, RCWD, will receive flood flows under Reclamation's Section 215 water. The availability of these waters varies based on hydrologic conditions of San Joaquin and Kings rivers and their durations change from year to year as shown in Tables 4.1, 4.3, and 4.4. These tables were used to develop annual recharge quantities and schedules for recharge scenarios. Monthly recharge rates remain as those in Table 7.1; however, the number of months with active recharge ponds were estimated based on historical data shown in Tables 4.1, 4.3, and 4.4.

The annual recharge rates and schedules in Figures 7.1 and 7.2 were used to develop the recharge rates and schedules of the recharge scenarios. The simulated recharge rates at RCWD Pond are based on availability of Section 215 water from Friant-Kern Canal and the annual recharge rates for the forty one year simulation period are shown in Figure 7.1. This figure shows the annual low and high recharge rates for the years with Section 215 water.

The simulated recharge rates at Dry Creek Pond, Goldie Pond, and Marks Pond are based on availability of Kings River flood waters and the annual recharge rates for the forty one year simulation period are shown in Figure 7.2. This figure shows the annual low and high recharge rates for the years with Kings River flood water.

SECTION 8 PROJECT IMPACTS AND BENEFITS

8.1 RECHARGE SCENARIOS

Suitability of four sites in and around RCWD was evaluated in Section 2 for recharge at a regional scale. Based on the proposed recharge sites and the recharge schedule of Section 7, five scenarios were developed as follows:

- Scenario 1 – Recharge at RCWD Pond
- Scenario 2 – Recharge at FID Pond
- Scenario 3 – Recharge at Goldie Pond
- Scenario 4 –Recharge at Marks Pond
- Scenario 5 –Recharge at All Ponds

For each one of the above scenarios two sub-scenarios were developed for low and high recharge rates as follows:

- Scenario a - Low Recharge Rate
- Scenario b – High Recharge Rate

Thus, a total of 10 scenarios were developed to evaluate the impact of recharge operations at the four potential recharge sites. The first column of Table 8.1 lists all ten simulated recharge scenarios. Columns 2 to 6 of Table 8.1 present the average annual recharge rates for all scenarios. Average recharge rates for Dry Creek, Goldie, and Marks ponds are based on 17 years of Kings River flood years; while the average recharge rates of Scenarios 1a and 1b for RCWD pond are based on 12 years of Section 215 water years. Average recharge rates for Scenarios 5a and 5b is for a combination of Kings River flood years and Section 215 water years. As some of the Kings River flood years and Section 215 water years occur in the same year, there are a total of 22 years of flood years for Scenarios 5a and 5b. The impact of the simulated recharge scenarios are presented in Section 9.

The impacts of 10 recharge scenarios, 1a to 5b, were evaluated using the Kings IGSM Model and compared to the results of the EC Baseline Scenario. The following criteria were used to compare the impacts of the EC Baseline conditions to the project scenarios:

- Hydrographs of groundwater levels at the recharge sites,
- Contour maps of changes in groundwater levels at RCWD and the surrounding areas, and
- Change in groundwater storage in RCWD subregion.

Hydrographs and contour maps are presented in this section to show the project impacts and benefits. Changes in groundwater storage will be used in Section 9 to prioritize the scenarios and select the preferred recharge project.

8.2 RECHARGE AT RCWD POND

Impacts of recharging Section 215 water at low and high recharge rates (Scenarios 1a and 1b) at RCWD Recharge Pond are shown by groundwater hydrographs in Figure 8.1 and groundwater level change contour maps for year 21 in Figures 8.2 and 8.3.

The EC Baseline groundwater hydrographs, Figure 8.1, shows the comparison of groundwater levels at the RCWD recharge pond for Scenarios 1a and 1b, and Scenarios 5a and 5b. The lowest water levels are for EC Baseline, the two highest water levels are for Scenarios 1b and 5b (i.e. high recharge rates at the RCWD pond and all ponds, respectively), and the two middle water levels are for Scenarios 1a and 5a (i.e. low recharge rates at the RCWD pond and all ponds, respectively). Groundwater levels rise by approximately 25 feet in year 21 of Scenarios 1a and 5a when the highest recharge rates occur (see Figure 7.1). Groundwater levels rise by approximately 50 feet in year 21 of Scenarios 1b and 5b.

Maximum increases of groundwater levels in RCWD occur in year 21 of Scenarios 1a and 1b and are shown by contour maps in Figures 8.2 and 8.3, respectively. As shown in these figures, the impacted areas are mostly within RCWD service area and areas with 5 feet or more increase in groundwater levels are approximately 8,000 acres and 18,000 acres for Scenarios 1a and 1b, respectively.

Average annual groundwater recharge of Scenario 1a is 4,370 acre-feet/year, which results in approximately 3,300 acre-feet/year increase in groundwater storage in RCWD and approximately 1,100 acre-feet/year less groundwater subsurface flow from neighboring areas (Table 8.1). Similarly, recharge of approximately 9,300 acre-feet/year in Scenario 1b results in approximately 6,500 acre-feet/year of increase in groundwater storage in RCWD and approximately 2,800 acre-feet/year less groundwater subsurface flow from neighboring areas.

8.3 RECHARGE AT DRY CREEK POND

Impacts of recharging Kings River flood water at low and high recharge rates (Scenarios 2a and 2b) at Dry Creek recharge pond are shown by groundwater hydrographs in Figure 8.4 and groundwater level change contour maps for year 21 in Figures 8.5 and 8.6.

Hydrographs in Figure 8.4 show groundwater levels under the Dry Creek recharge pond under EC Baseline, Scenarios 2a and 2b, and Scenarios 5a and 5b. The lowest water levels are for EC Baseline, the two highest water levels are for Scenarios 2b and 5b (i.e. high recharge rates at Dry Creek pond and all ponds, respectively), and the two middle water levels are for Scenarios 2a and 5a (i.e. low recharge rates at the Dry Creek Pond and all ponds, respectively). Groundwater levels rise by approximately 20 feet in year 21 of Scenarios 2a and 5a when the highest recharge rates occur (see Figure 7.2). Groundwater levels rise by approximately 40 feet in year 21 of Scenarios 2b and 5b.

Maximum increases of groundwater levels at Dry Creek pond occur in year 21 of Scenarios 2a and 2b and are shown by contour maps of Figures 8.5 and 8.6, respectively. As shown in these figures, the impacted areas extend to RCWD and result in increased groundwater subsurface flow to RCWD.

Average annual groundwater recharge at Dry Creek pond in Scenario 2a is approximately 5,100 acre-feet/year, which results in approximately 1,300 acre-feet/year increase in groundwater storage in RCWD and approximately 1,300 acre-feet/year more groundwater subsurface flow from neighboring areas (Table 8.1). Similarly, recharge of approximately 10,200 acre-feet/year at Dry Creek pond in Scenario 2b results in approximately 2,600 acre-feet/year increase in groundwater storage in RCWD and approximately 2,600 acre-feet/year more groundwater subsurface flow from neighboring areas to RCWD.

8.4 RECHARGE AT GOLDIE POND

Impacts of recharging Kings River flood water at low and high recharge rates (Scenarios 3a and 3b) at Goldie recharge pond are shown by groundwater hydrographs in Figure 8.7 and groundwater level change contour maps for year 21 in Figures 8.8 and 8.9.

Hydrographs of Figure 8.7 show groundwater levels under the Goldie recharge pond under EC Baseline, Scenarios 3a and 3b, and Scenarios 5a and 5b. The lowest water levels are for EC Baseline, the two highest water levels are for Scenarios 3b and 5b (i.e. high recharge rates at Goldie pond and all ponds, respectively), and the two middle water levels are for Scenarios 3a and 5a (i.e. low recharge rates at the Goldie pond and all ponds, respectively). Groundwater levels rise by approximately 15 feet in year 21 of Scenarios 3a and 5a when the highest recharge rates occur (see Figure 7.2). Groundwater levels rise by approximately 30 feet in year 21 of Scenarios 3b and 5b.

Maximum increases of groundwater levels at Goldie pond occur in year 21 of Scenarios 3a and 3b and are shown by contour maps of Figures 8.8 and 8.9, respectively. As shown in these figures, the impacted areas extend to RCWD and result in increased groundwater subsurface flow to RCWD.

Average annual groundwater recharge at Goldie pond in Scenario 3a is approximately 5,100 acre-feet/year, which results in approximately 1,100 acre-feet/year increase in groundwater storage in RCWD and approximately 1,100 acre-feet/year more groundwater subsurface flow from neighboring areas (Table 8.1). Similarly, recharge of approximately 10,200 acre-feet/year at Goldie pond in Scenario 3b results in approximately 2,300 acre-feet/year increase in groundwater storage in RCWD and approximately 2,300 acre-feet/year more groundwater subsurface flow from neighboring areas to RCWD.

8.5 RECHARGE AT MARKS POND

Impacts of recharging Kings River flood water at low and high recharge rates (Scenarios 4a and 4b) at Marks recharge pond are shown by groundwater hydrographs of Figure 8.10 and groundwater level change contour maps for year 21 of Figures 8.11 and 8.12.

Hydrographs of Figure 8.10 show groundwater levels under the Marks recharge pond under EC Baseline, Scenarios 4a and 4b, and Scenarios 5a and 5b. The lowest water levels are for EC Baseline, the two highest water levels are for Scenarios 4b and 5b (i.e. high recharge rates at Marks pond and all ponds, respectively), and the two middle water levels are for Scenarios 4a and 5a (i.e. low recharge rates at the Marks pond and all ponds, respectively). Groundwater levels rise by approximately 20 feet in year 21 of Scenarios 4a and 5a when the highest recharge rates occur (see Figure 7.2). Groundwater levels rise by approximately 40 feet in year 21 of Scenarios 4b and 5b.

Maximum increases of groundwater levels at Marks pond occur in year 21 of Scenarios 4a and 4b and are shown by contour maps of Figures 8.11 and 8.12, respectively. As shown in these figures, the impacted areas extend to RCWD and result in increased groundwater subsurface flow to RCWD.

Average annual groundwater recharge at Marks pond in Scenario 4a is approximately 5,100 acre-feet/year, which results in approximately 1,200 acre-feet/year increase in groundwater storage in RCWD and approximately 1,200 acre-feet/year more groundwater subsurface flow from neighboring areas (Table 8.1). Similarly, recharge of approximately 10,200 acre-feet/year at Marks pond in Scenario 4b results in approximately 2,400 acre-feet/year increase in groundwater storage in RCWD and approximately 2,400 acre-feet/year more groundwater subsurface flow from neighboring areas to RCWD.

8.6 RECHARGE AT ALL PONDS

Impacts of recharging Section 215 water at RCWD recharge pond and Kings River flood water at all other recharge ponds at low and high recharge rates (Scenarios 5a and 5b) are shown by groundwater hydrographs of Figure 8.1, 8.4, 8.7, and 8.10 and groundwater level change contour maps for year 21 of Figures 8.13 and 8.14.

Maximum increases of groundwater levels at recharge ponds occur in year 21 of Scenarios 5a and 5b and are shown by contour maps of Figures 8.13 and 8.14, respectively. As shown in these figures, the impacted areas extend to most of RCWD service area and result in increased groundwater subsurface flow to RCWD.

Average annual groundwater recharge at all ponds in Scenario 5a is approximately 14,300 acre-feet/year, which results in approximately 3,900 acre-feet/year increase in groundwater storage in RCWD and approximately 1,300 acre-feet/year more groundwater subsurface flow from

neighboring areas (Table 8.1). Similarly, recharge of approximately 28,600 acre-feet/year Scenario 5b results in approximately 7,900 acre-feet/year increase in groundwater storage in RCWD and approximately 2,500 acre-feet/year more groundwater subsurface flow from neighboring areas to RCWD.

SECTION 9 PROJECT PRIORITIZATION AND PREFERRED PROJECT

The selection of the preferred project was determined by ranking the projects impact in reduction of the groundwater overdraft in RCWD. There were two primary factors in determining project impacts to the groundwater; the volume of surface water available to recharge at each site, and the resulting change in groundwater storage in RCWD. The projects were ranked in order of highest degree of impact under each project scenario. The second consideration in the prioritization process was to consider other factors such as water availability, soil investigation, construction costs, EIR and permitting requirements, right-of-ways and landowner participation. The budget constraints under this project did not allow for a comprehensive analysis of other factors, however, landowner participation, land accessibility and viability, and water costs were qualitatively discussed with prospective project participants and agencies.

A total of 10 recharge scenarios were developed to simulate recharge operations at four recharge ponds in RCWD, FID, and CID. Impacts of recharge operations under these scenarios were quantified in the previous sections. Table 8.1 presents a summary of the recharge scenarios and impact on groundwater storage in RCWD (column 8). The last column of Table 8.1 presents the percentage of recharged water that result in groundwater storage increase for RCWD. In Scenario 1a, recharge of 4,370 acre-feet/year of Section 215 water at RCWD recharge ponds results in 3,272 acre-feet/year of groundwater storage increase. In other words, 75% of every acre-foot of Section 215 water recharged at RCWD pond will results in groundwater storage increase. The remaining 25% of recharge water will result in reduced groundwater subsurface flow from adjacent areas. In contrast, recharge of 5,075 acre-feet/year of Kings River flood water at Dry Creek pond in Scenario 2a results in only 1,305 acre-feet/year of groundwater storage increase at RCWD. Only 25% of every acre-foot of Kings River flood water recharged at Dry Creek pond will result in groundwater storage increase at RCWD. The ranking in order of project impact to the groundwater storage in RCWD from greatest is: RCWD Pond (3,272 af), Dry Creek Pond (1,305 af), Marks Pond (1,167 af) and Goldie Pond (1,135 af).

Based on the results of field investigation (Section 5) CID ponds have higher coarse aquifer material and recharge capacity. However, based on the recharge scenarios (Section 8) and analysis of benefits to the aquifer at RCWD, recharging at RCWD pond has higher benefits to groundwater at RCWD and will result in increased groundwater elevations at RCWD. Recharging at RCWD pond would require new conveyance system and agreements between RCWD and CID or RCWD and FID for transfer of Section 215 water through CID or FID canals. Additionally, other recharge projects based on Scenarios 2, 3, and 4 could be developed by cooperation of RCWD and the participating agencies. Cumulatively, the potential benefit to cooperatively working to implement three projects with the participating agencies would be

greater than the one project at RCWD and a reduced cost and eliminating other factors previously described.

SECTION 10 SUMMARY

RCWD conducted this groundwater recharge feasibility study, which was funded by California Department of Water Resources through the Local Groundwater Assistance Grant (AB303) Program. The goal of the study was to identify the available land, water, and conveyance structures, determine methods to replenish the groundwater supply through recharge projects, and evaluate the impacts and benefits of the recharge operations on groundwater supply.

The study consisted of eight tasks ranging from data collection and analysis, field investigation, simulation of potential recharge projects, and project management. This report presented the details of technical work and field investigation conducted for the study.

Available recharge sites, flood water and conveyance systems for delivering water to the recharge sites are presented in Sections 2 to 4 of the report. Four sites (one at RCWD, one at FID and at the boundary with RCWD, two at CID at the boundary with RCWD) were identified for recharge operations. Kings River flood water and Section 215 flood water releases from Friant-Kern Canal are potentially available for recharge at the identified sites. Enhancements to some of CID canal are needed to deliver recharge water to CID ponds. Delivery of recharge water to the RCWD pond will require development of new canals and pipelines.

Site characterization was conducted by CPT tests for top 100 feet at RCWD and CID sites and analysis of well logs from DWR and USGS for lower parts of the aquifer at all sites. RCWD site generally contains finer grain materials while CID sites have coarser materials.

The Kings Basin Integrated Groundwater and Surface water Model (Kings IGSM) was used to evaluate the impacts of the recharge activities at the four proposed sites. A total of 10 scenarios were developed and simulated for evaluation of project impacts. This modeling effort showed that recharging at RCWD pond has higher benefits to groundwater at RCWD and will result in increased groundwater elevations at RCWD. However, the potential benefit to cooperatively working to implement three projects with participating agencies would be greater than the one project at RCWD.

SECTION 11 REFERENCES

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TABLES

Table 1.1 - Summary of Data Used in the Analysis

Purpose of Analysis	Database Description	Source	Spatial and/or Temporal Coverage
Land Suitability	Land Use	DWR	Kings County (2003) Fresno County (2000)
	Hydrologic Soils	NRCS	Fresno Central, Fresno West, and Kings,
	A Clay and E Clay	KRCD	2004
	Specific Yield	KRCD	2004
	Depth to Water	DWR	Spring 2003
Conveyance Capacity	FID facilities	FID	2005,2011
	CID facilities	CID	2003,2011
	FID Carrying Capacities of Ditches	FID	2005,2011
	CID Canal Capacities	KRCD and CID	2005, 2011
	Head Gate Diversions to CID and FID	KRWA	1964 - 2001
Water Availability	Kings River Flow	KRWA	1964 - 2011
	Stream flow rates at James Weir	KRWA, USGS	1964 - 2009
	San Joaquin River Flow at Millerton and Mendota	USGS	1907-2011 1939-2011
	Friant-Kern Canal Deliveries	KRWA, USGS	1964 - 2011
	Section 215 Deliveries	Friant Water Authority	1982 – 2006
	Section 215 Water Rate	US Bureau of Reclamation	2004-2011
	Wastewater effluent flow	Fresno Regional WWTP	1970-2011
Environmental Impacts Assessment	Environmental Impacts	California Natural Diversity Database	2011
	Groundwater Contamination	DWR	2011
	Land Subsidence	USGS, 2011	1961-2003

Table 2.1 - Ranking Factors and Quantification Methods

Factor	Quantification Method	Attribute	Ranking Index
Appropriate land uses	Land use is quantified by land use maps, preferring idle or annual crops to urban or habitat areas.	**Land Use** Idle / Existing Ponds Vacant Field Crop, Pasture Other Crops Urban, Semi Ag Riparian, Water, Native	 5 4 3 2 1 0
Surface and Subsurface Conditions	Soil permeability is quantified using soils data from USDA-NRCS soil surveys in combination with the presence of the a-clay and e-clay.	**Hydrologic Soil** Groups Type A Type B Type C Type D **A and E Clay** Neither Clay E Clay Both Clays	 5 * * 1.25 5 3.33 1.67
Available storage	Available storage is quantified by depth to water and specific yield maps	**Specific Yield** 17% - 19% 14% - 16 % 13% 10% - 12% 8% - 10 % **Depth to Water (ft)** >100 76 – 100 51-75 26-50 11 – 25 0 – 10	 5 4 3 2 1 5 4 3 2 1 0

* Hydrologic Soil Groups are ranked in a continuous range from 1.25 to 5 based on the relative percentage of A, B, C, and D soils in each mapped area.

Table 2.2 - Proposed Recharge Sites

Site	Owner	Location (Figure #)	Area (Acres)	Estimated/ Proposed Wetted Area (Acres)	Land Elevation (ft above MSL)
FID Lower Dry Creek Pond	FID	36°37'39.05"N , 120°01'32.44"W (Figure 10-a)	60	80	205
RSWD District Vacant Land	RSWD	36°36'22.70"N , 119°55'52.25"W (Figure 10-b)	64	80	230
CID Goldie Pond	CID	36°36'39.97" N , 119°51'4.26" W (Figure 10-c)	24	40	240
CID Marks Pond	CID	36°34'13.86"N , 119°51'7.26"W (Figure 10-d)	32	40	240

Table 2.3 - Site Conditions Related to Land Use, Soil Permeability, E-Clay, Depth to GW, and Relative Specific Capacity with Ranking Index in Parenthesis

Site	Land Use	Soil Permeability	E-Clay	Most Recent Measured Depth to GW (ft)	Relative Specific Capacity
FID Lower Dry Creek Pond	Idle & Existing Ponds (5)	Moderate to poor (2) *	Present (3.33)	135 (5)	Moderate to poor (2)
RSWD District Vacant Land	Other Crops (2)	High to Moderate (4)	Present (3.33)	181 (5)	Moderate (3)
CID Goldie Pond	Idle & Existing Ponds (5)	Poor (1.25) *	None (5)	87.6 (4)	Moderately high (4)
CID Marks Pond	Idle & Existing Ponds (5)	Poor (1.25) *	None (5)	129.9 (5)	Moderately high (4)

* Even though FID Lower Dry Creek Pond, CID Goldie Pond, and CID Marks Pond are existing ponds, their soil permeability shows low. Besides, they are surrounded by high permeability soil. The soil permeability of these sites should have been assigned wrong.

Table 3.1 - Estimated Recharge Volumes and Design Flows for Proposed Recharge Sites

Site	Proposed Ponded Area (Acres)	Estimated Min Recharge Rate *			Estimated Max Recharge Rate **		
		Recharge Rate (ft/day)	Recharge Volume (AF/day)	Design Flow (cfs)	Recharge Rate (ft/day)	Recharge Volume (AF/day)	Design Flow (cfs)
FID Lower Dry Creek Pond	80	0.5	40	20	1.0	80	40
RSWD District Vacant Land	80	0.5	40	20	1.0	80	40
CID Goldie Pond	40	1.0	40	20	2.0	80	40
CID Marks Pond	40	1.0	40	20	2.0	80	40
Total	240	N/A	160	80	N/A	320	160

***** These recharge rates are relatively conservative given the soil conditions and personal communications with local authorities who have operational experience around the project area.
** These recharge rates are relatively high given the soil conditions and personal communications with local authorities who have operational experience around the project area.

Table 3.2 - Canal Capacity for Major FID and CID Canals and Friant-Kern Canal

Canal Name	Capacity (cfs)
Friant-Kern Canal	5,000
Consolidated Canal	2,100
Fresno Canal	1,500
Gould Canal	500

Table 3.3 - Frequency Analysis of Available Canal Capacity for Major FID and CID Canals and Friant-Kern Canal from 1964 to 2011

Canal Name	Capacity (cfs)	% of Days When Available Canal Capacity was Greater Than				
		75 cfs	100 cfs	150 cfs	200 cfs	250 cfs
Friant-Kern Canal	5,000	100%	100%	100%	100%	99%
Fresno Canal + Gould Canal	2,000	98%	98%	97%	95%	94%
Consolidated Canal	2,100	100%	100%	100%	100%	99%

Table 3.4 - Canal Capacity for Tail-End Canals

Canal Name	District	Capacity (cfs)
Central Wasteway	FID	50
McMullin Grade	FID	50
Lower Dry Creek	FID	100
Wristen Ditch	CID	45-50
Dan Smith Ditch	CID	45-50

Table 4.1 - Annual Estimates of Available Water in Kings River Flood Events at James Bypass

Water Year	Flood Dates	Duration (days)	Min Daily Flow (cfs)	Max Daily Flow (cfs)	Ave Daily Flow (cfs)	Total Water Lost out of the Service Area (AF)
1964	-	-	-	-	-	-
1965	-	-	-	-	-	-
1966	-	-	-	-	-	-
1967	4/17 - 7/21	99	0	3,260	2,440	479,023
1968	12/7 - 12/18, 12/20 - 12/26	19	-	-	-	-
1969	1/27 - 8/4	190	732	5,570	4,067	1,532,353
1970	12/2 - 12/12, 12/19 - 1/5, 1/12-2/4	53	0	1,851	559	58,725
1971	-	-	-	-	-	-
1972	-	-	-	-	-	-
1973	6/9 - 6/12	4	-	-	-	-
1974	4/13 - 5/10, 5/16 - 6/18	62	0	2,181	670	82,431
1975	-	-	-	-	-	-
1976	-	-	-	-	-	-
1977	-	-	-	-	-	-
1978	3/7 - 6/30	116	50	4,407	2,359	542,557
1979	4/10 - 4/23, 5/18 - 6/2	30	0	984	169	10,034
1980	1/15 - 2/7, 2/18 - 7/7	165	0	4,830	1,744	570,543
1981	-	-	-	-	-	-
1982	4/6 - 6/21, 6/30-7/13	91	7	4874	2494	449965
1983	11/4 - 7/20, 8/10 -9/30	311	20	5,355	3,732	2,301,563
1984	10/1 - 2/2	125	4	4,296	2,287	566,793
1985	-	-	-	-	-	-
1986	2/21 - 6/12	112	88	4,975	2,948	654,739
1987	-	-	-	-	-	-
1988	-	-	-	-	-	-
1989	-	-	-	-	-	-
1990	-	-	-	-	-	-
1991	-	-	-	-	-	-
1992	-	-	-	-	-	-
1993	-	-	-	-	-	-
1994	-	-	-	-	-	-
1995	3/23 - 7/20	120	53	3,994	2,405	572,294
1996	3/14 - 3/28, 5/9 - 5/30	37	0	3,783	996	73,052
1997	1/6 - 3/17	71	249	4,849	3,013	424,231
1998	2/24 - 7/20	147	140	4,969	3,351	976,709
1999	11/23 - 12/16	24	73	620	370	17,605
2000	-	-	-	-	-	-

2001	-	-	-	-	-	-
2002	-	-	-	-	-	-
2003	-	-	-	-	-	-
2004	-	-	-	-	-	-
2005	5/19 - 6/13	25	50	2,550	1,262	60,637
2006	4/6 - 6/28	84	1,370	4,500	3,674	611,993
2007	-	-	-	-	-	-
2008	-	-	-	-	-	-
2009	-	-	-	-	-	-
Total		1,885	N/A	N/A	N/A	9,985,247
Average (Flood Years)		94	N/A	N/A	N/A	554,736
Average (1964 to 2009)		41	N/A	N/A	N/A	217,070
Min		4	N/A	N/A	N/A	10,034
Max		311	N/A	N/A	N/A	2,301,563

Table 4.2 - Frequency Analysis of Measured Flows at James Bypass during Flood Events from 1964 to 2009

	% of Days When Flow was Greater Than						
Flow	**50 cfs**	**75 cfs**	**100 cfs**	**150 cfs**	**200 cfs**	**250 cfs**	**300 cfs**
%	95%	93%	93%	92%	90%	89%	89%

Table 4.3 - Comparison of the Duration and Timing of the Flood Events at the James Bypass and Section 215 Water Releases from Water Year 1983 to Water Year 2006

Water Year	King River Flows at James River		Section 215 Water	
	Flood Dates	Duration (Days)	Delivery Dates	Duration (Months)
1983	11/4 - 7/20, 8/10 -9/30	311	11/1 - 10/30	11
1984	10/1 - 2/2	125	10/1 - 11/30	2
1985	-	-	-	-
1986	2/21 - 6/12	112	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	-	-	-
1993	-	-	-	-
1994	-	-	-	-
1995	3/23 - 7/20	120	-	-
1996	3/14 - 3/28, 5/9 - 5/30	37	-	-
1997	1/6 - 3/17	71	-	-
1998	2/24 - 7/20	147	2/1 - 3/31, 5/1 - 6/30	4
1999	11/23 - 12/16	24	11/1- 2/28	4
2000	-	-	3/1 -4/30	2
2001	-	-	-	-
2002	-	-	-	-
2003	-	-	6/1 - 6/30	1
2004	-	-		-
2005	5/19 - 6/13	25	3/1 - 7/31	5
2006	4/6 - 6/28	84	1/1 - 1/31, 3/1 - 7/31	6
Total	N/A	1056	N/A	35
Average (Flood Years)	N/A	106	N/A	4.4
Average (1983-2006)	N/A	44	N/A	1.5

Table 4.4 - Annual Section 215 Deliveries

Water Year	Delivery Dates	Duration (Months)	Min Monthly Delivery (AF)	Max Monthly Delivery (AF)	Ave Monthly Delivery (AF)	Total Annual Delivery (AF)
1983	11/1 - 10/30	11	117	9,699	2,761	30,370
1984	10/1 - 11/30	2	103	162	133	265
1985	-	-				
1986	-	-				
1987	-	-				
1988	-	-				
1989	-	-				
1990	-	-				
1991	-	-				
1992	-	-				
1993	-	-				
1994	-	-				
1995	-	-				
1996	-	-				
1997	-	-				
1998	2/1 - 3/31, 5/1 - 6/30	4	28	115,756	29,703	148,515
1999	11/1- 2/28	4	7,118	173,889	57,992	231,969
2000	3/1 -4/30	2	4,128	14,586	9,357	18,714
2001	-	-				
2002	-	-				
2003	6/1 - 6/30	1	20,998	20,998	20,998	20,998
2004		-				
2005	3/1 - 7/31	5	11,391	170,912	80,230	401,148
2006	1/1 - 1/31, 3/1 - 7/31	6	2,372	40,792	16,545	99,269
Total		35.0	N/A	N/A	N/A	951,248
Average (Flood Years)		4.4	N/A	N/A	N/A	118,906
Average (1983 to 2006)		1.5	N/A	N/A	N/A	39,635
Min		1.0	N/A	N/A	N/A	265
Max		11.0	N/A	N/A	N/A	401,148

Table 4.5 - Central Valley Project Section 215 Irrigation and M&I Spill Water Rates ($/AF)

Year	Water Marketing				Conveyance				Friant Surcharge		Restoration Fund		Trinity PUD Assesment		Total	
	Capital		O&M		Capital		O&M									
	Irrig.	M&I	Irrig.	M&I	Irrigation	M&I	Irrig *	M&I	Irrig.	M&I	Irrig.	M&I	Irrig.	M&I	Irrig.	M&I
2004	-	-	7.59	5.01	5.80	17.05	-	5.32	7.00	7.00	7.82	15.64	-	-	28.21	50.02
2005	-	-	6.61	3.89	5.60	10.10	-	5.16	7.00	7.00	7.93	15.87	-	-	27.14	42.02
2006	-	-	6.09	4.36	5.32	6.10	-	14.17	7.00	7.00	8.24	16.49	-	-	26.65	48.12
2007	-	-	6.86	5.76	5.33	6.51	-	7.19	7.00	7.00	8.58	17.15	-	-	27.77	43.61
2008	-	-	6.53	4.22	5.32	6.76	-	7.74	7.00	7.00	8.79	17.57	-	-	27.64	43.29
2009	-	-	5.99	3.48	5.50	6.67	-	19.96	7.00	7.00	9.06	18.12	-	-	27.55	55.23
2010	-	-	6.01	3.20	6.12	6.46	-	12.21	7.00	7.00	9.11	18.23	0.11	0.11	28.35	47.21
2011	-	-	6.53	3.79	5.31	5.63	-	15.16	7.00	7.00	9.29	18.59	0.05	0.05	28.18	50.22

Table 5.1 - Soil Behavior Types and Estimated Permeability

SBT Zone No.	SBT Zone	Estimated Permeability (ft/sec)
1	sensitive fine grained	3x10-8
2	organic soil	3x10-7
3	clay	1x10-9
4	clay & silty clay	3x10-8
5	clay & silty clay	3x10-8
6	sandy silt & clayey silt	3x10-6
7	silty sand & sandy silt	3x10-6
8	sand & silty sand	3x10-4
9	sand	3x10-2
10	sand	3x10-2
11	very dense/stiff soil*	3x10-6
12	very dense/stiff soil*	1x10-8

*heavily overconsolidated and/or cemented

Table 6.1 - Model Assumptions for Existing Conditions (EC) Baseline

No.	Data Type	Assumptions
1	Land Use	2005 Land Use by West Yost.
2	Agricultural Water Demand	Based on 2004 Land Use and Crop Acreage and subject to 1964-2004 hydrology.
3	Crop Acreage	2004 Crop Acreage
4	Urban Water Demand	2005 Urban Demand Estimate by West Yost
5	Recharge @ Leaky Ares	Use historical recharge rates for 1973-2004. For 1964-2004 use 1973-2004 recharge rates based on San Joaquin Hydrology Index
4	Recharge @ FMFCD Ponds	For 1994-2004 use historical recharge rates. For 1964-1993 use 1994-2004 recharge rates based on San Joaquin Hydrology Index. Use ponds that are active in 2004. Use 2000-2004 average recharge ratios for distribution of total recharge to individual ponds.
5	Recharge @ creeks and streams	Use 2004 conditions
6	Surface Water Treatment Plant	Use full capacity rates (32.5 TAF/yr) with no flow in November for maintenance)
7	Wastewater Treatment Plant Total Flows	78,400 AF
8	San Joaquin Settlement Flow Assumptions	No
9	Municipal Wells Pumping	Use wells that are active in 2005. Use 2005 pumping rates minus surface water plant's 2005 flows. Proportionally reduce pumping rate of each well.
10	Surface Water Deliveries – Kings River	Use historical deliveries and diversions. Adjust for SWTP flows.
11	Surface Water Deliveries – Friant-Kern	West Yost estimates of deliveries to FID and Fresno (60 TAF/yr, 17.9 TAF/yr for critically dry years). Adjust for SWTP
12	Land Use, Demand, Supply for Backman, Pinedale, and CSUF areas	Use 2004 conditions.
13	Initial Conditions	Use end of Sep 2004 values for groundwater levels, soil moisture, unsaturated soil moisture, and small watershed

Table 7.1 - Daily and Monthly Recharge Rates

Recharge Site	Pond Area (acres)	Low Recharge Rate Scenario		High Recharge Rate Scenario	
		Recharge Rate (ft/day)	Average Recharge Volume (Flood Years, AF/month)	Recharge Rate (ft/day)	Average Recharge Volume (Flood Years, AF/month)
Dry Creek Pond	80	0.5	1,215	1.0	2,430
RCWD Pond	80	0.5	1,220	1.0	2,440
Goldie Pond	40	1.0	1,215	2.0	2,430
Marks Pond	40	1.0	1,215	2.0	2,430
Total	240	N/A	4,865	N/A	9,730

Table 8.1 Average Annual Recharge Rates and Impact on Groundwater Storage for Flood Years

Scenario	Average Annual GW Recharge (Flood Years, AF/year)					Average Annual Changes in Water Budget Components with respect to Baseline (Flood Years, AF/year)			Impact of Recharge Operation on Groundwater Storage in RCWD (RCWD Storage Change/Total Recharge) (%)
						RCWD		Outside RCWD	
	Dry Creek Pond	RCWD Pond	Goldie Pond	Marks Pond	Total	Change in Underflow to RCWD	Change in Storage	Change in Storage and Other Water Budget Components	
1a - RCWD Pond - Low Recharge	-	4,370	-	-	4,370	-1,098	3,272	1,098	**75%**
1b - RCWD Pond - High Recharge	-	9,333	-	-	9,333	-2,792	6,542	2,792	**70%**
2a - Dry Creek Pond - Low Rehcarge	5,075	-	-	-	5,075	1,305	1,305	3,770	**26%**
2b - Dry Creek Pond - High Recharge	10,151	-	-	-	10,151	2,611	2,611	7,540	**26%**
3a - Goldie Pond - Low Recharge	-	-	5,075	-	5,075	1,135	1,135	3,940	**22%**
3b - Goldie Pond - High Recharge	-	-	10,151	-	10,151	2,261	2,261	7,890	**22%**
4a - Marks Pond - Low Recharge	-	-	-	5,075	5,075	1,167	1,167	3,908	**23%**
4b - Marks Pond - High Recharge	-	-	-	10,151	10,151	2,373	2,373	7,778	**23%**
5a - All Ponds - Low Rehcarge	3,922	2,545	3,922	3,922	14,311	1,279	3,938	10,373	**28%**
5b - All Ponds - High Recharge	7,844	5,090	7,844	7,844	28,622	2,535	7,855	20,767	**27%**

FIGURES

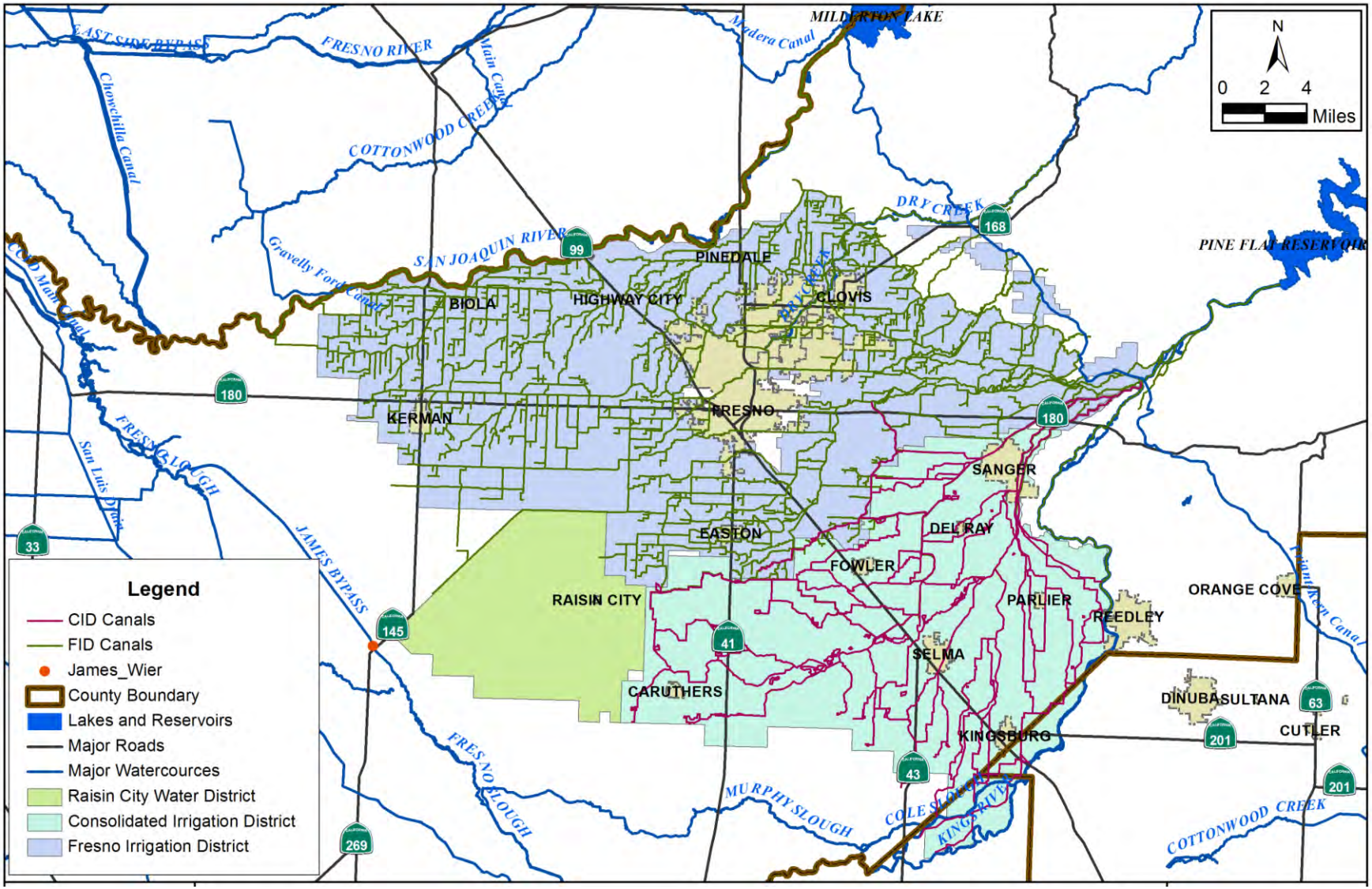


Figure 1.1 – Raisin City Water District

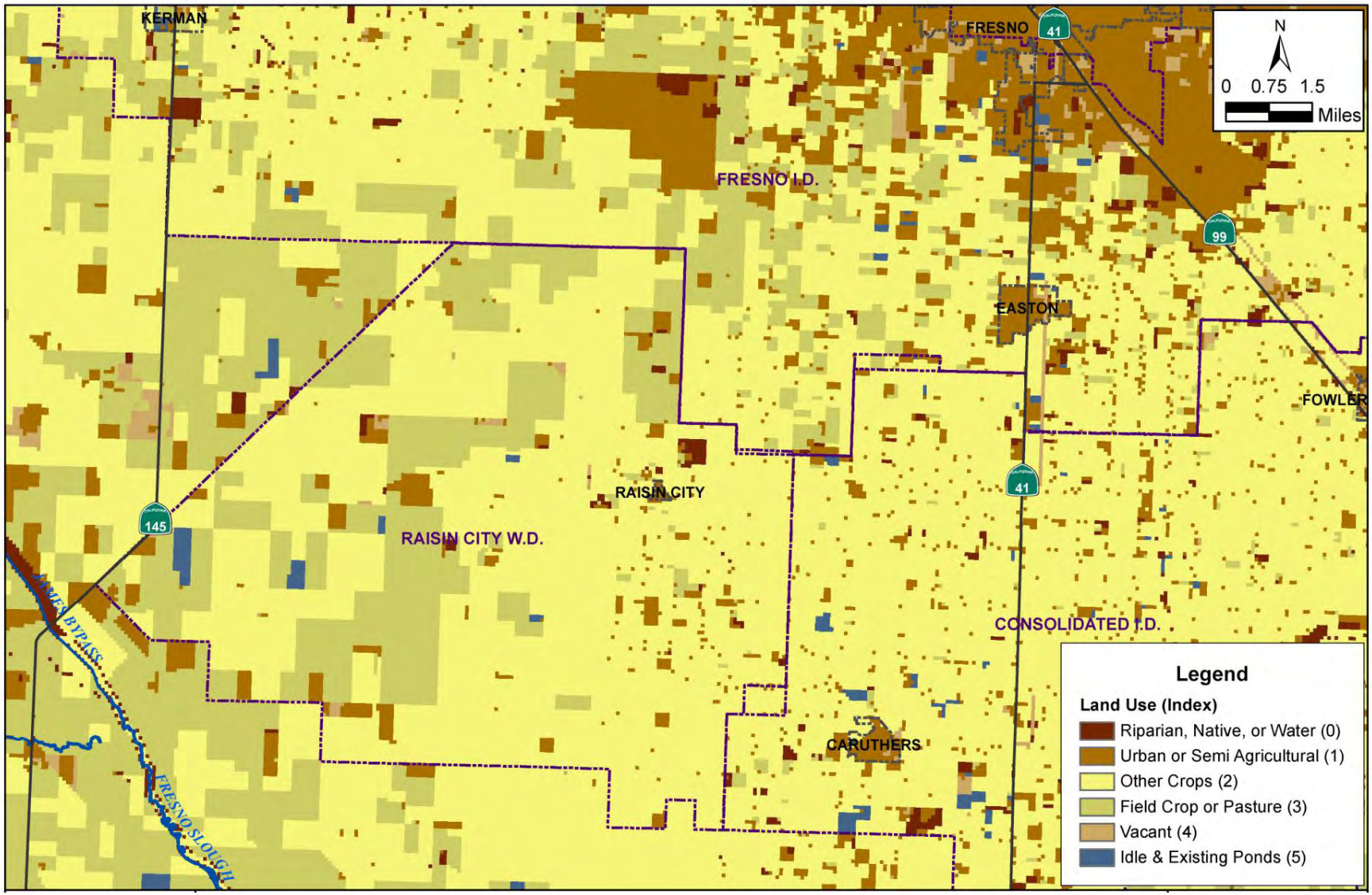


Figure 2.1 – Ranking Index for Land Use

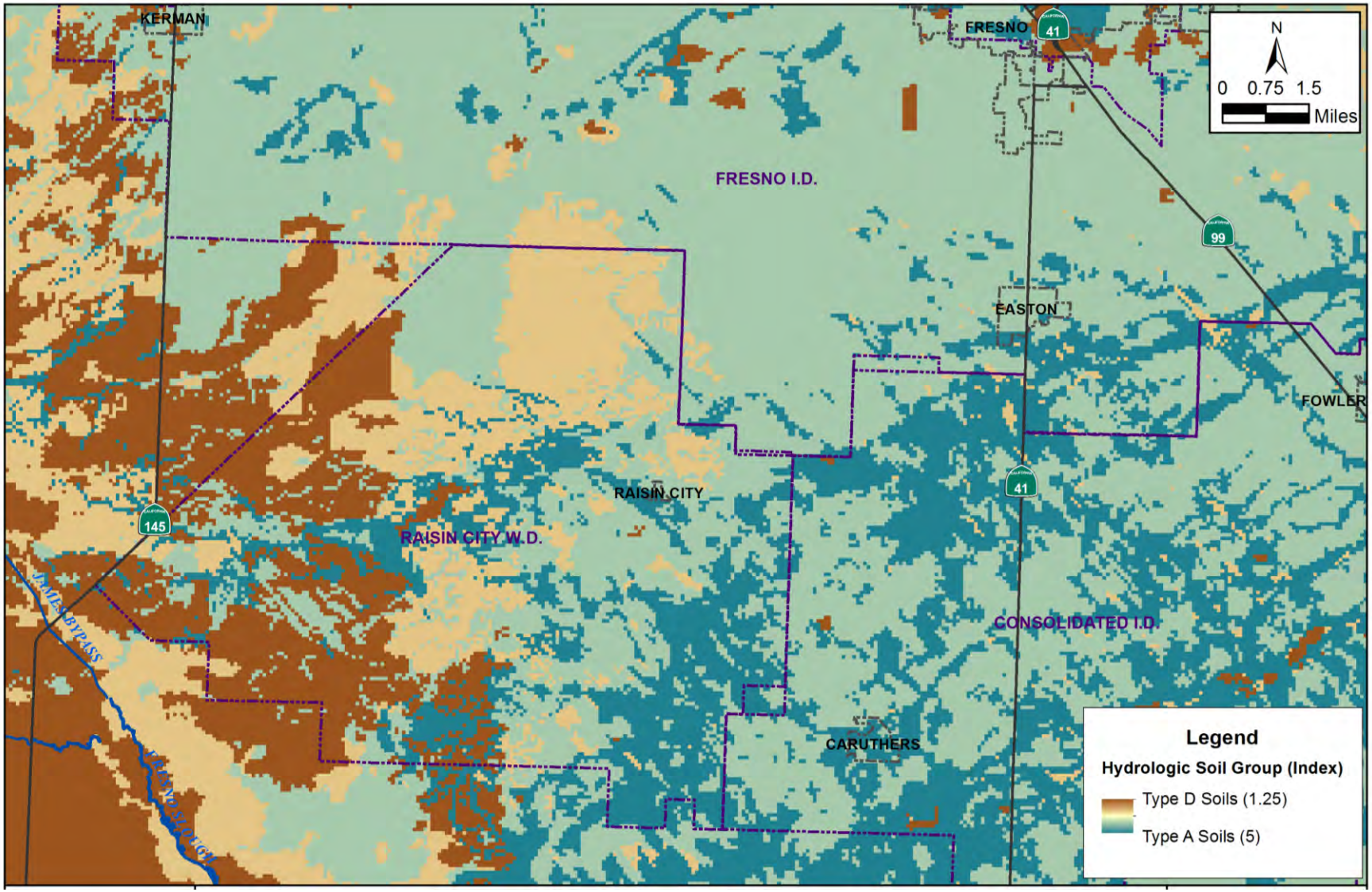


Figure 2.2 – Ranking Index for Hydrologic Soil Groups

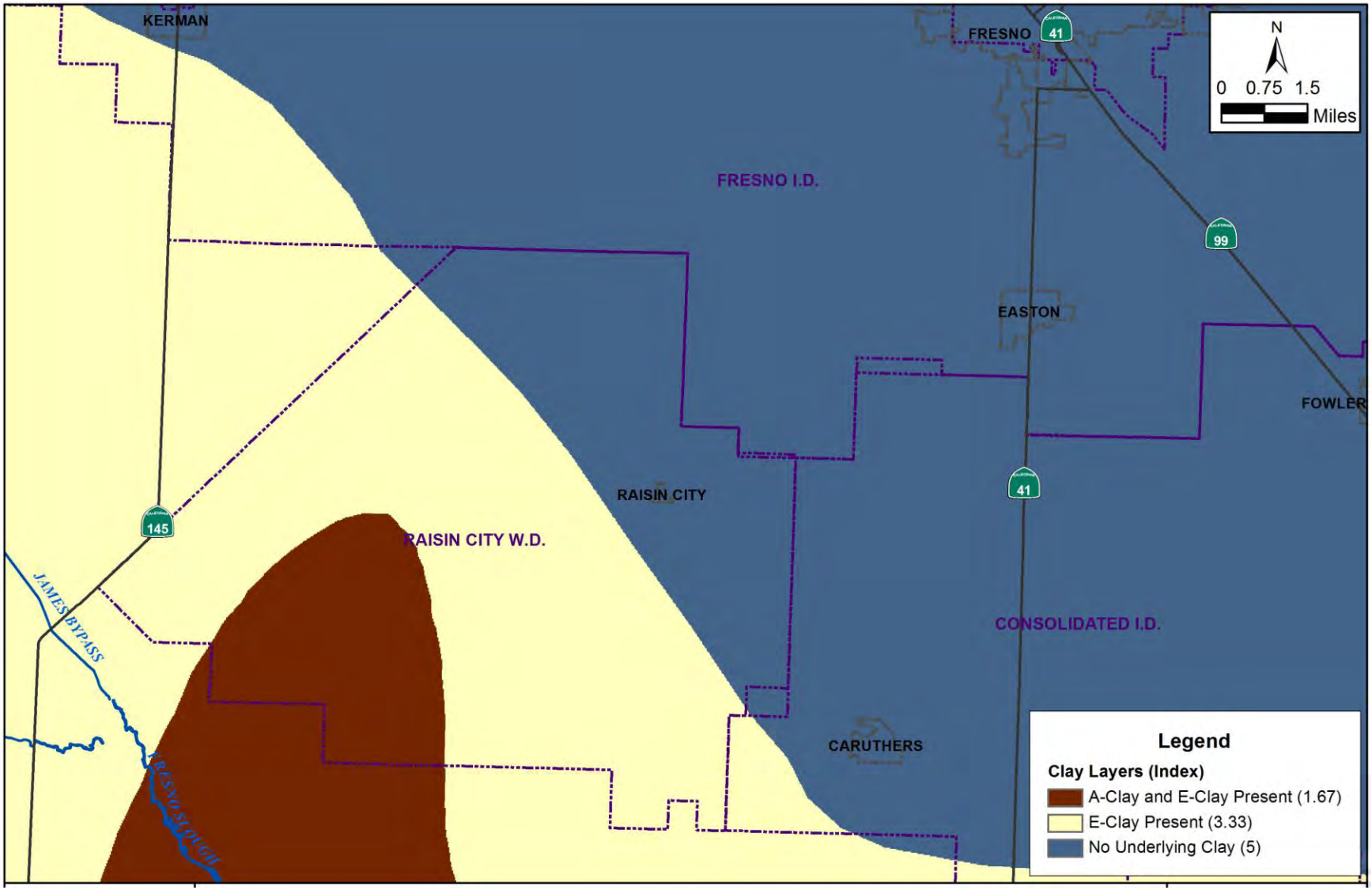


Figure 2.3 – Ranking Index for Presence of A & E Clays

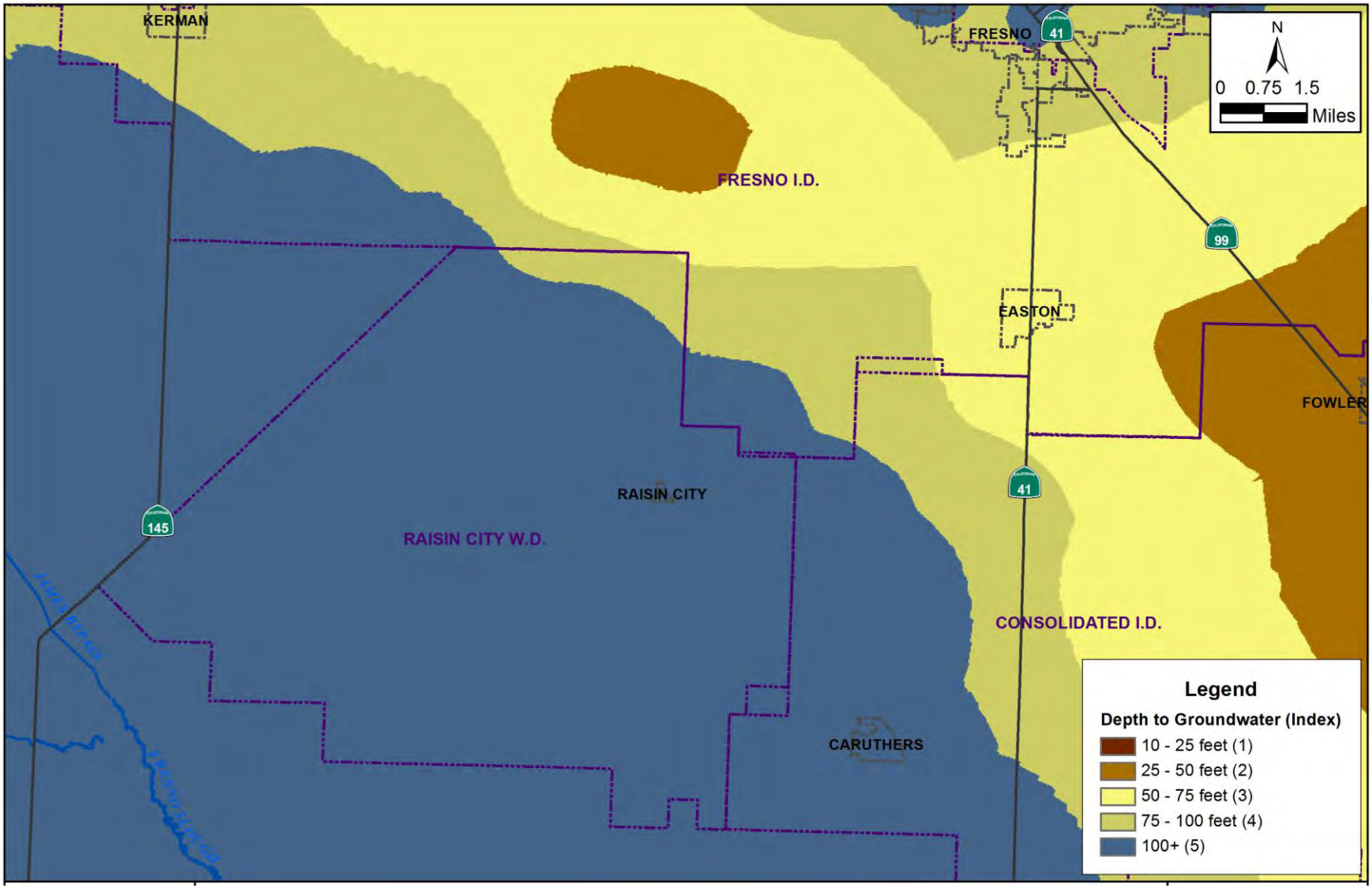


Figure 2.4 – Ranking Index for Depth to Groundwater, Spring 2003

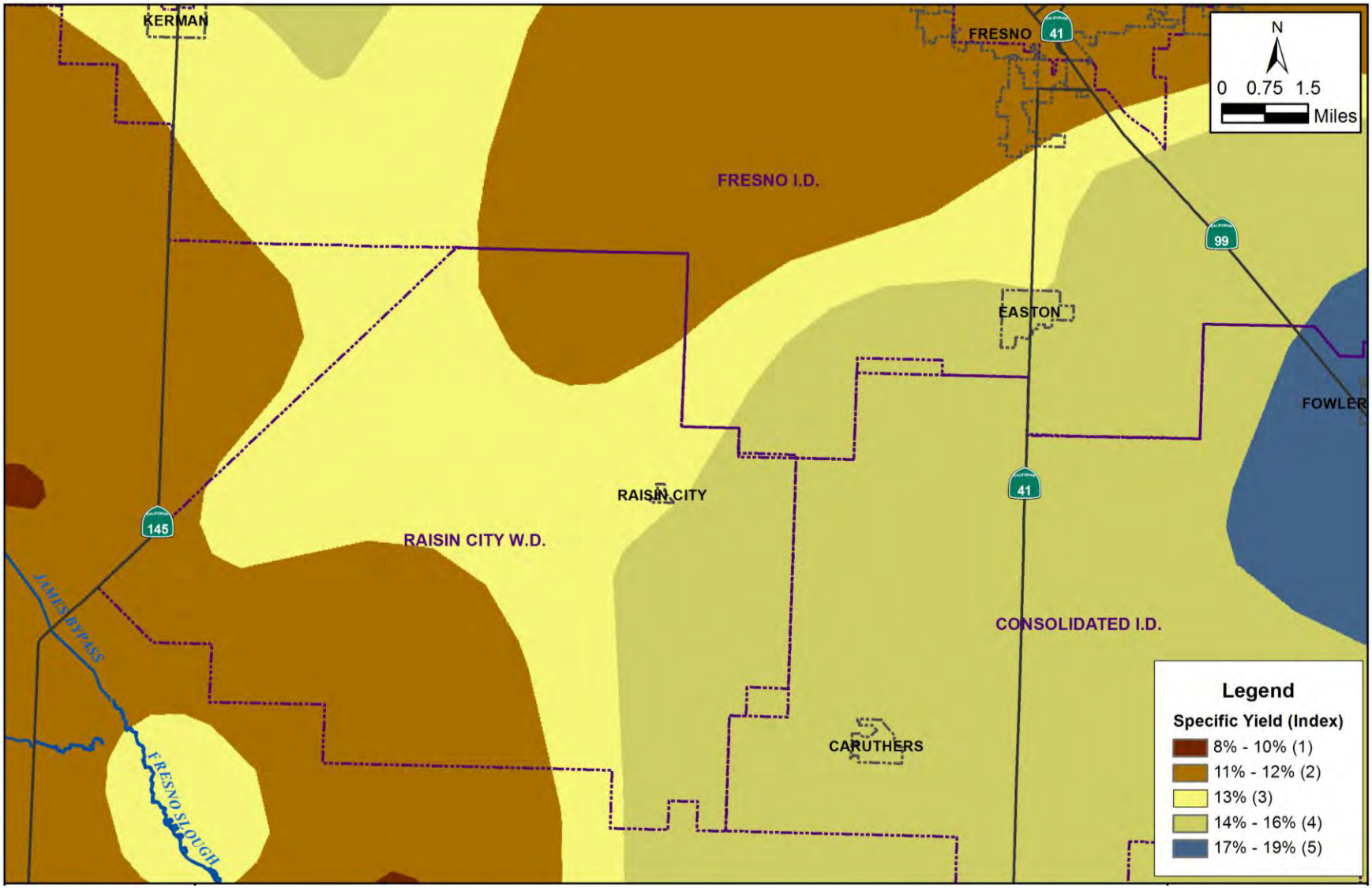


Figure 2.5 – Ranking Index for Specific Yield

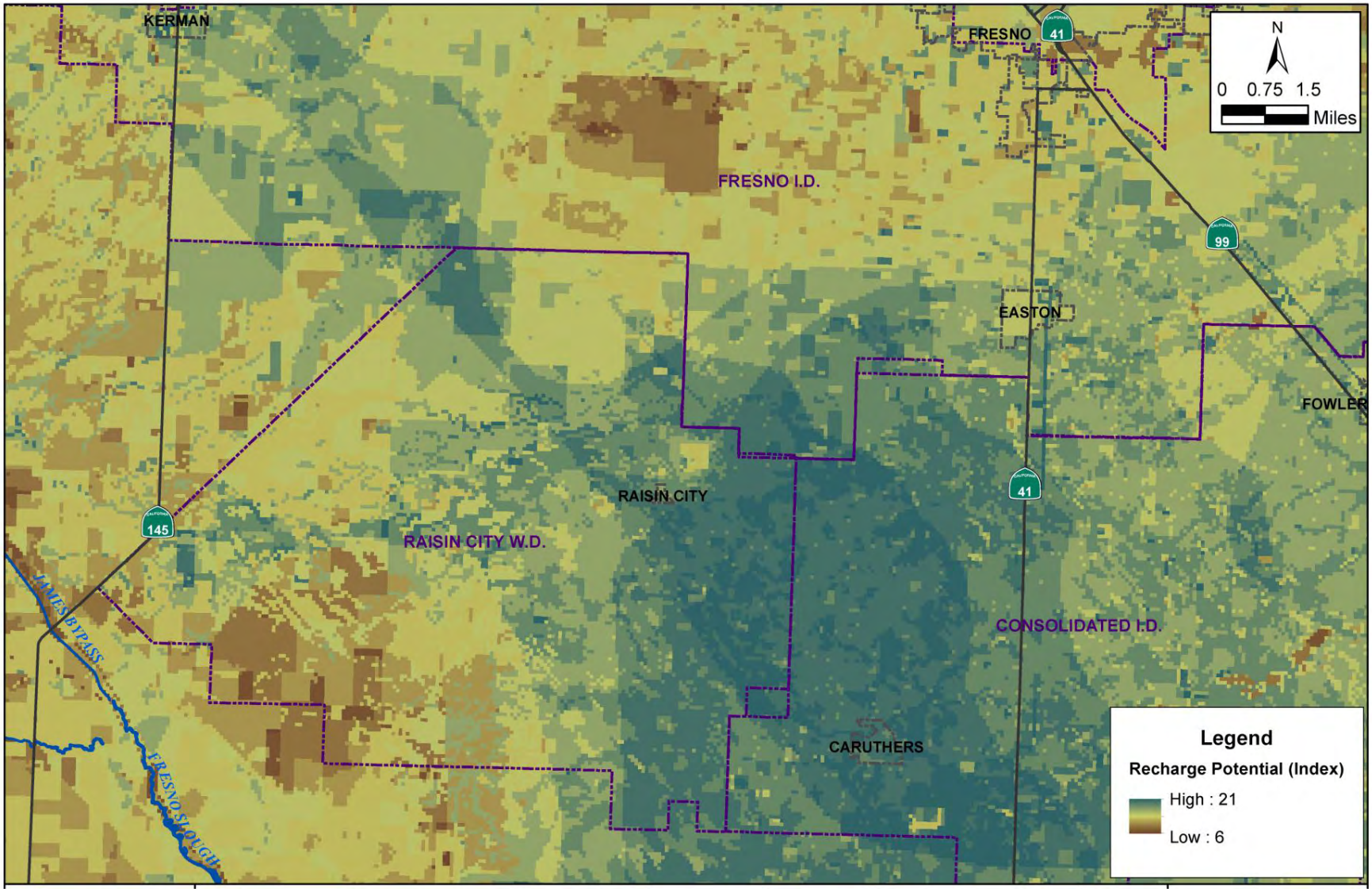


Figure 2.6 – Recharge Potential Index

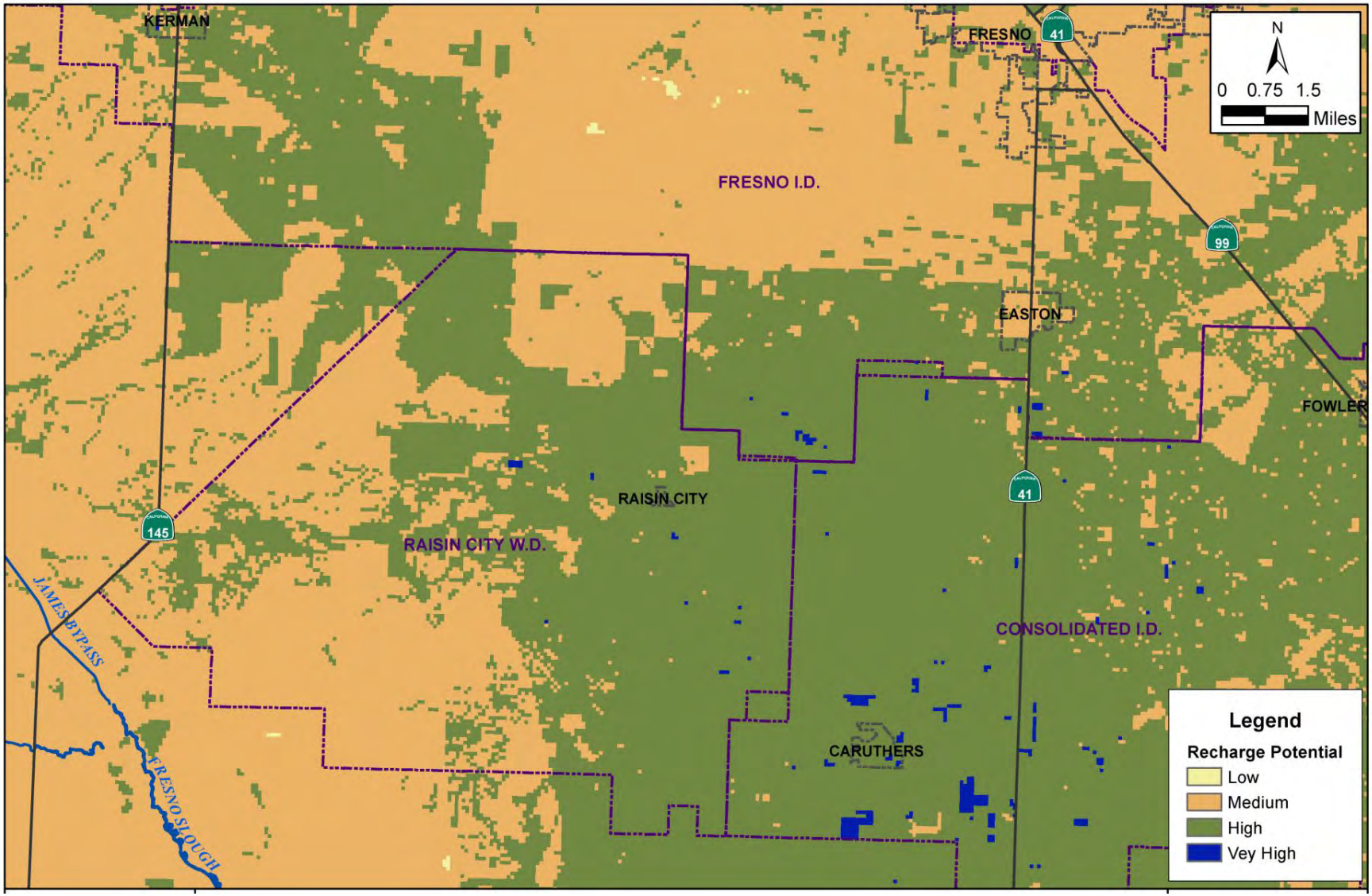


Figure 2.7 – Recharge Potential

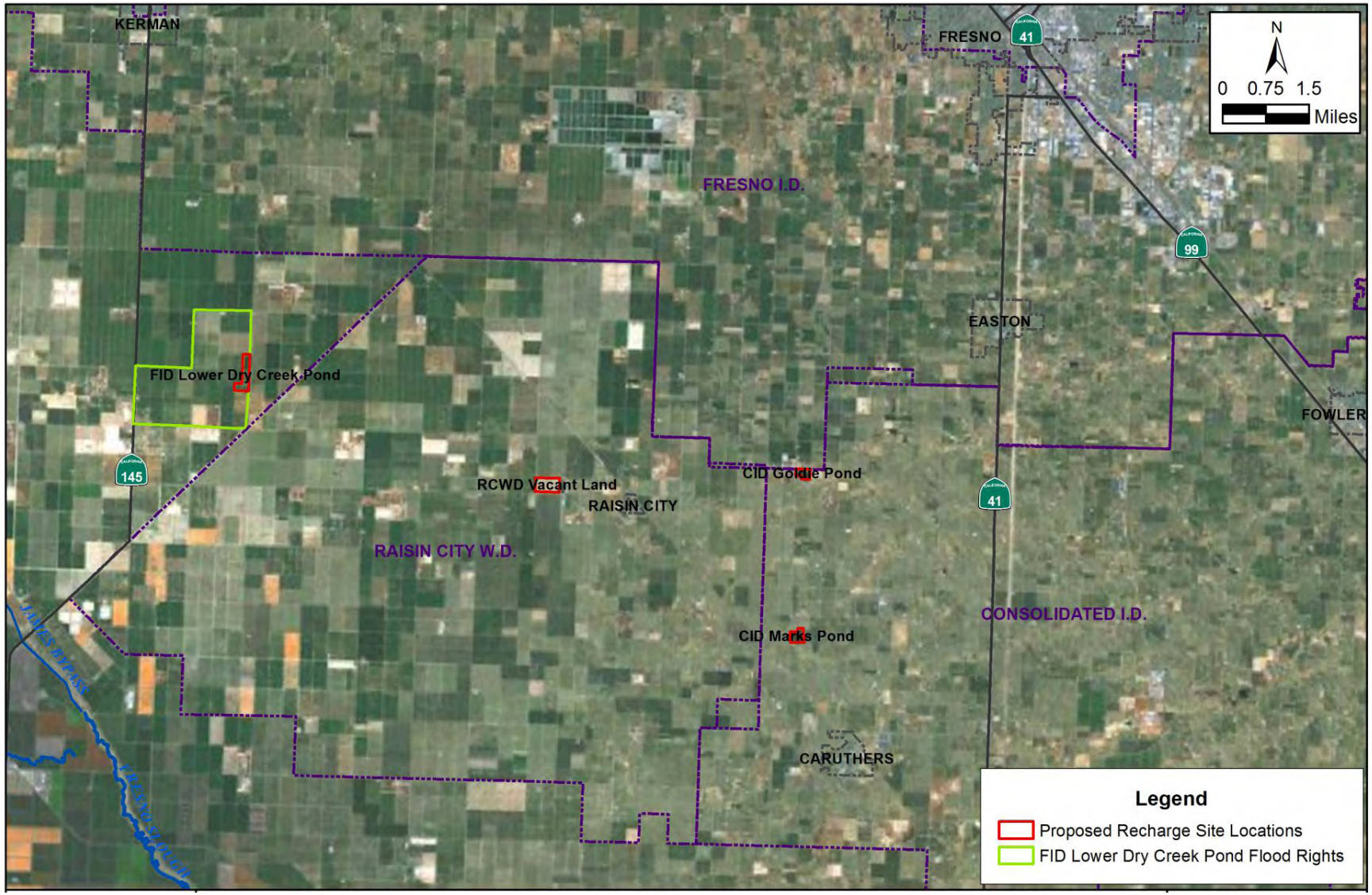


Figure 2.8 – Proposed Recharge Site Locations

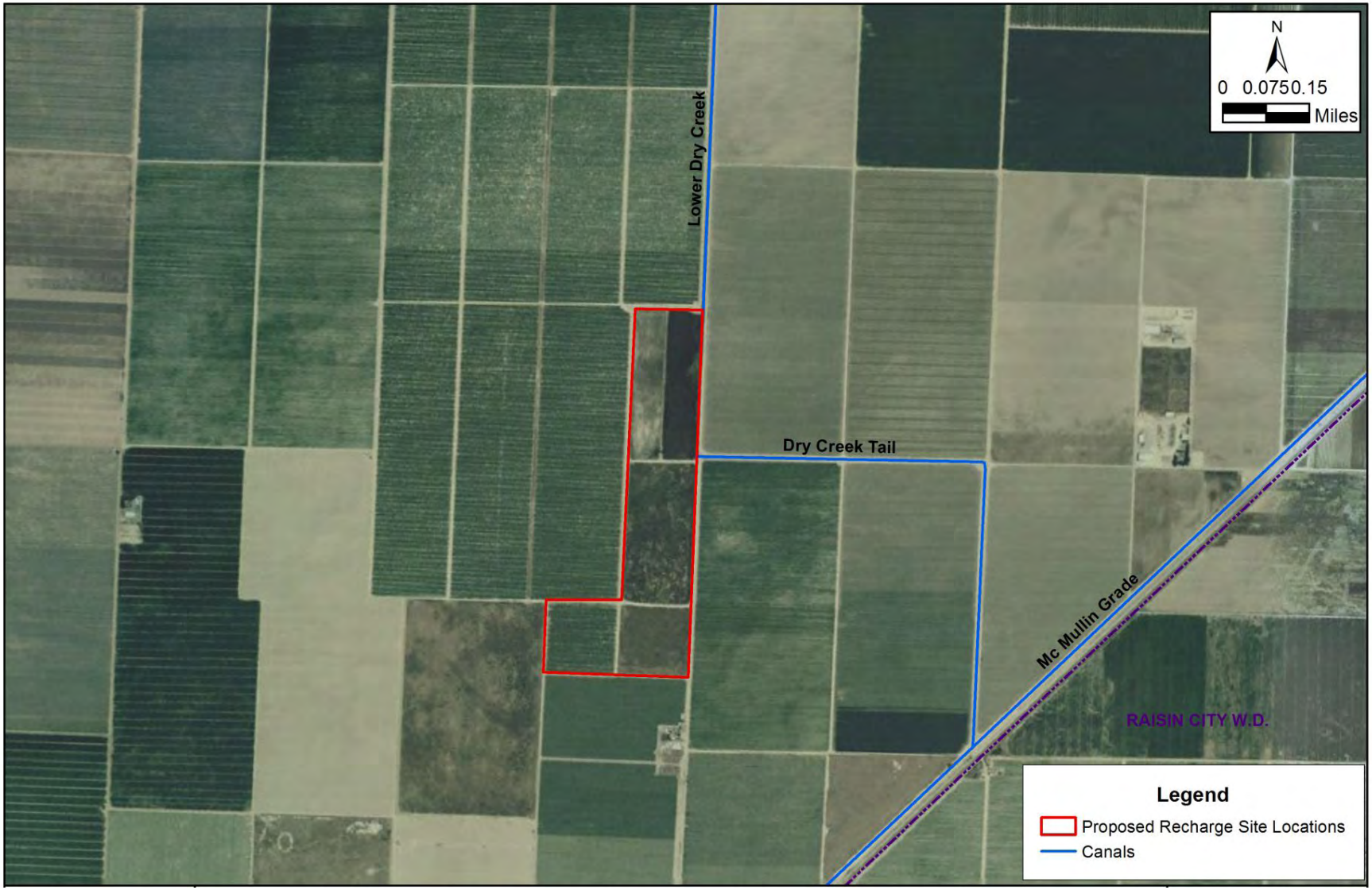


Figure 2.9.a – FID Lower Dry Creek Pond

Figure 2.9.b – RCWD Vacant Land Site

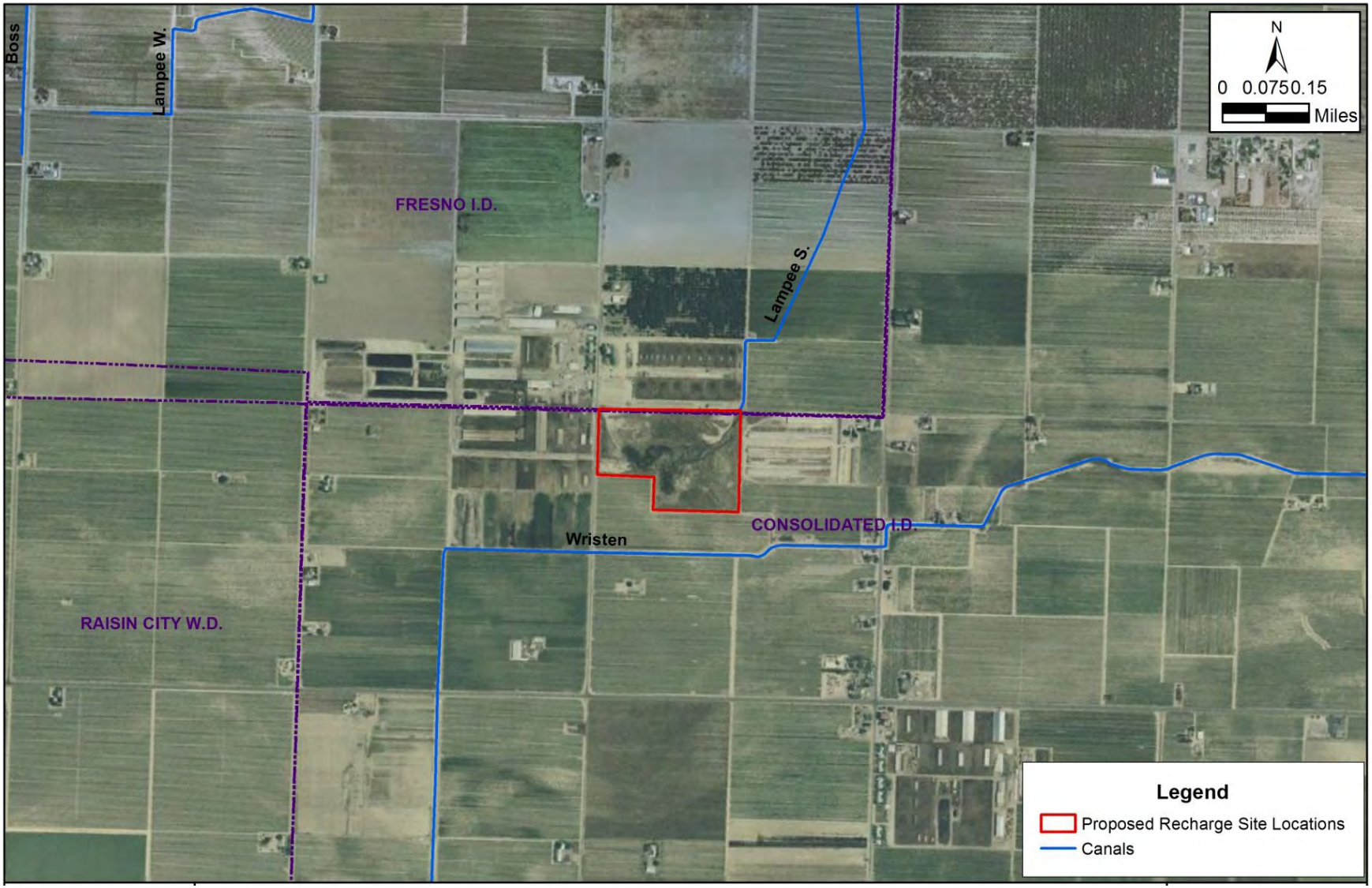


Figure 2.9.c – CID Goldie Pond

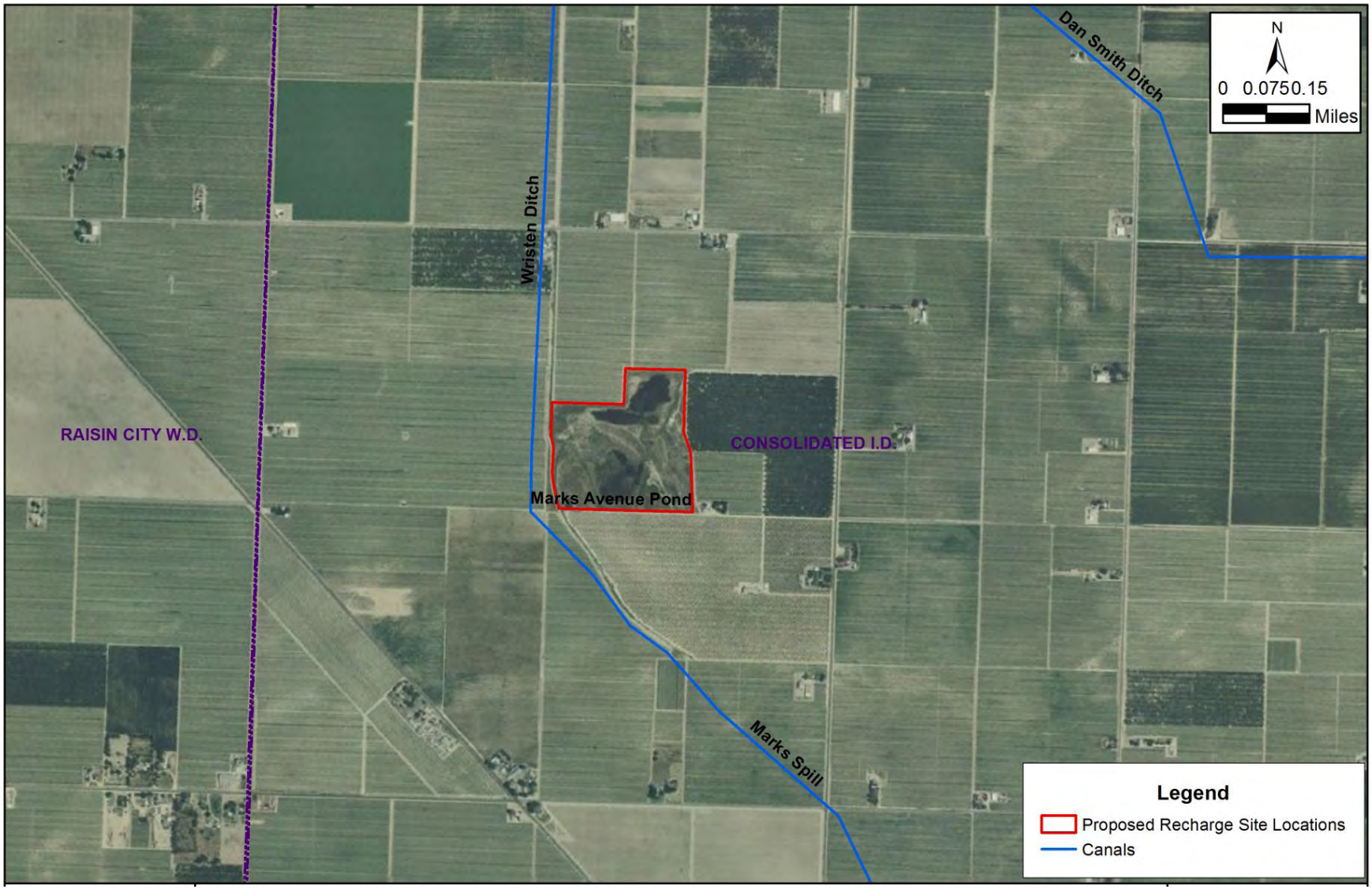


Figure 2.9.d – CID Marks Pond

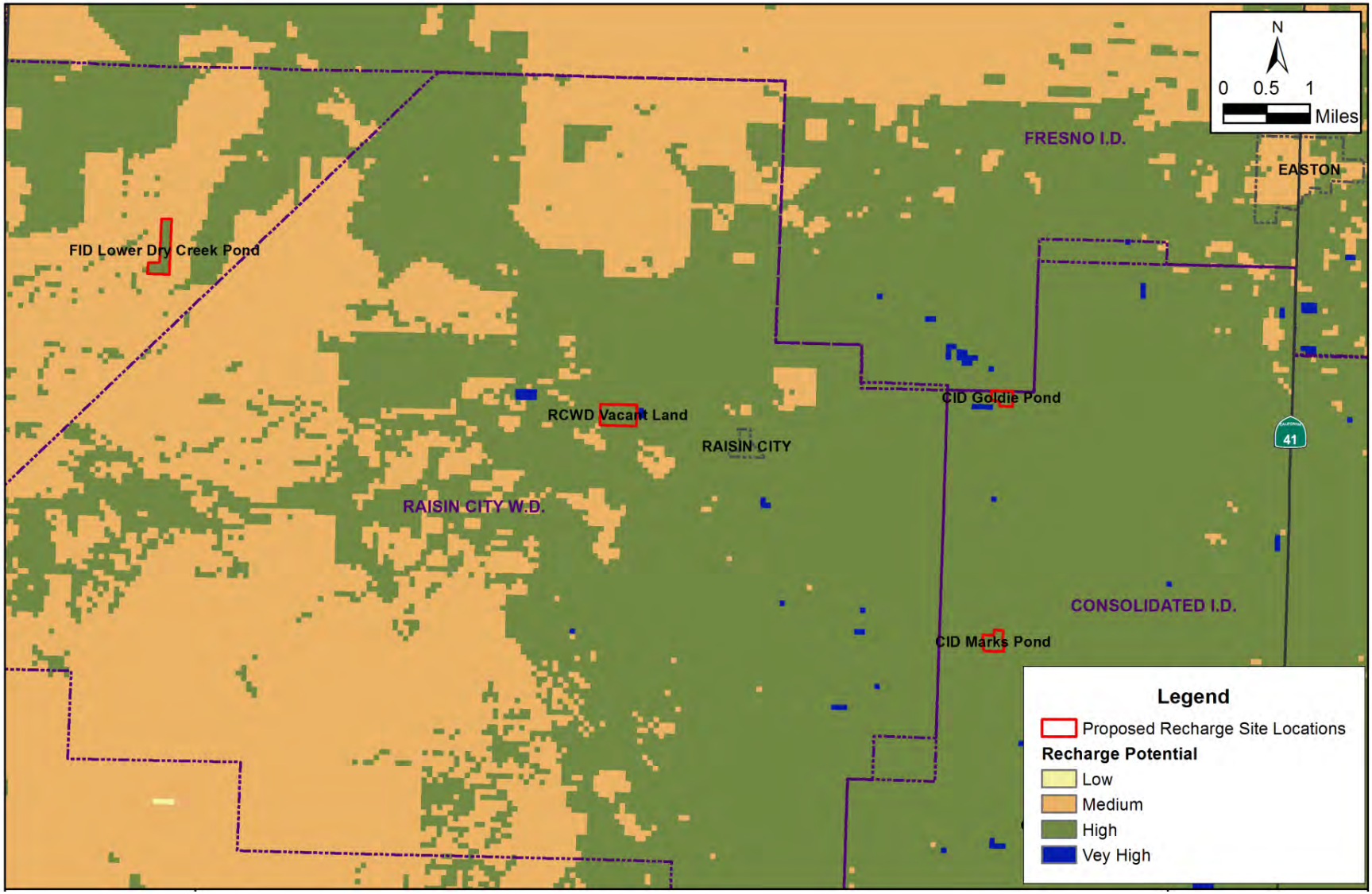


Figure 2.10 – Recharge Potential of Proposed Recharge Sites

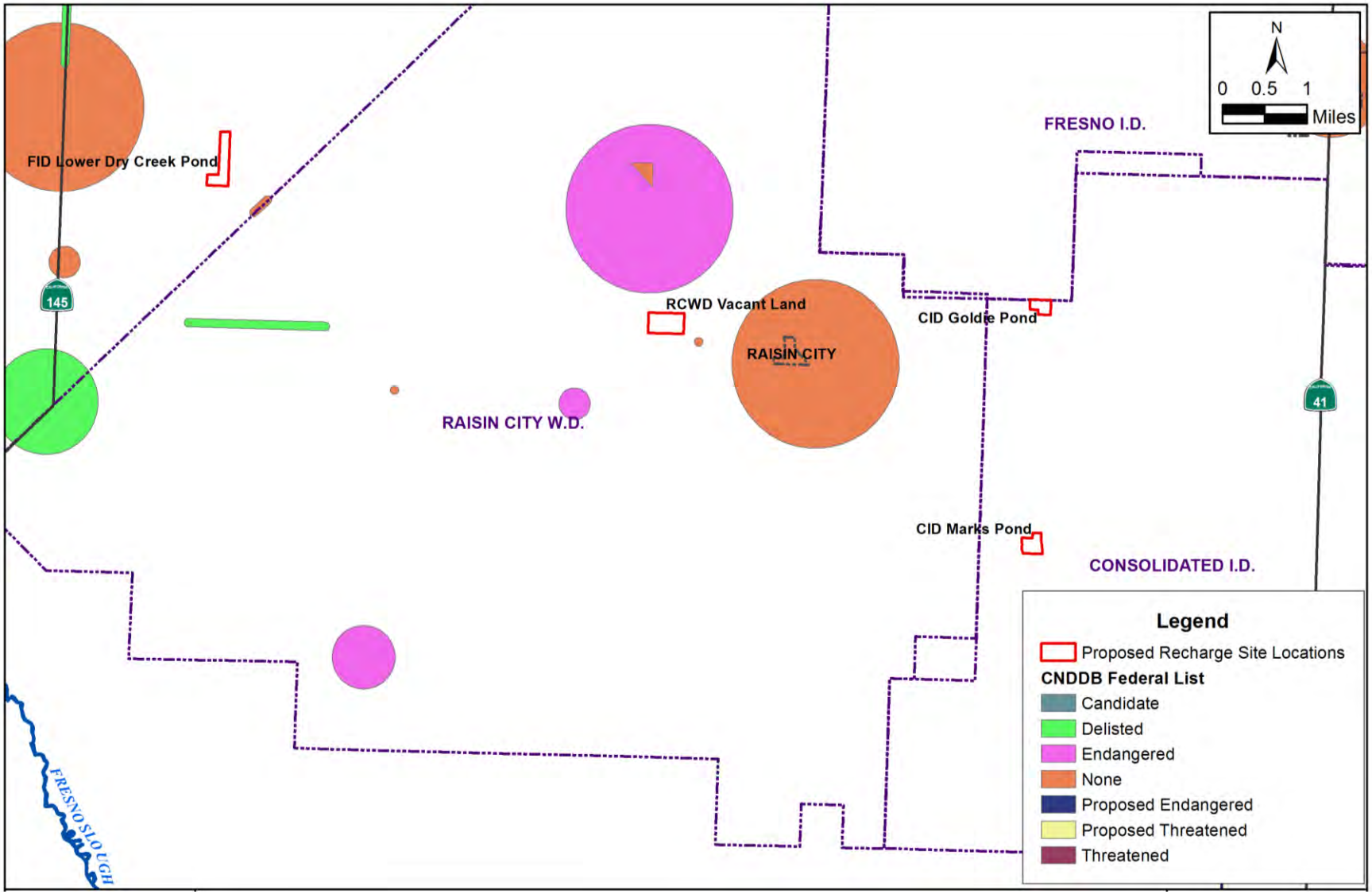


Figure 2.11.a – Areas Specified by CNDDB Federal List for Rare and Endangered Plant, Animals and Vegetation Types

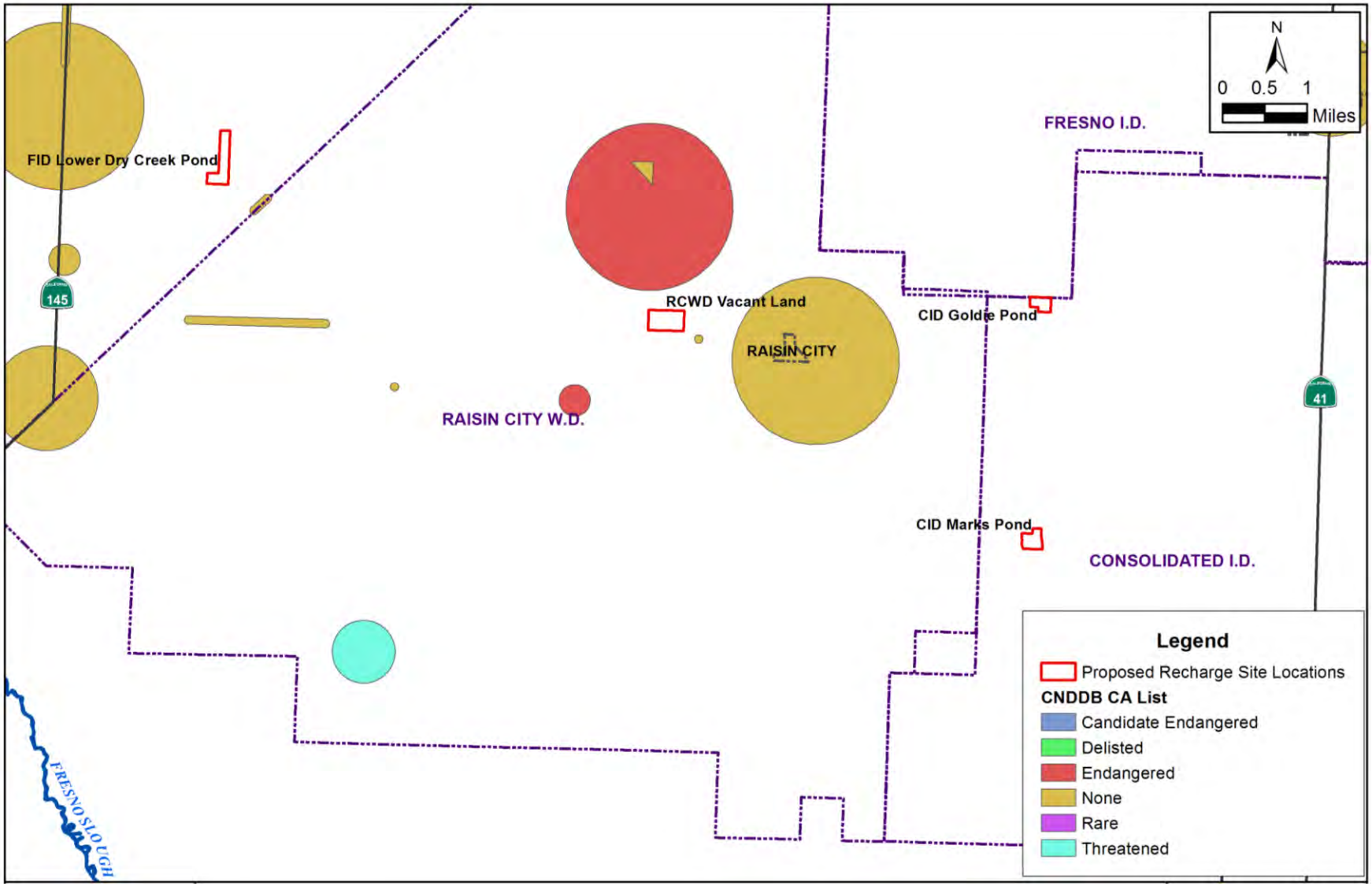


Figure 2.11.b – Areas Specified by CNDDB CA List for Rare and Endangered Plant, Animals and Vegetation Types

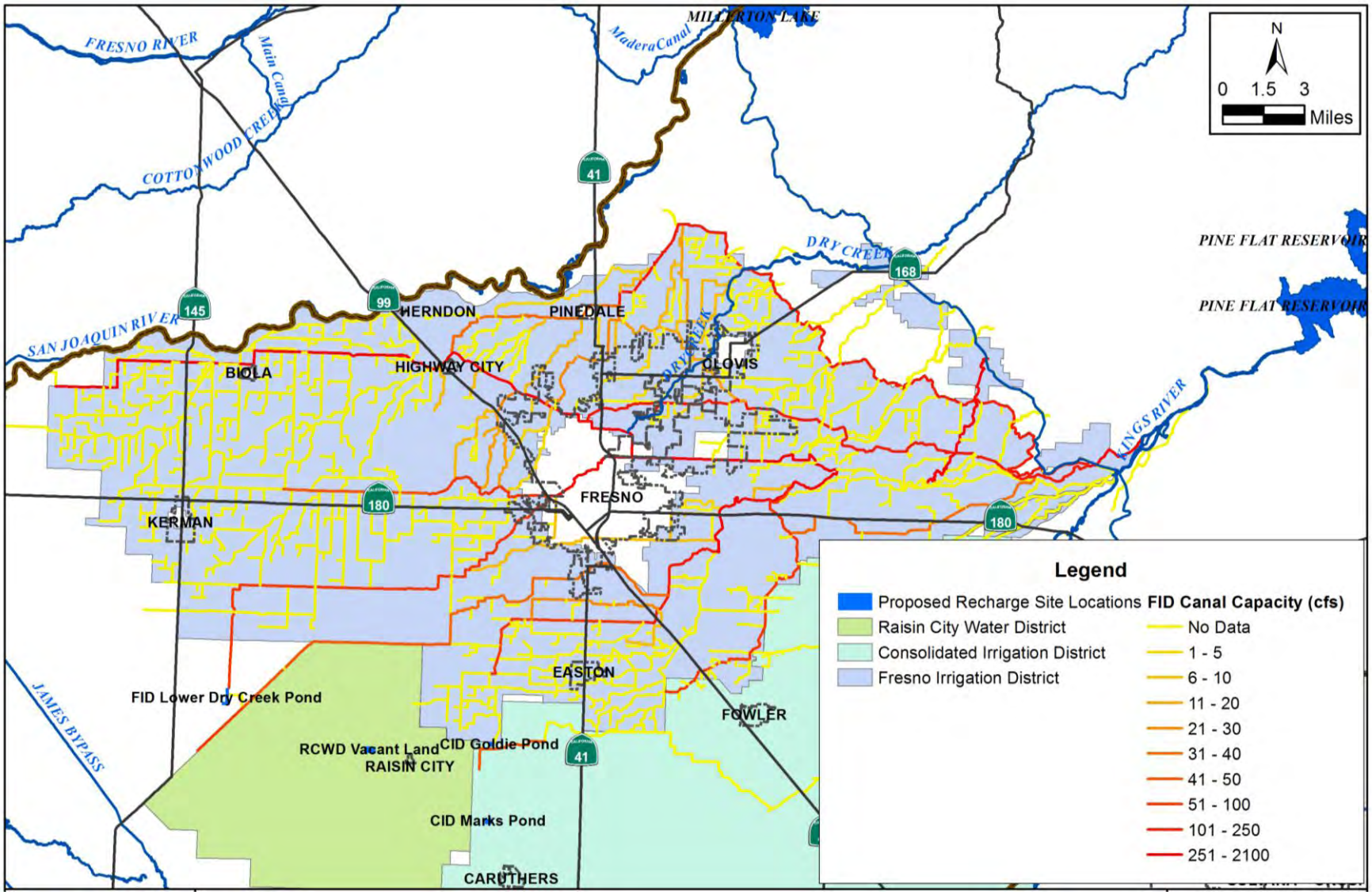


Figure 3.1 FID Canal Capacities

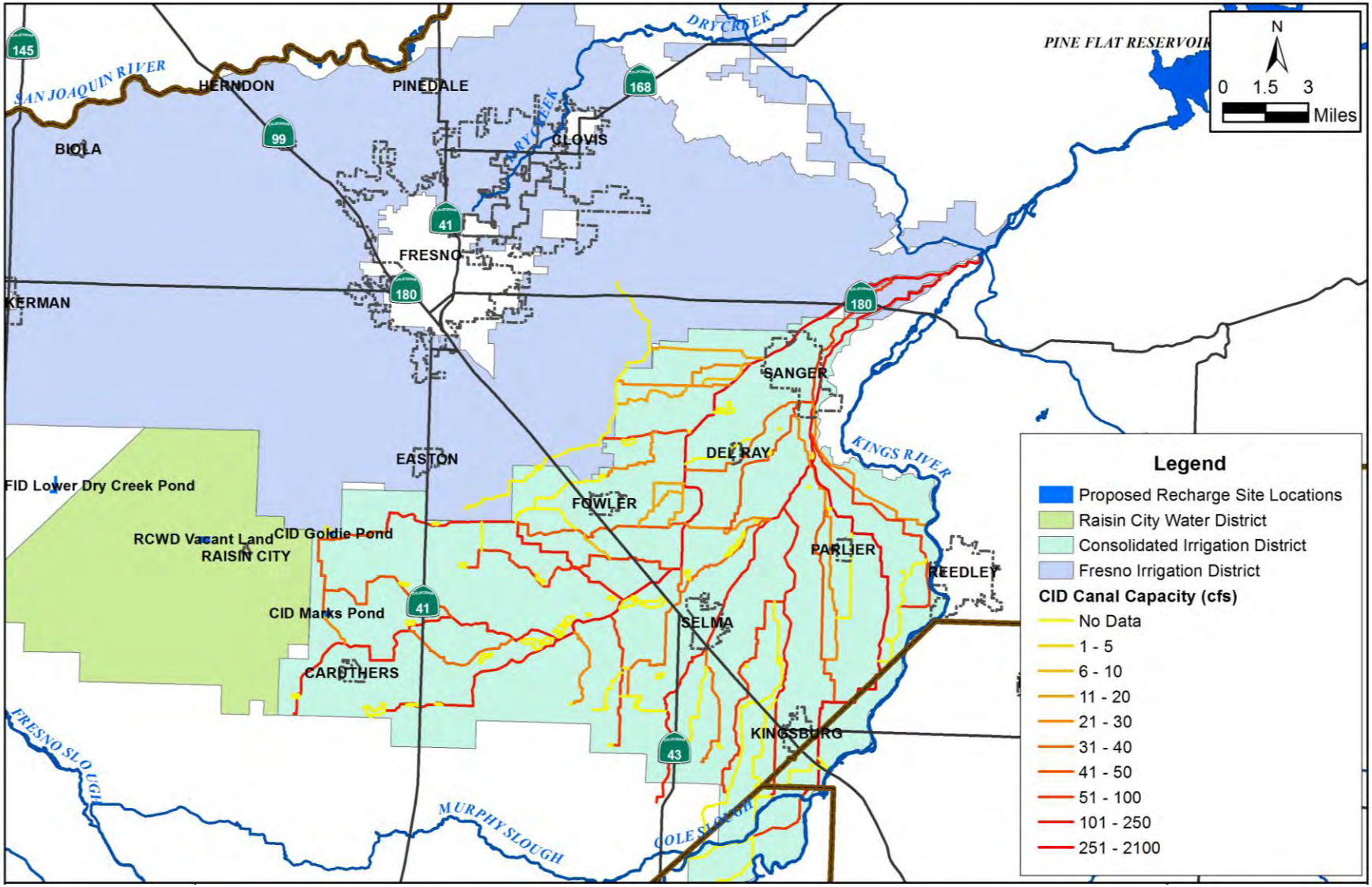


Figure 3.2 – CID Canal Capacities

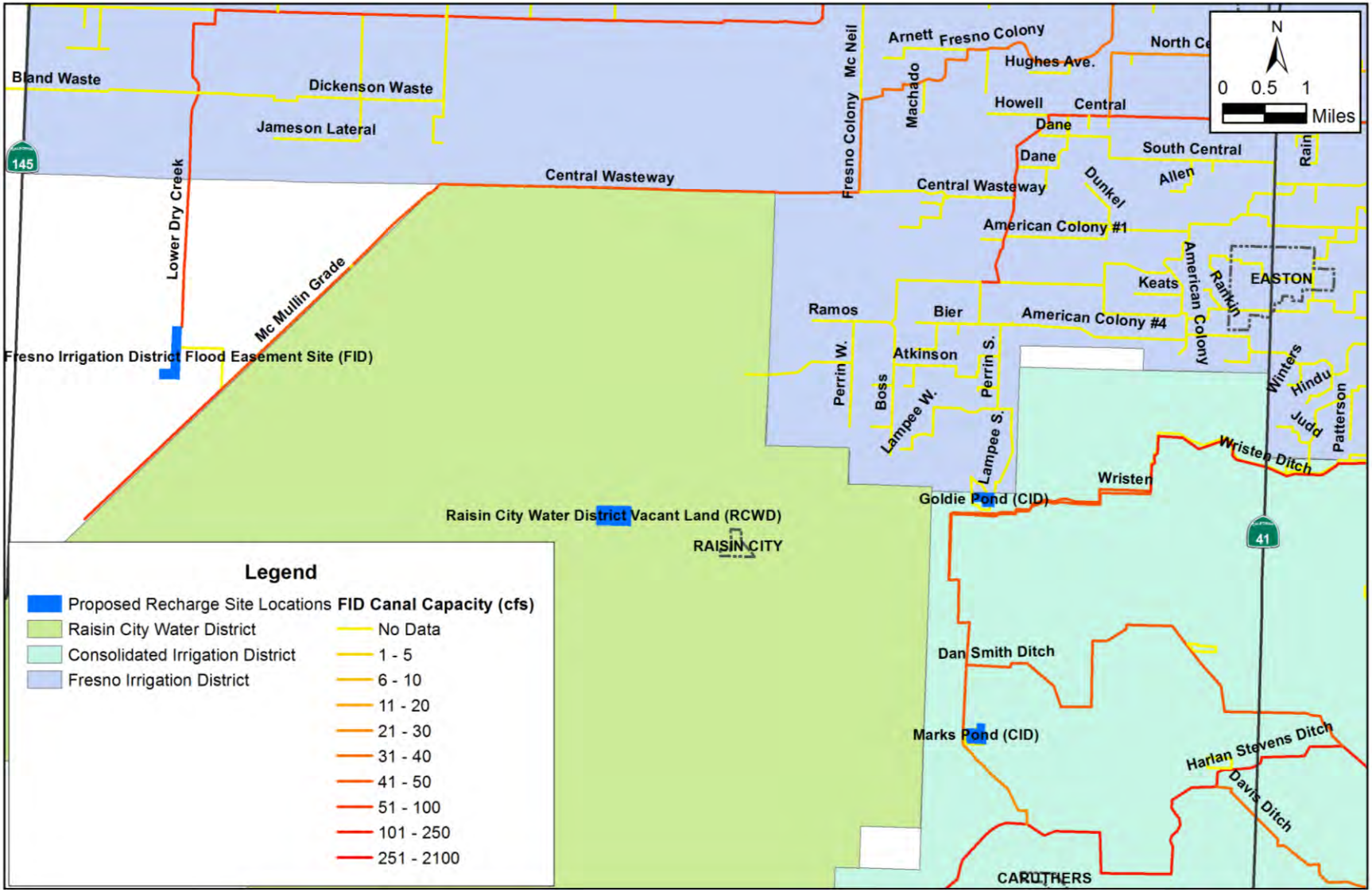


Figure 3.3 – Canal Capacities around Proposed Recharge Sites

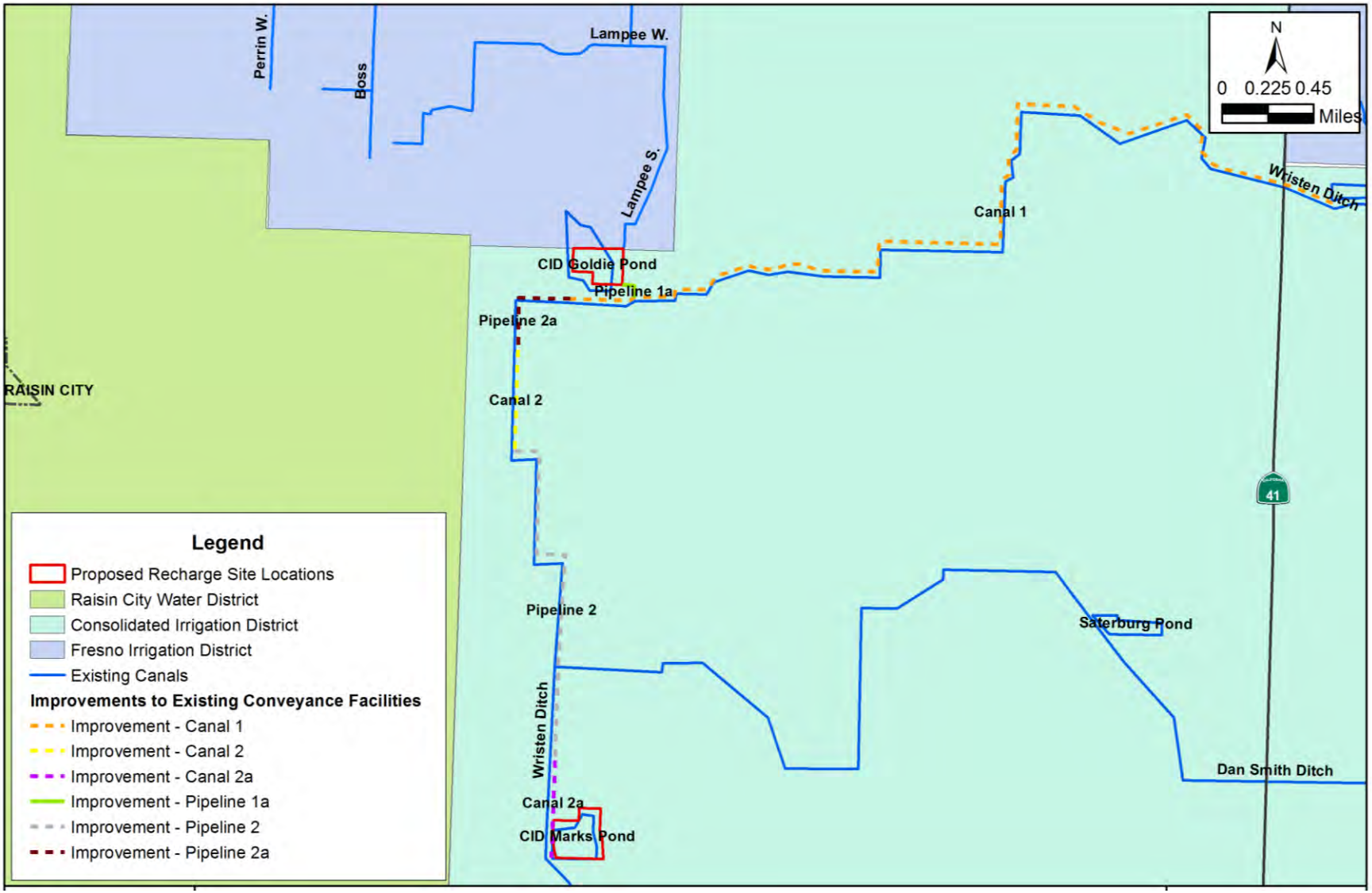


Figure 3.4 – Improvements to Existing Conveyance Facilities

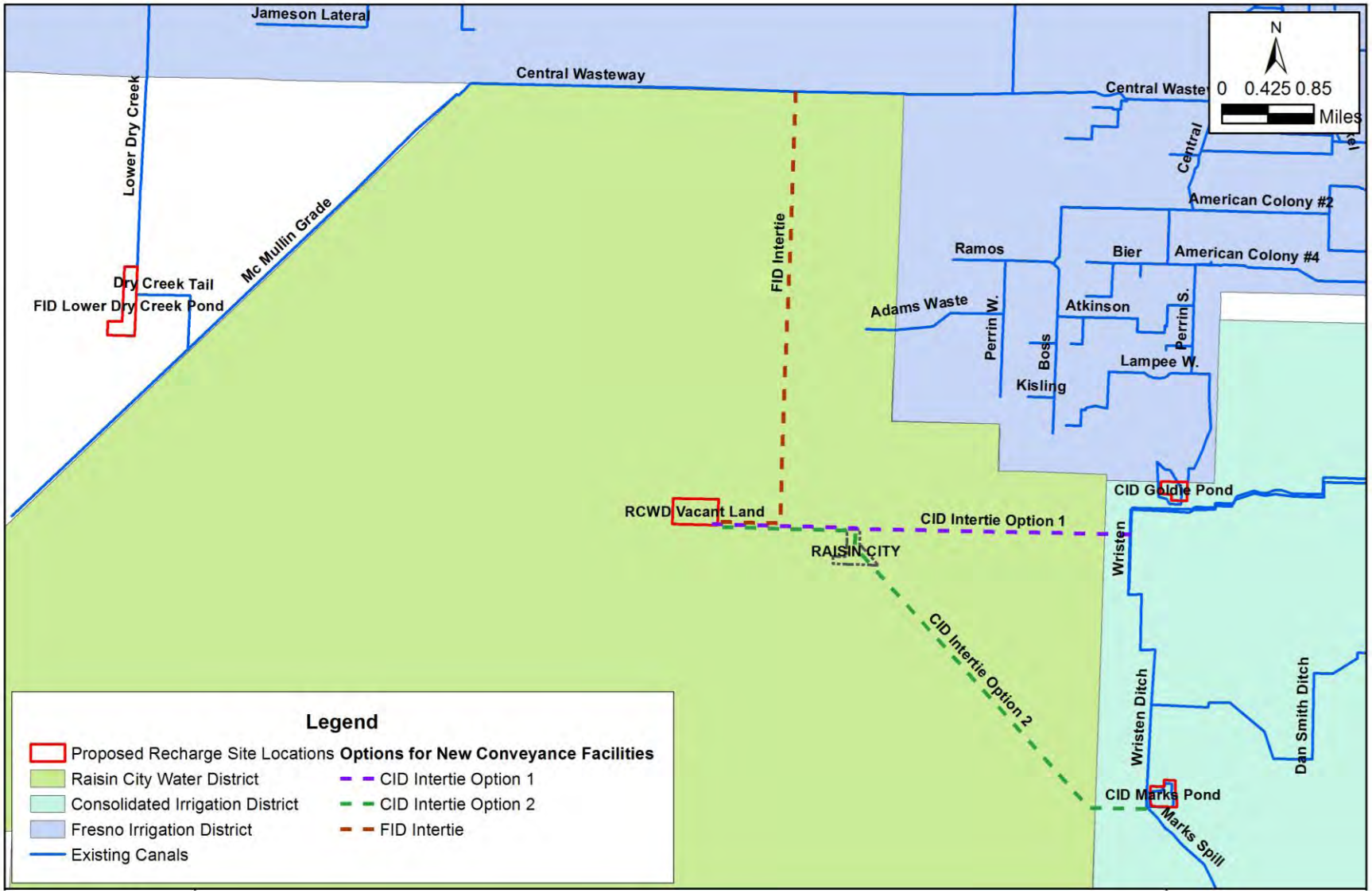


Figure 3.5 – New Conveyance Facilities

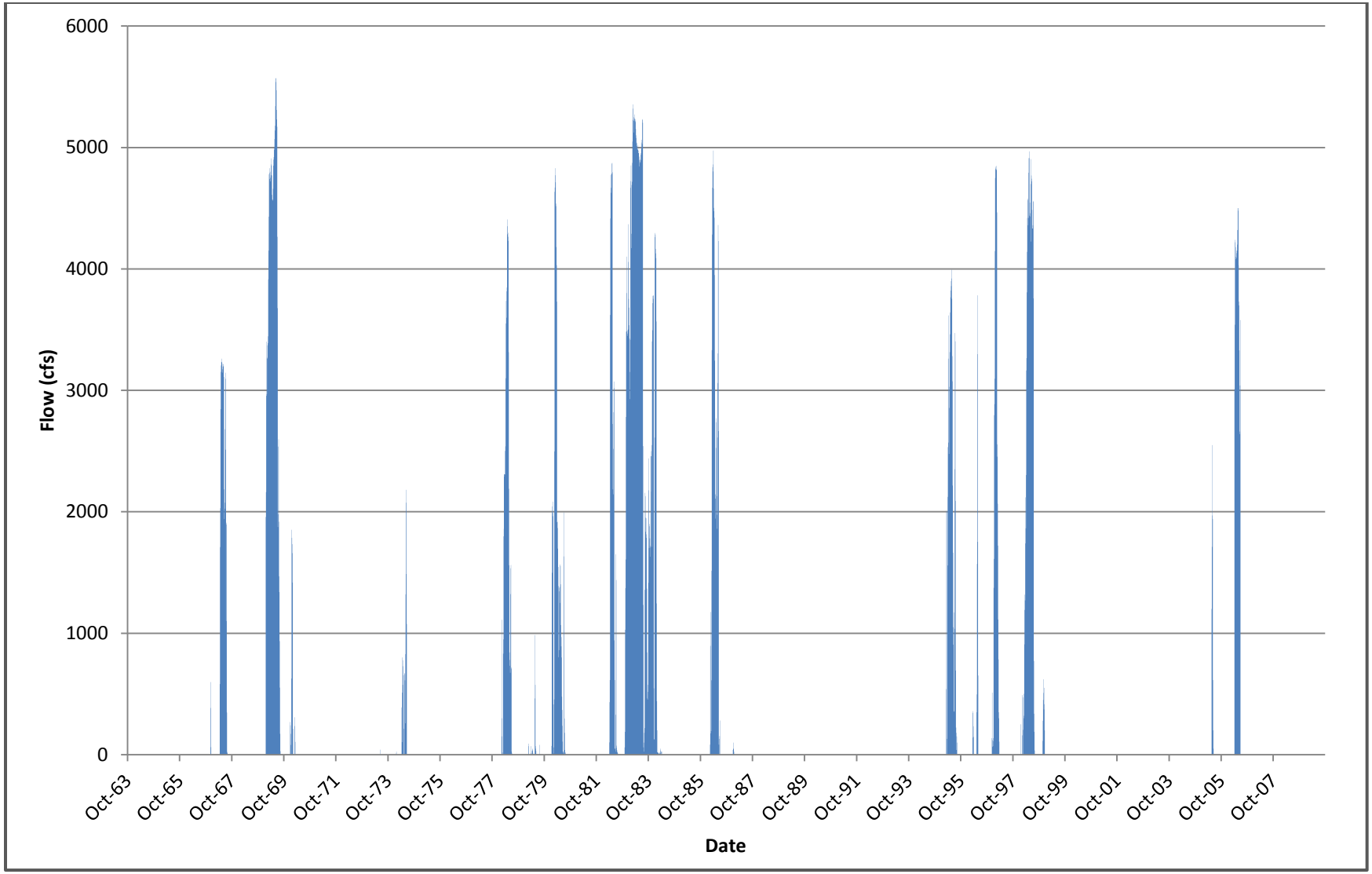


Figure 4.1 – Daily Kings River Flows at James Bypass Based on daily records from 10/01/1963 to 9/30/2009

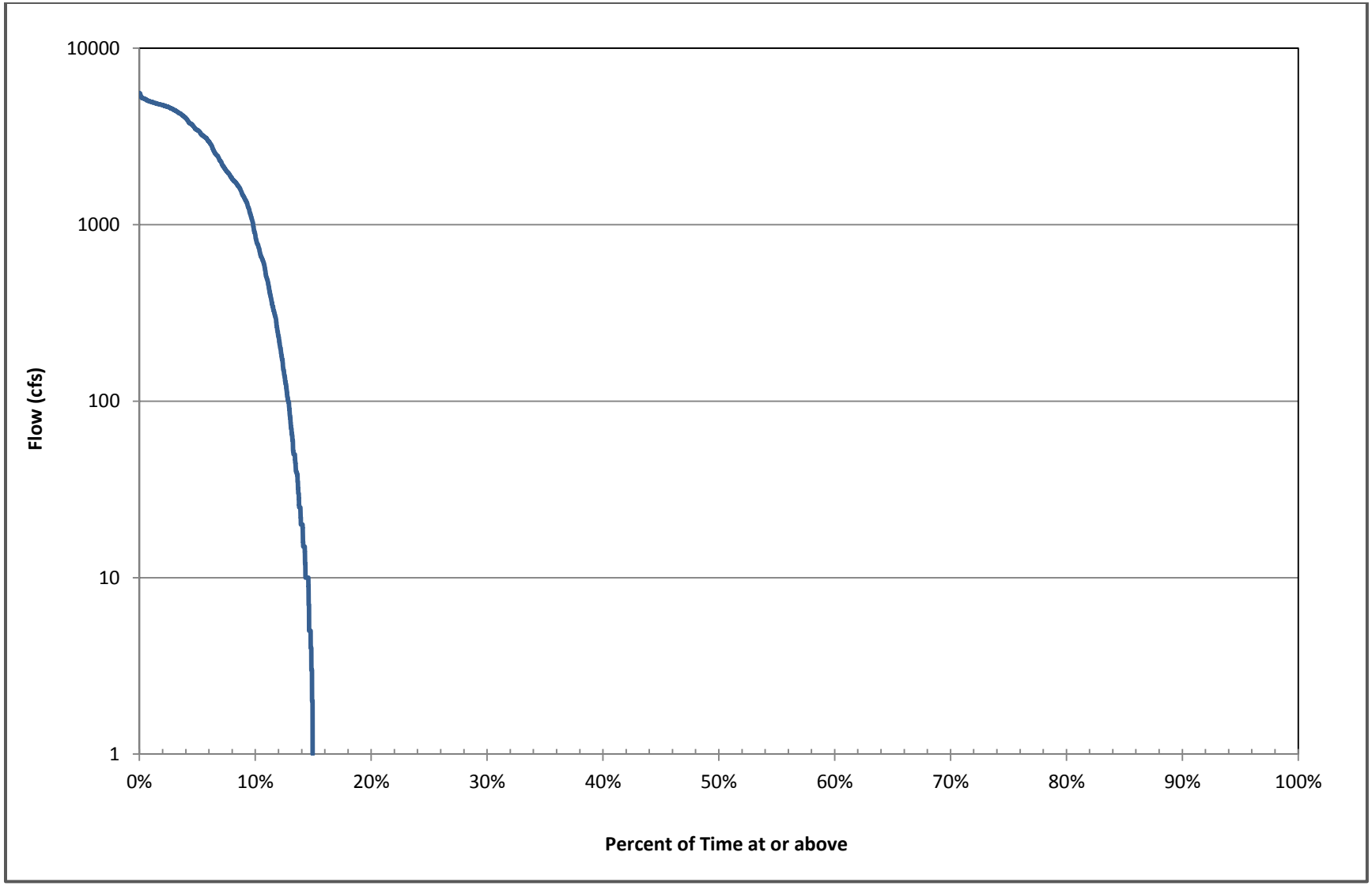


Figure 4.2 - Exceedance of Daily Kings River Flows at James Bypass

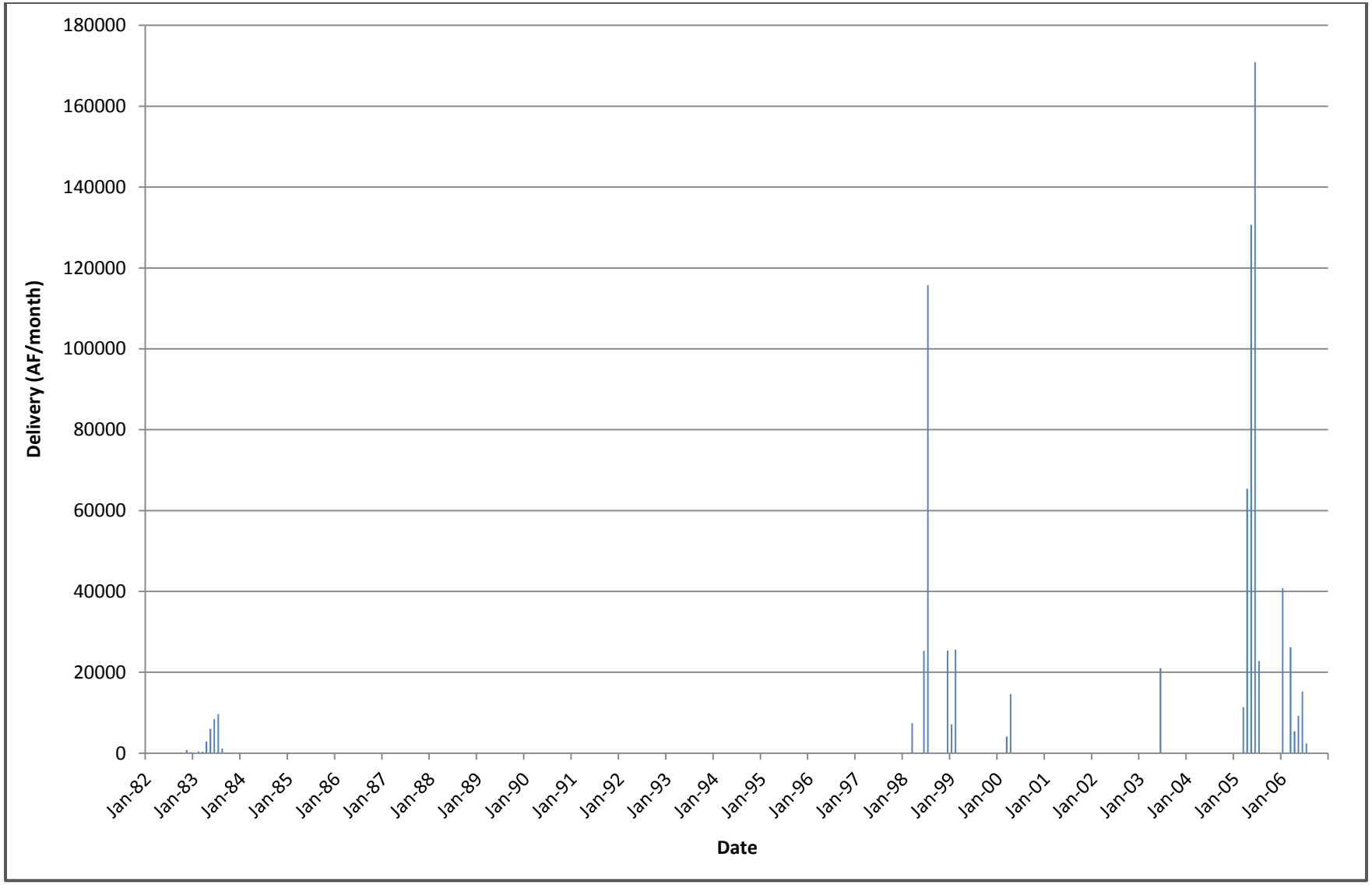


Figure 4.3 - Monthly Section 215 Deliveries Based on Monthly Records from 01/1982 to 12/2006

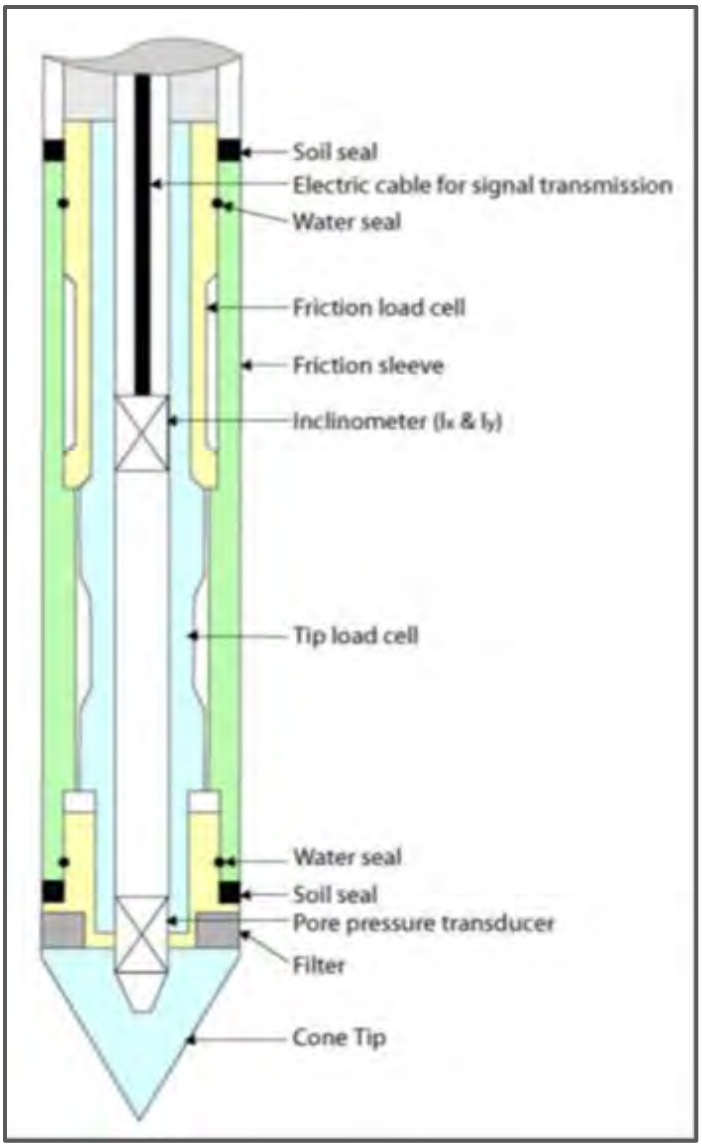


Figure 5.1 – CPT Diagram

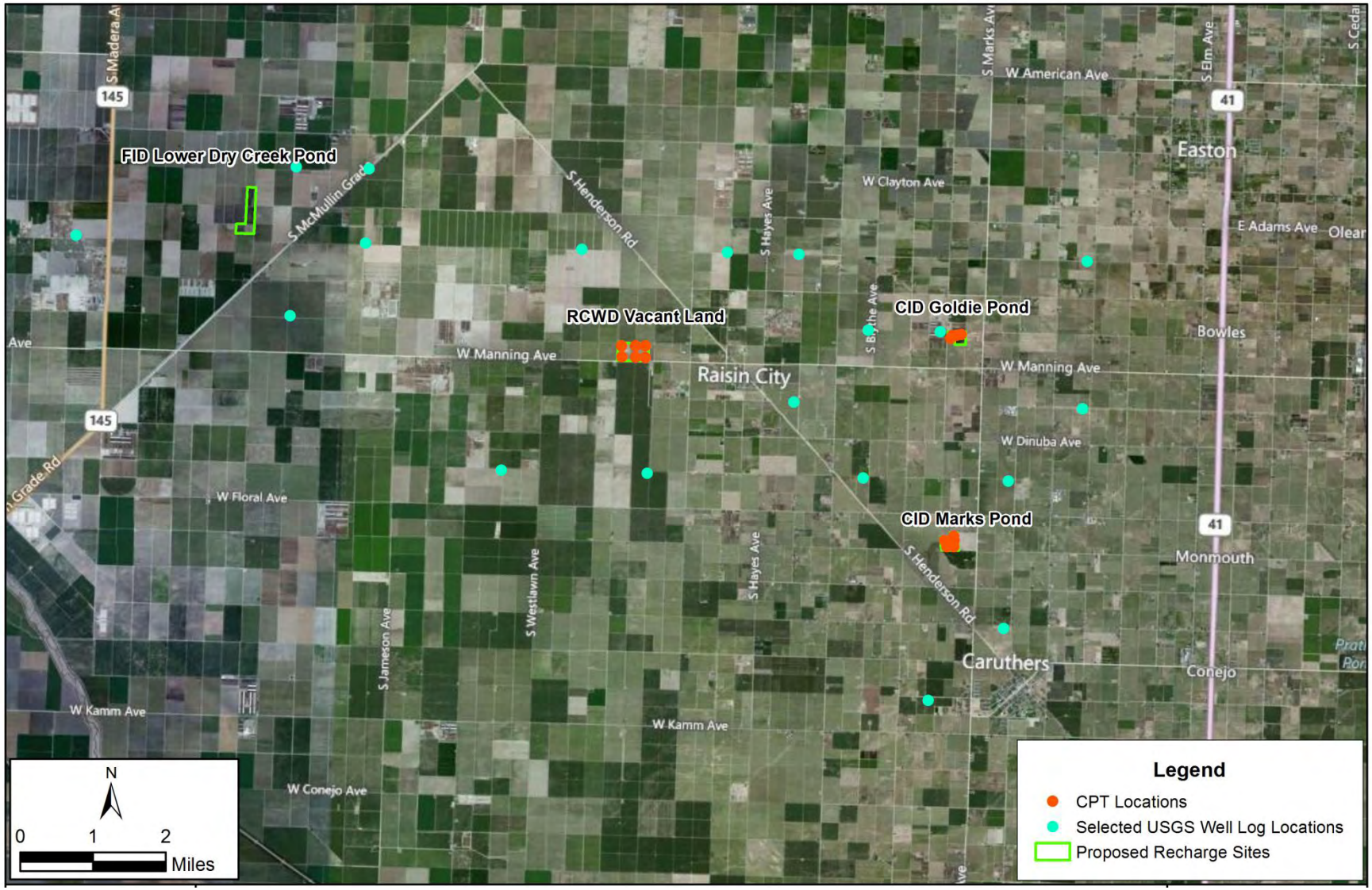


Figure 5.2 – CPT Locations and Selected USGS Well Log Locations around the Project Area

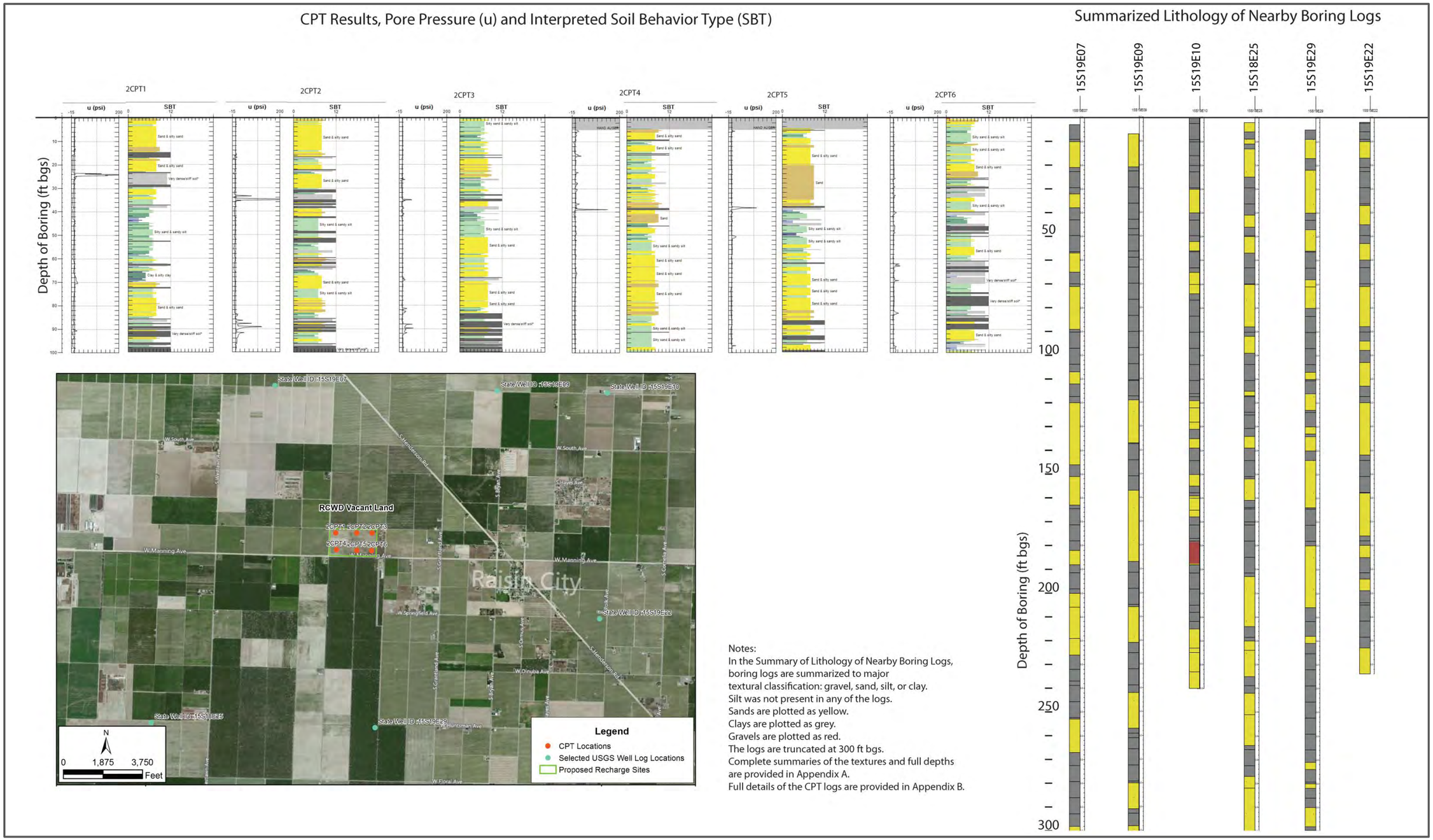
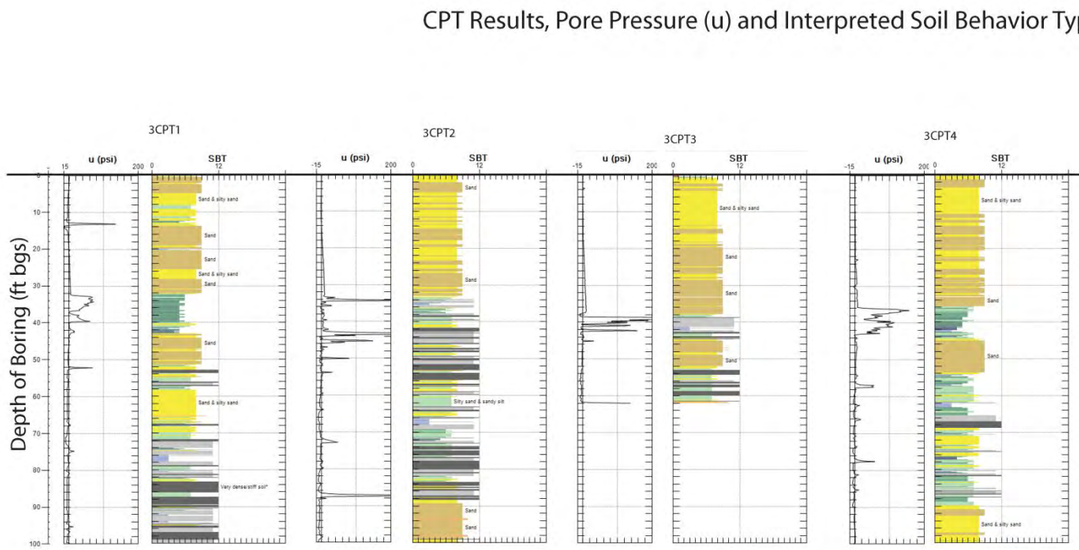


Figure 5.3 – CPT Results and Nearby Boring Logs for RCWD Vacant Land Site



Notes:
In the Summary of Lithology of Nearby Boring Logs, boring logs are summarized to major textural classification: gravel, sand, silt, or clay.
Silt was not present in any of the logs.
Sands are plotted as yellow.
Clays are plotted as grey.
Gravels are plotted as red.
Complete summaries of the textures are provided in Appendix A.
Full details of the CPT logs are provided in Appendix B.

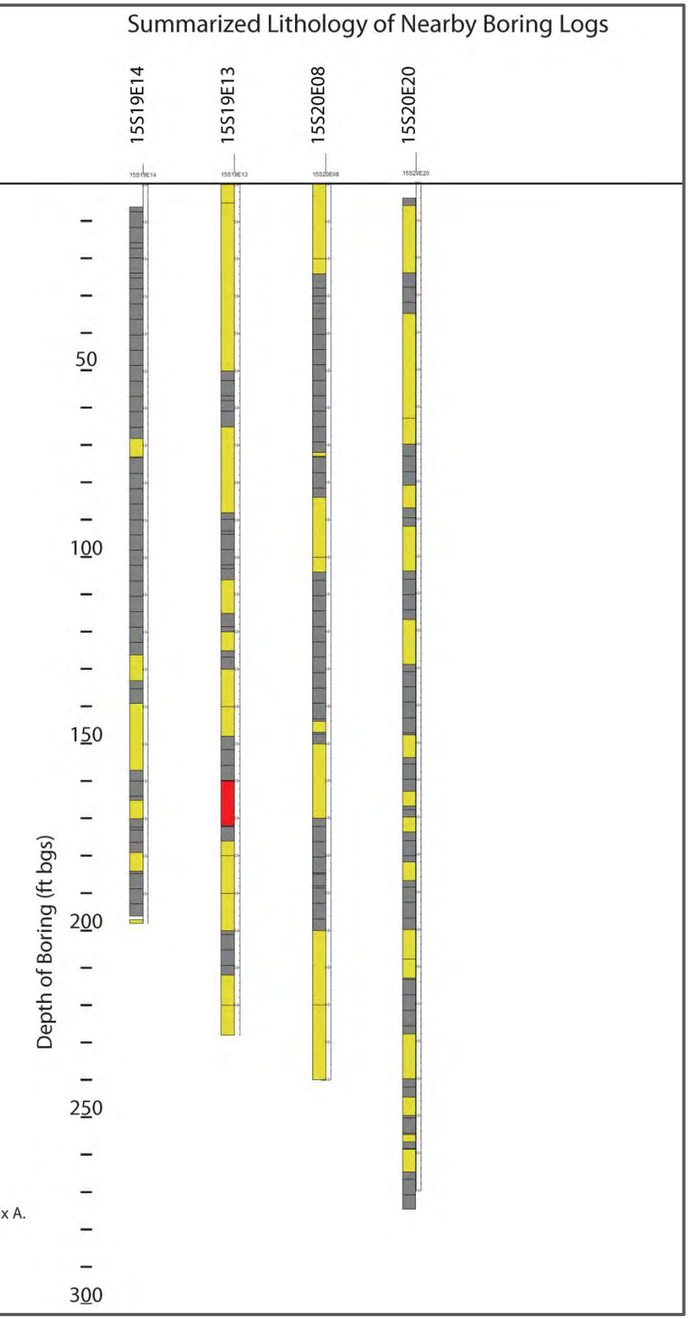
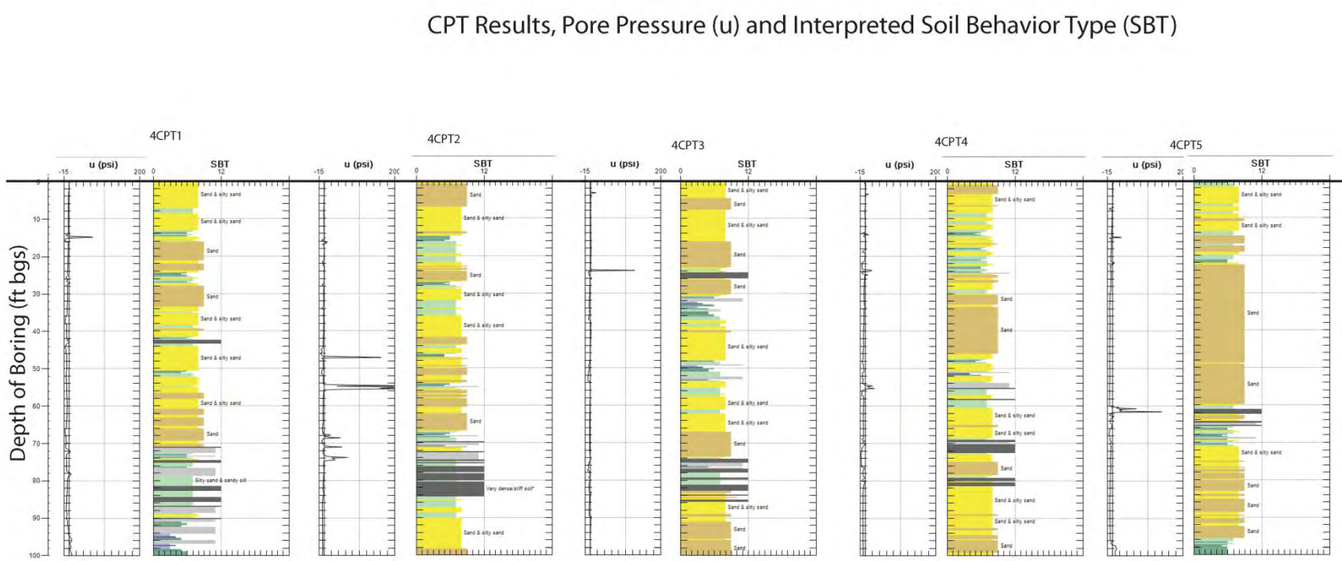


Figure 5.4 – CPT Results and Nearby Boring Logs for CID Goldie Pond Site



Notes:
In the Summary of Lithology of Nearby Boring Logs, boring logs are summarized to major textural classification: gravel, sand, silt, or clay.
Silt and gravel was not present in any of the logs.
Sands are plotted as yellow.
Clays are plotted as grey.
Complete summaries of the textures are provided in Appendix A.
Full details of the CPT logs are provided in Appendix B.

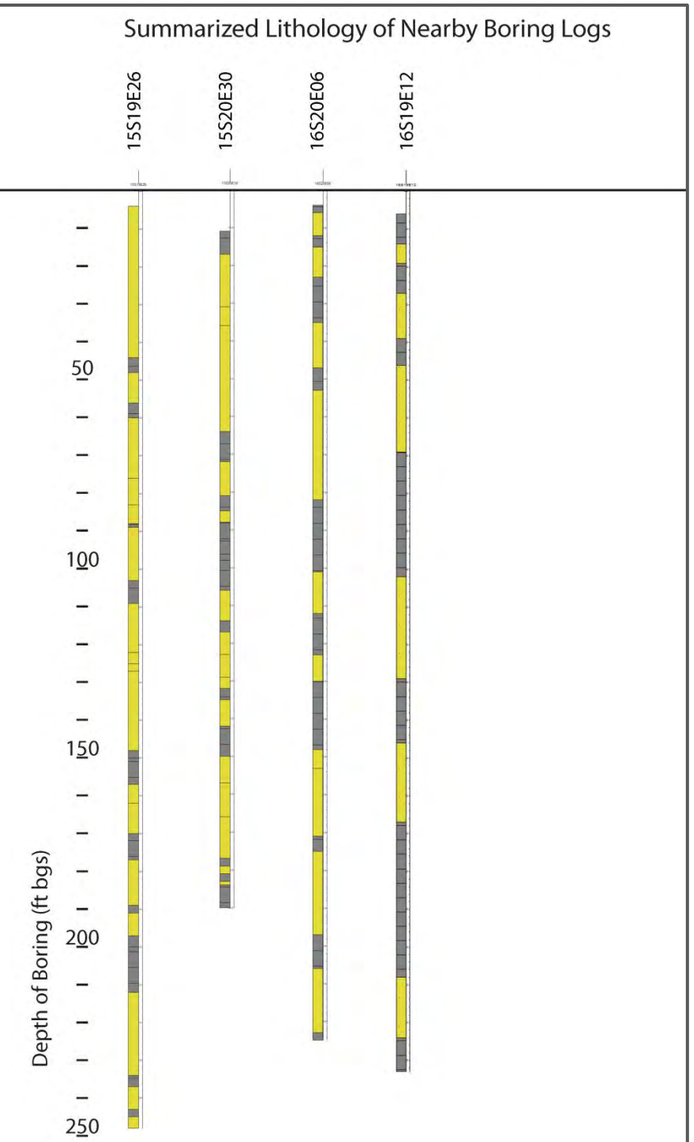


Figure 5.5 – CPT Results and Nearby Boring Logs for CID Marks Pond Site

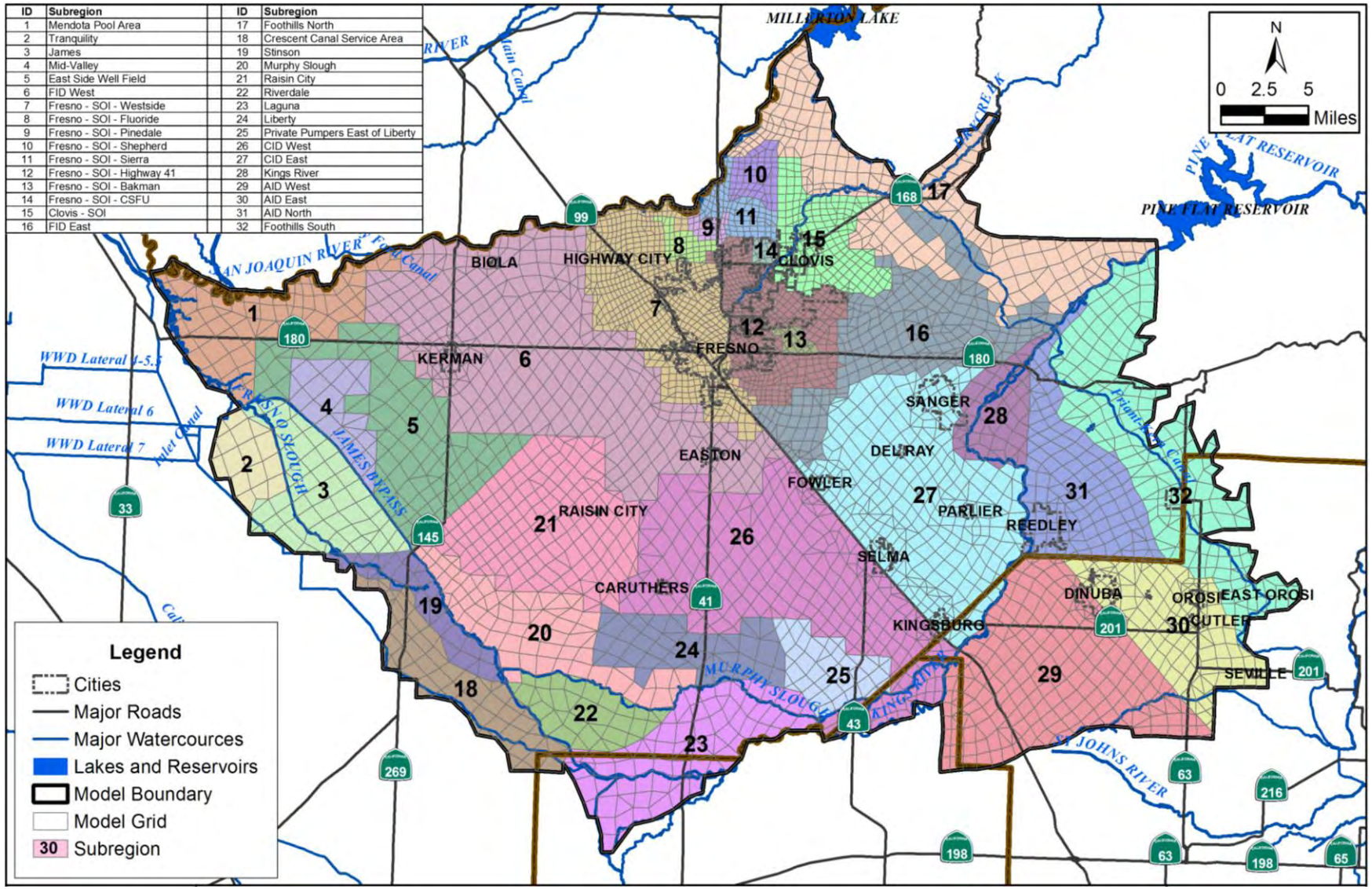
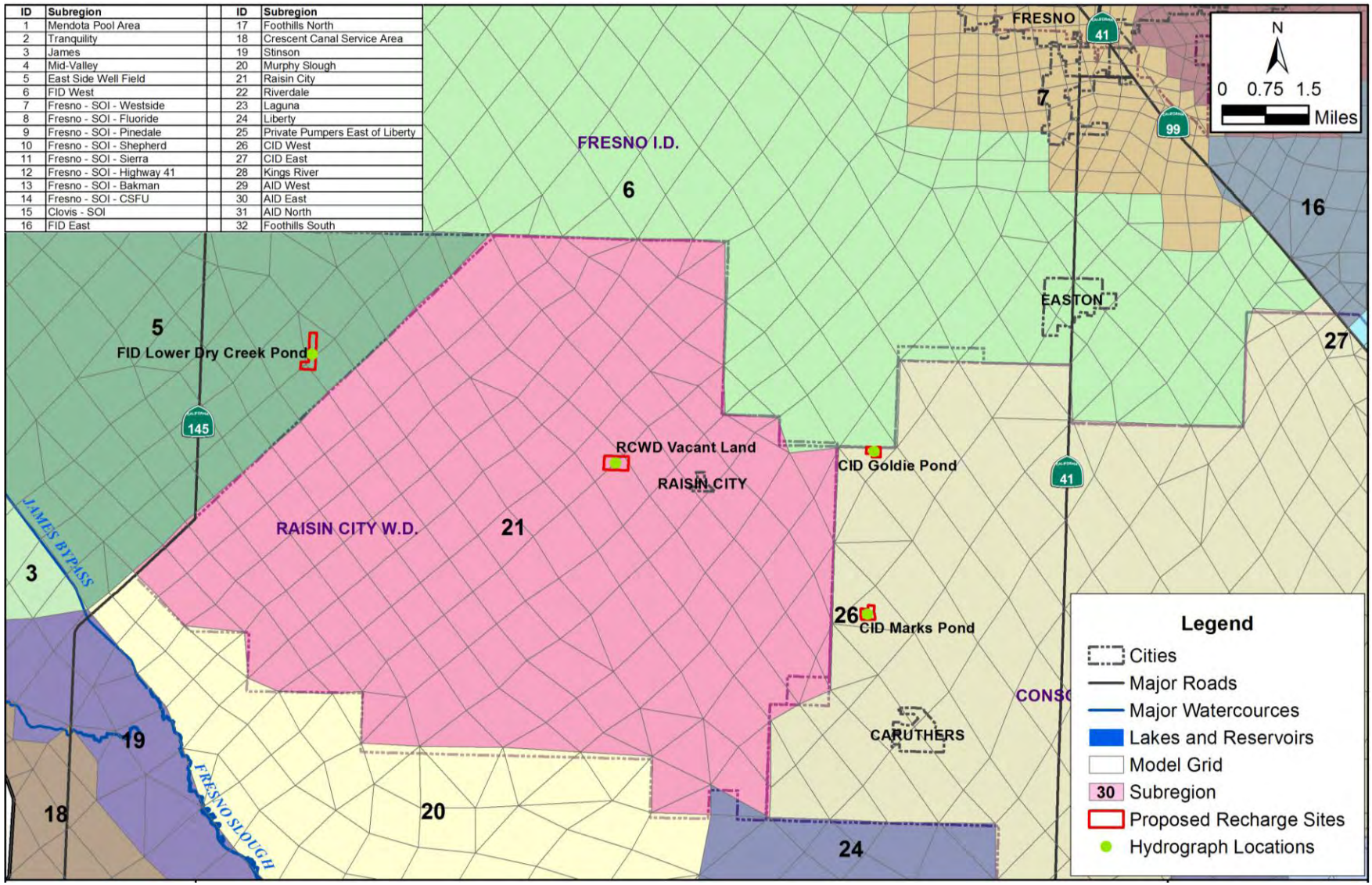


Figure 6.1 - Kings IGSM Model Grid and Subregions



ID	Subregion	ID	Subregion
1	Mendota Pool Area	17	Foothills North
2	Tranquility	18	Crescent Canal Service Area
3	James	19	Stinson
4	Mid-Valley	20	Murphy Slough
5	East Side Well Field	21	Raisin City
6	FID West	22	Riverdale
7	Fresno - SOI - Westside	23	Laguna
8	Fresno - SOI - Fluoride	24	Liberty
9	Fresno - SOI - Pinedale	25	Private Pumpers East of Liberty
10	Fresno - SOI - Shepherd	26	CID West
11	Fresno - SOI - Sierra	27	CID East
12	Fresno - SOI - Highway 41	28	Kings River
13	Fresno - SOI - Bakman	29	AID West
14	Fresno - SOI - CSFU	30	AID East
15	Clovis - SOI	31	AID North
16	FID East	32	Foothills South

Figure 6.2 - Model Grid, Subregions, and Hydrograph Locations in the vicinity of Raisin City Water District

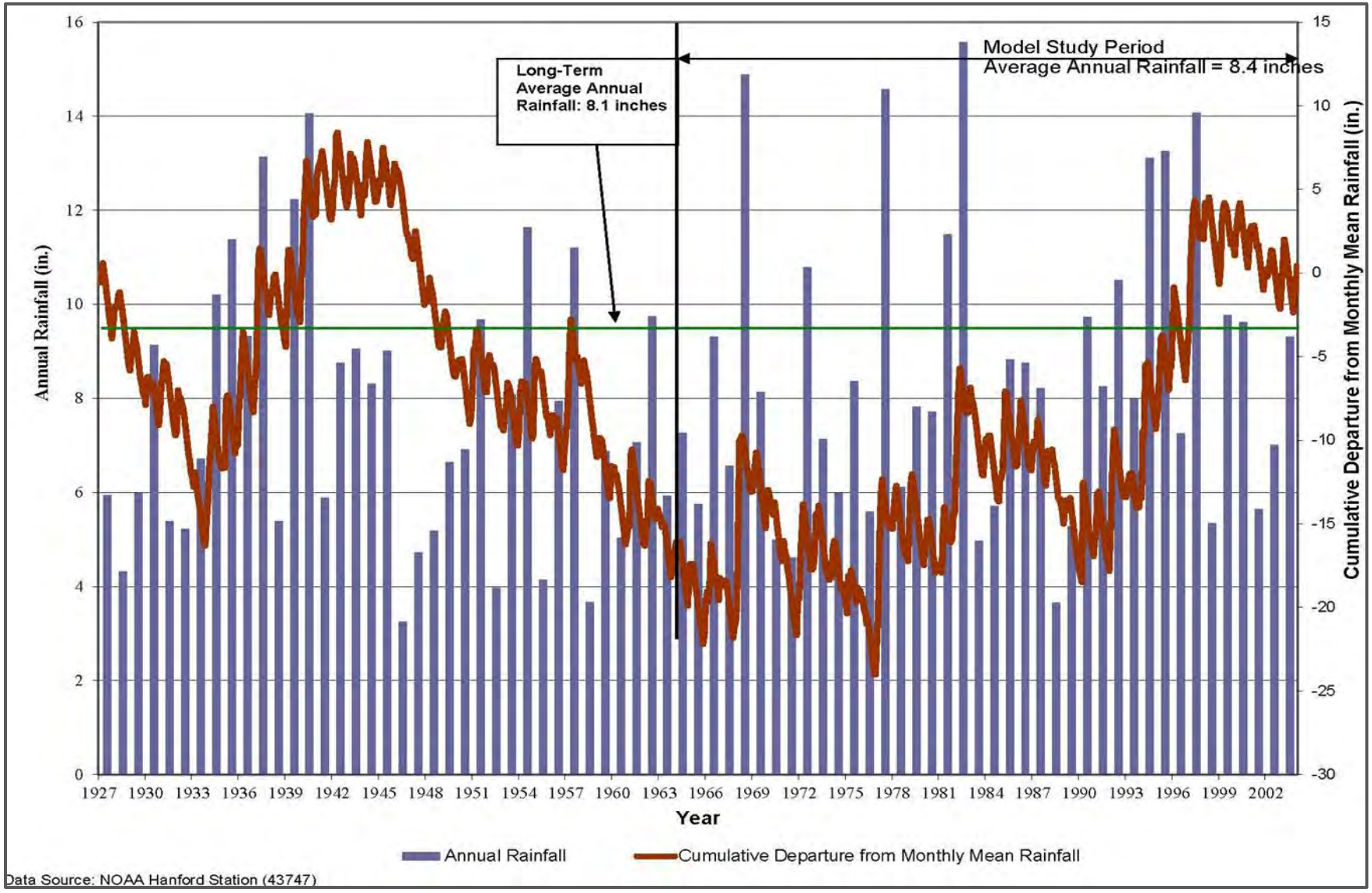


Figure 6.3 - Historical Rainfall for Project Area

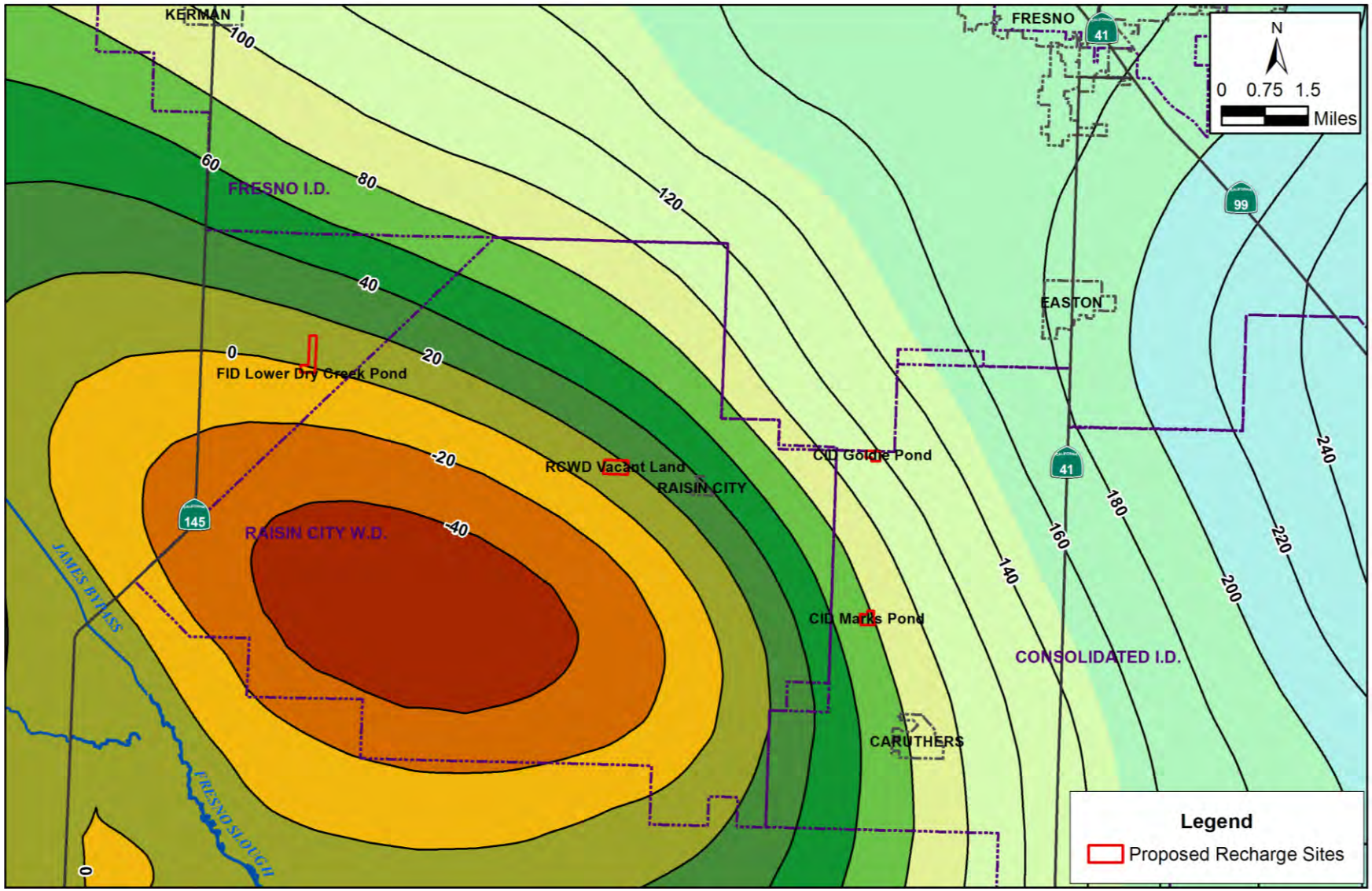


Figure 6.4 - Simulated Groundwater Levels for Wet Hydrologic Conditions (Fall 1983)

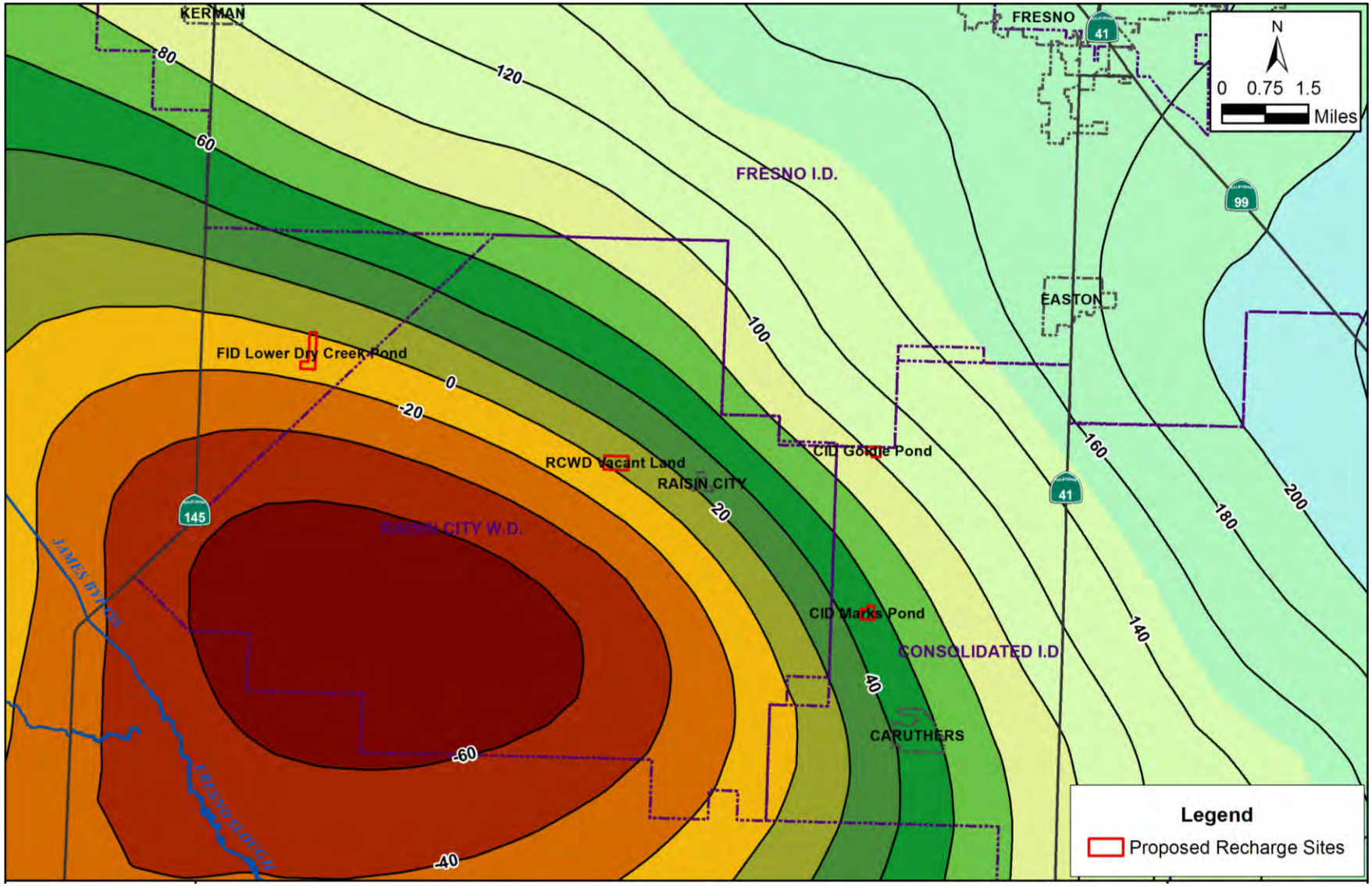


Figure 6.5 - Simulated Groundwater Levels for Average Hydrologic Conditions (Fall 2004)

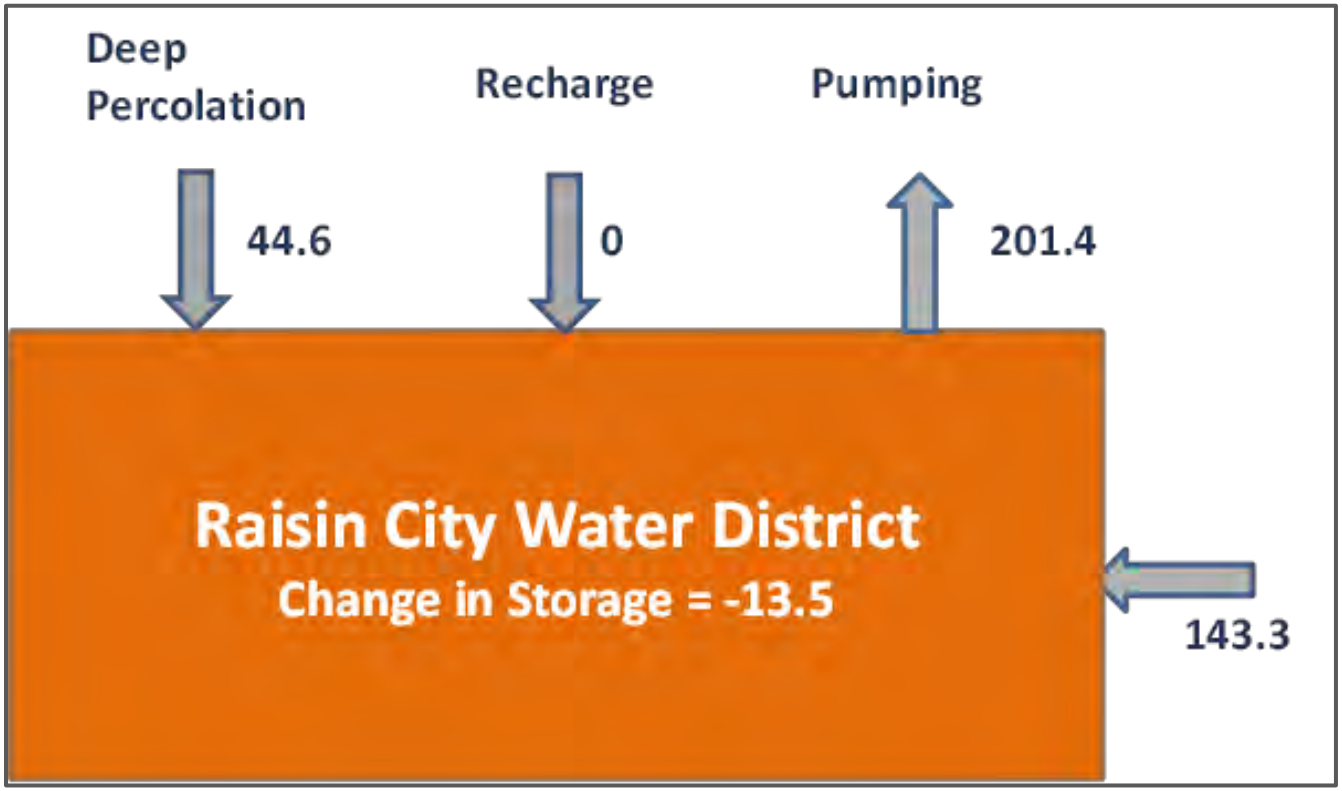


Figure 6.6 - Long-Term Annual Average Water Budget for RCWD Subregion (TAF/yr)

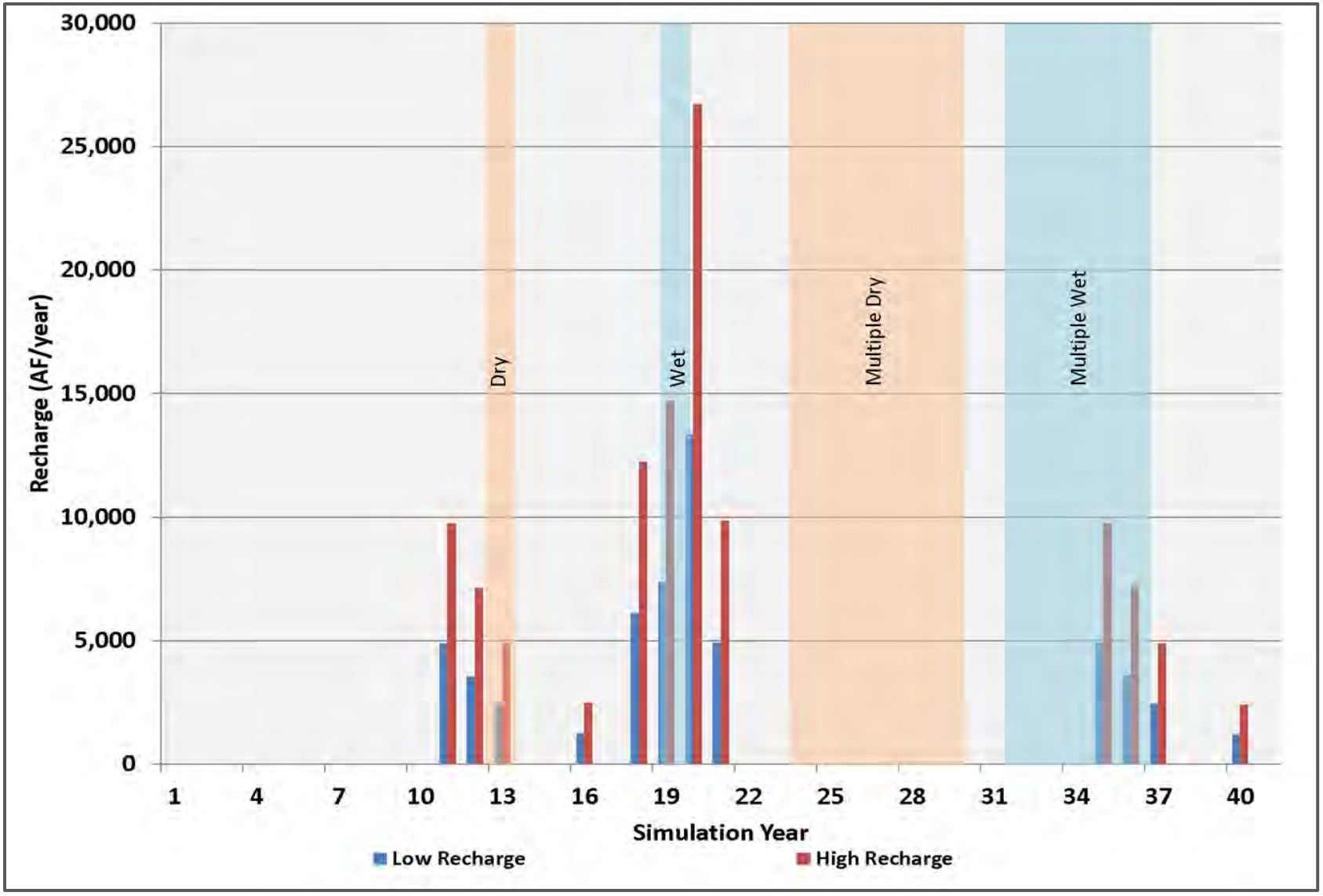


Figure 7.1 - Annual Recharge Rates for RCWD Pond

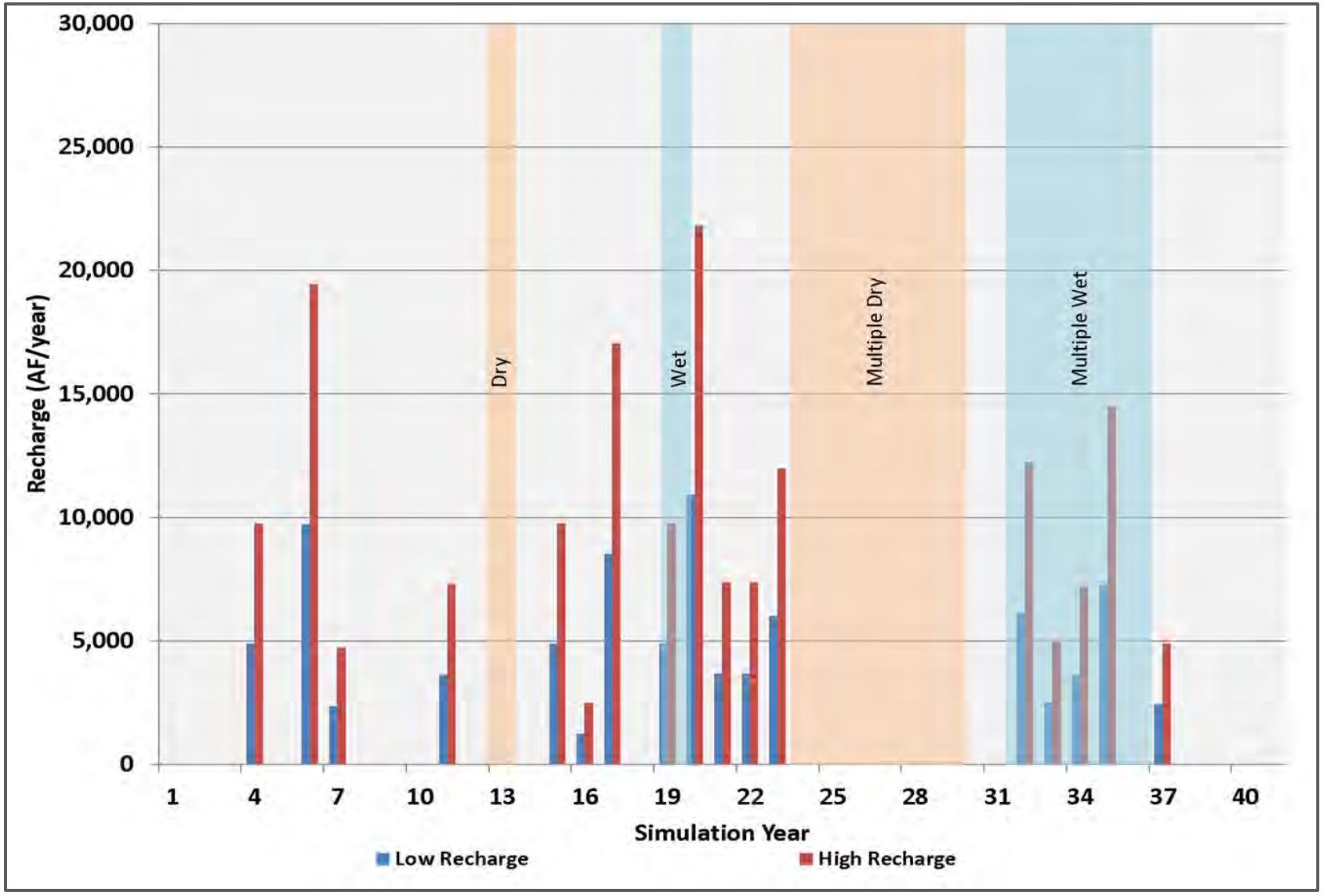


Figure 7.2 - Annual Recharge Rates for FID and CID Ponds

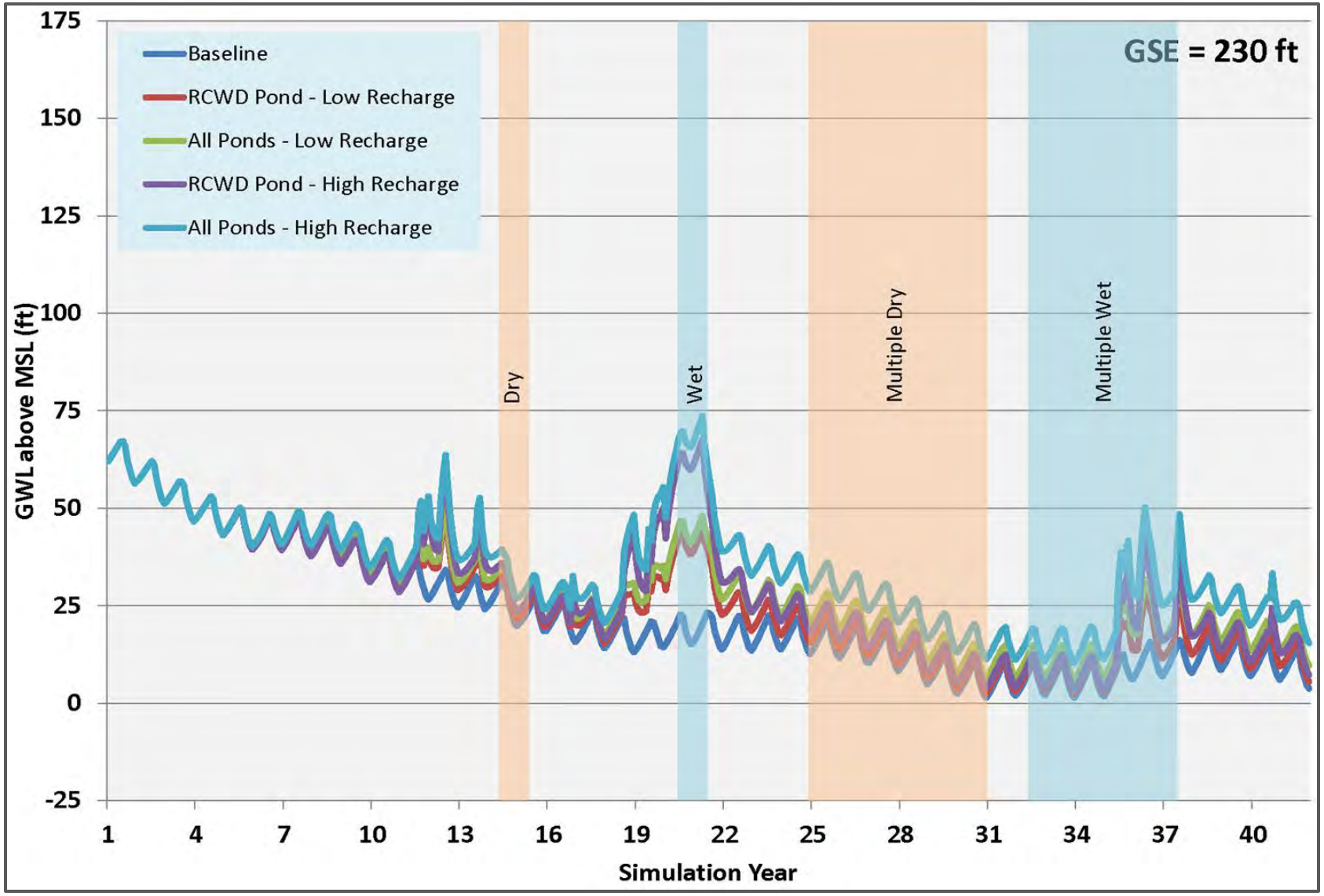


Figure 8.1 - Hydrographs of Groundwater Levels at RCWD Pond

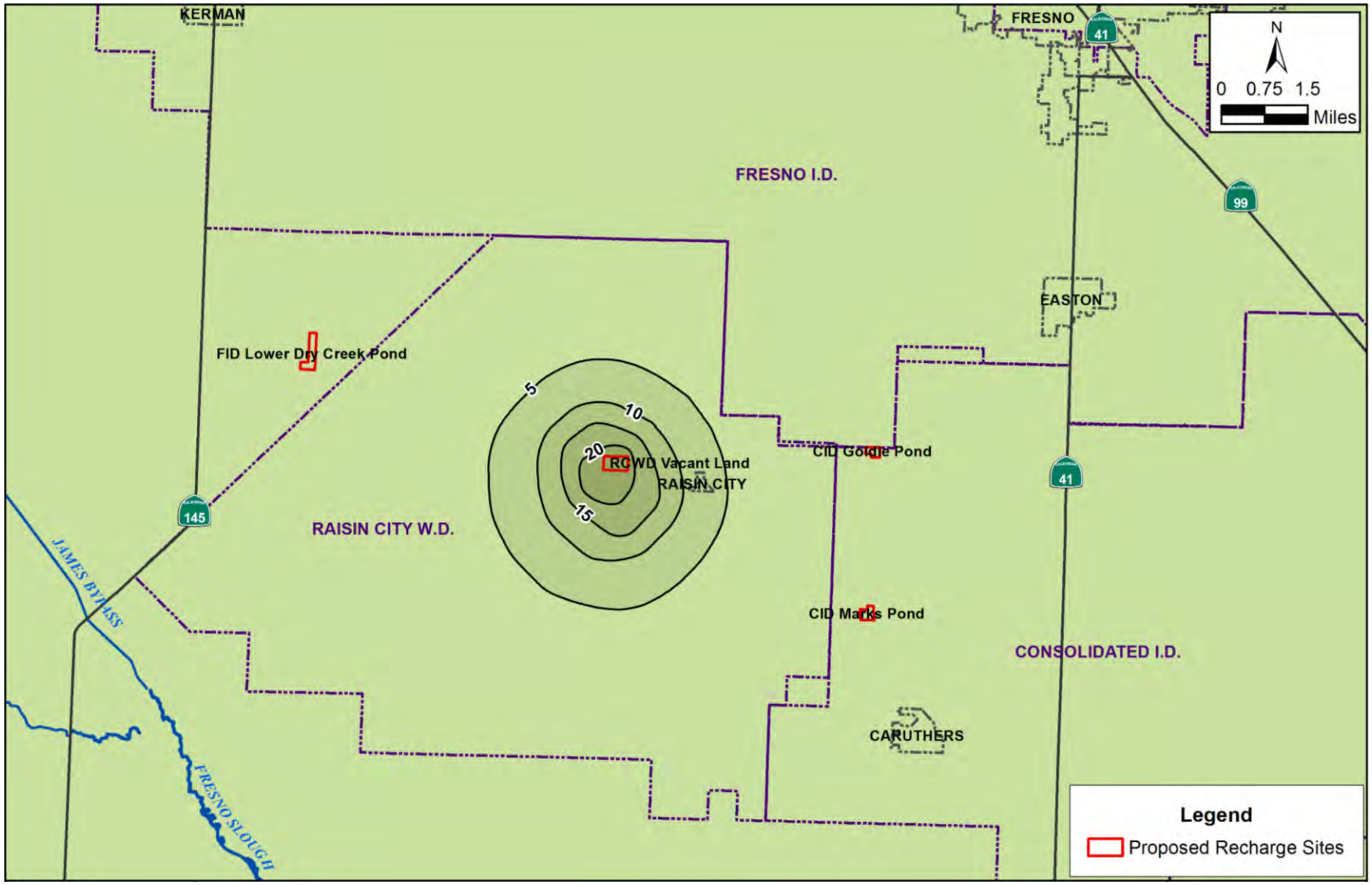


Figure 8.2 - Contour Map of Groundwater Level Increases for year 21 at RCWD Pond for Low Recharge Scenario 1a (feet)

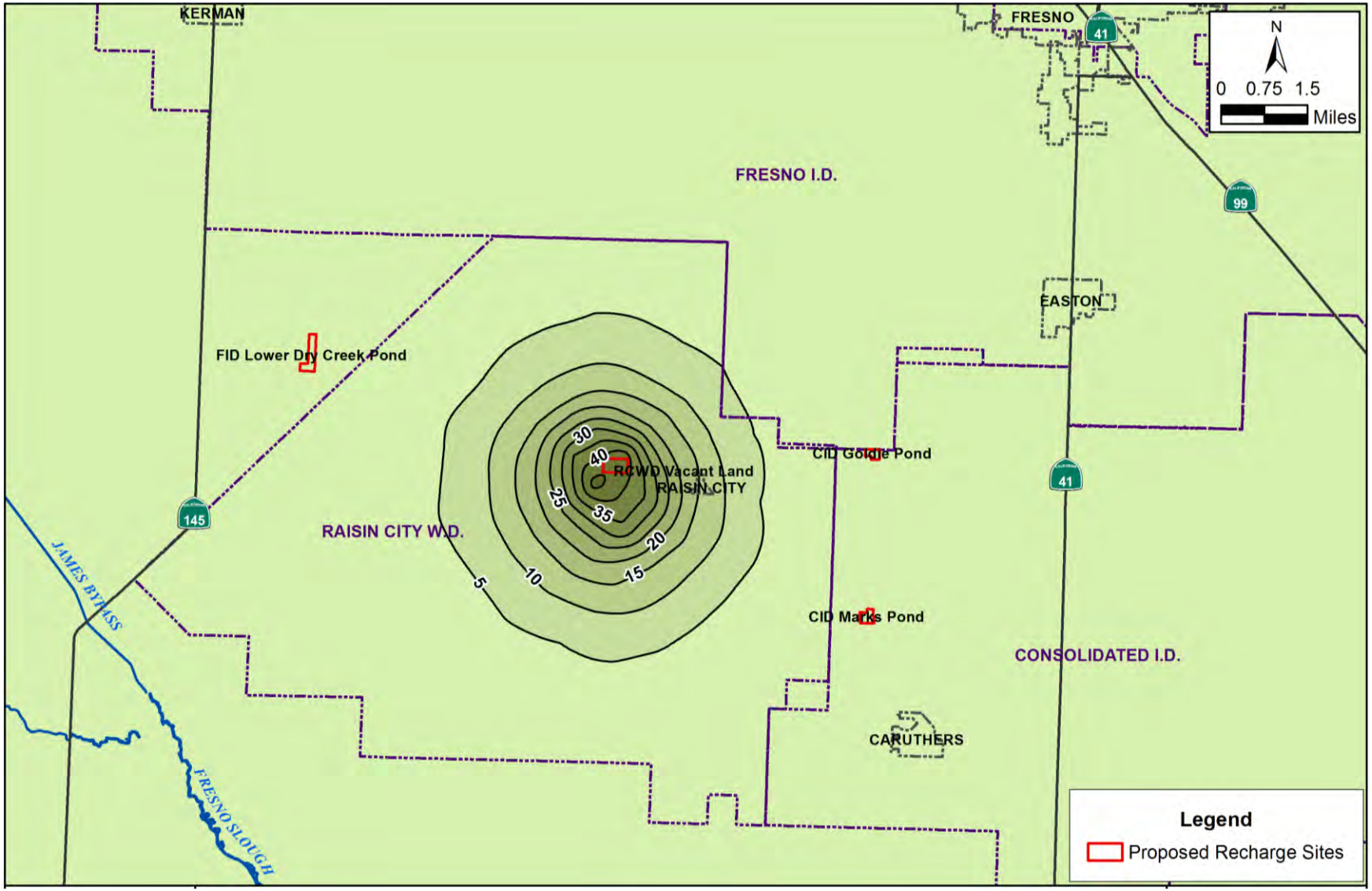


Figure 8.3 - Contour Map of Groundwater Level Increases for year 21 at RCWD Pond for High Recharge Scenario 1b (feet)

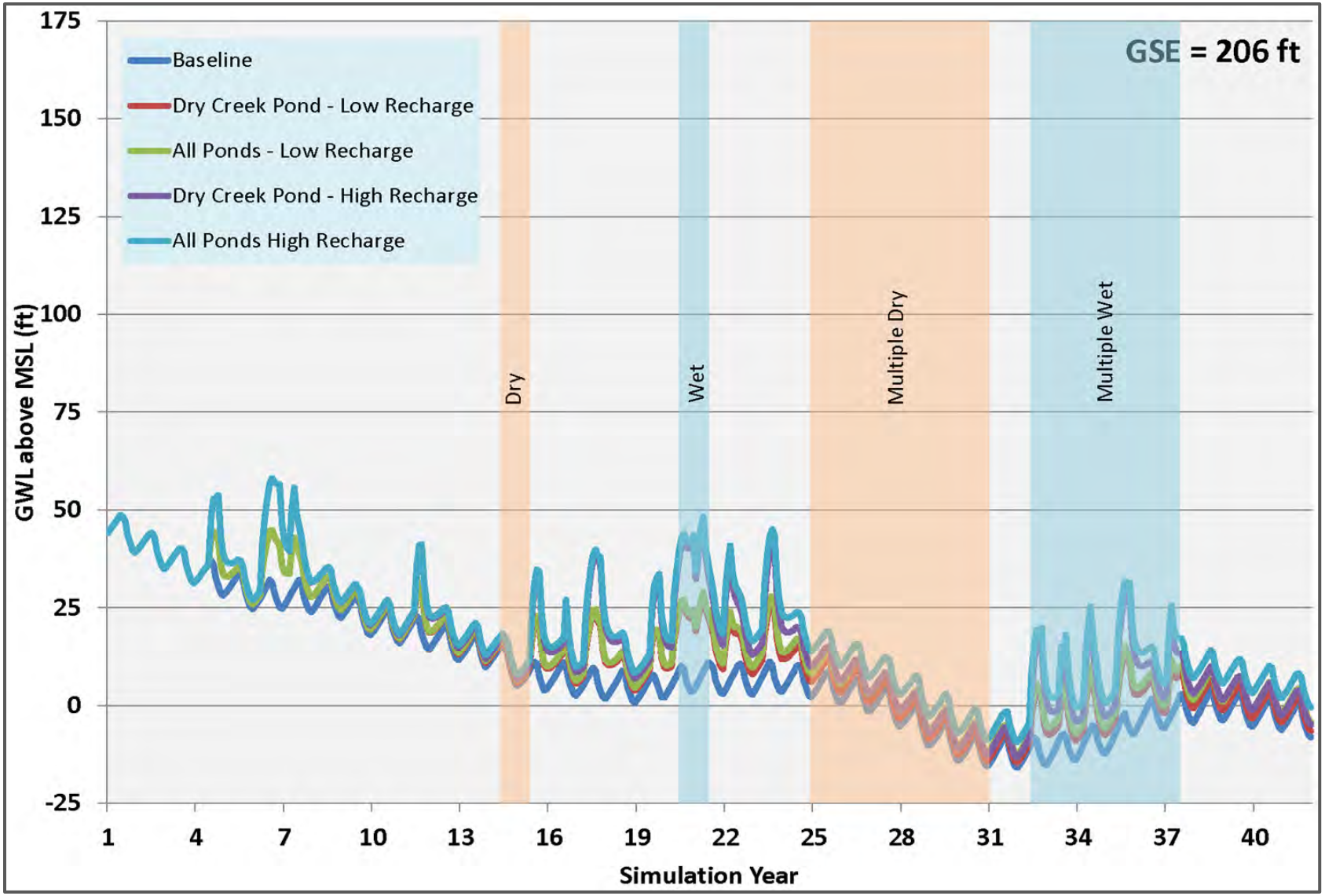


Figure 8.4 - Hydrographs of Groundwater Levels at Dry Creek Pond

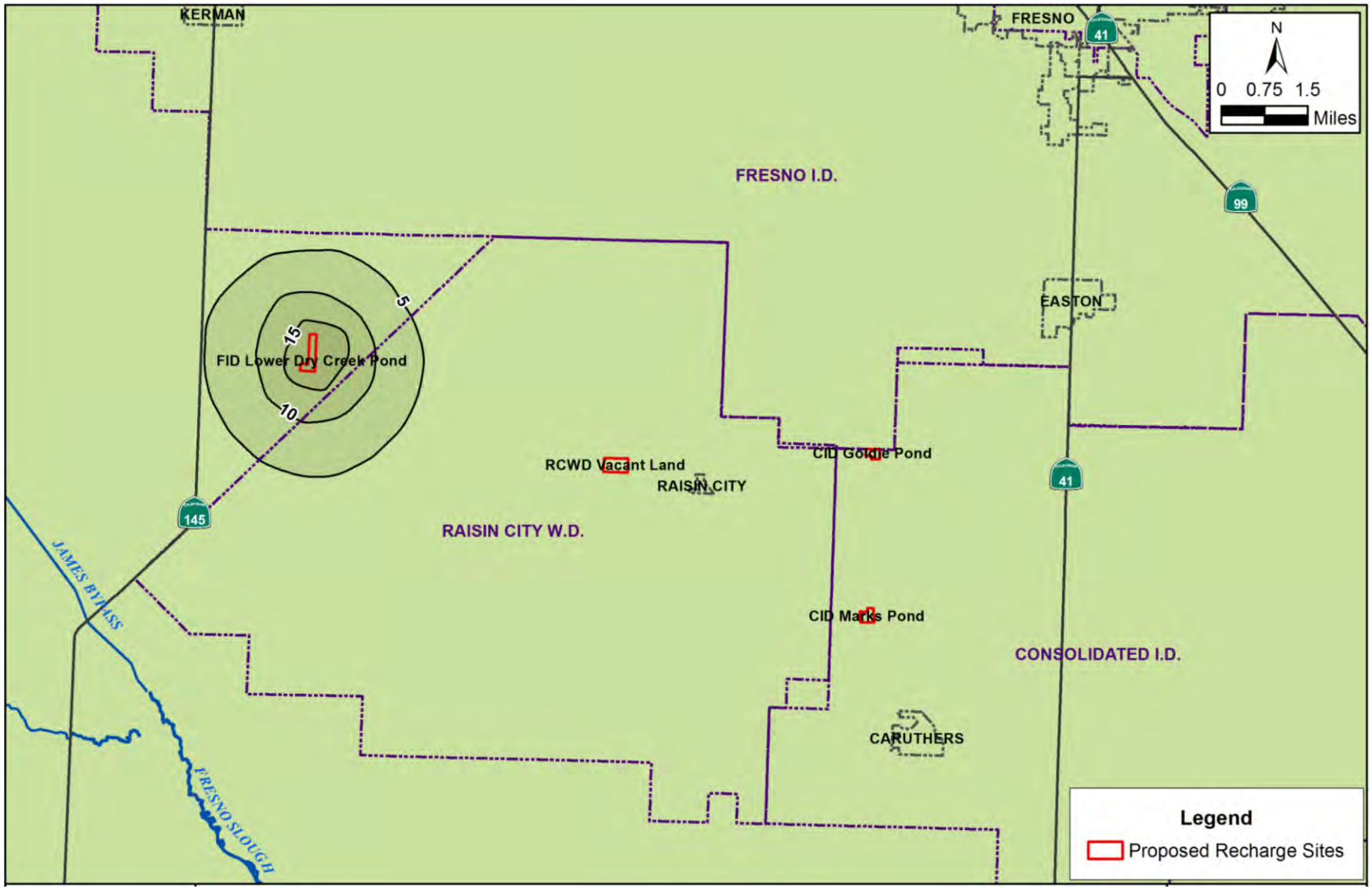


Figure 8.5 - Contour Map of Groundwater Level Increases for year 21 at Dry Creek Pond for Low Recharge Scenario 2a, (feet)

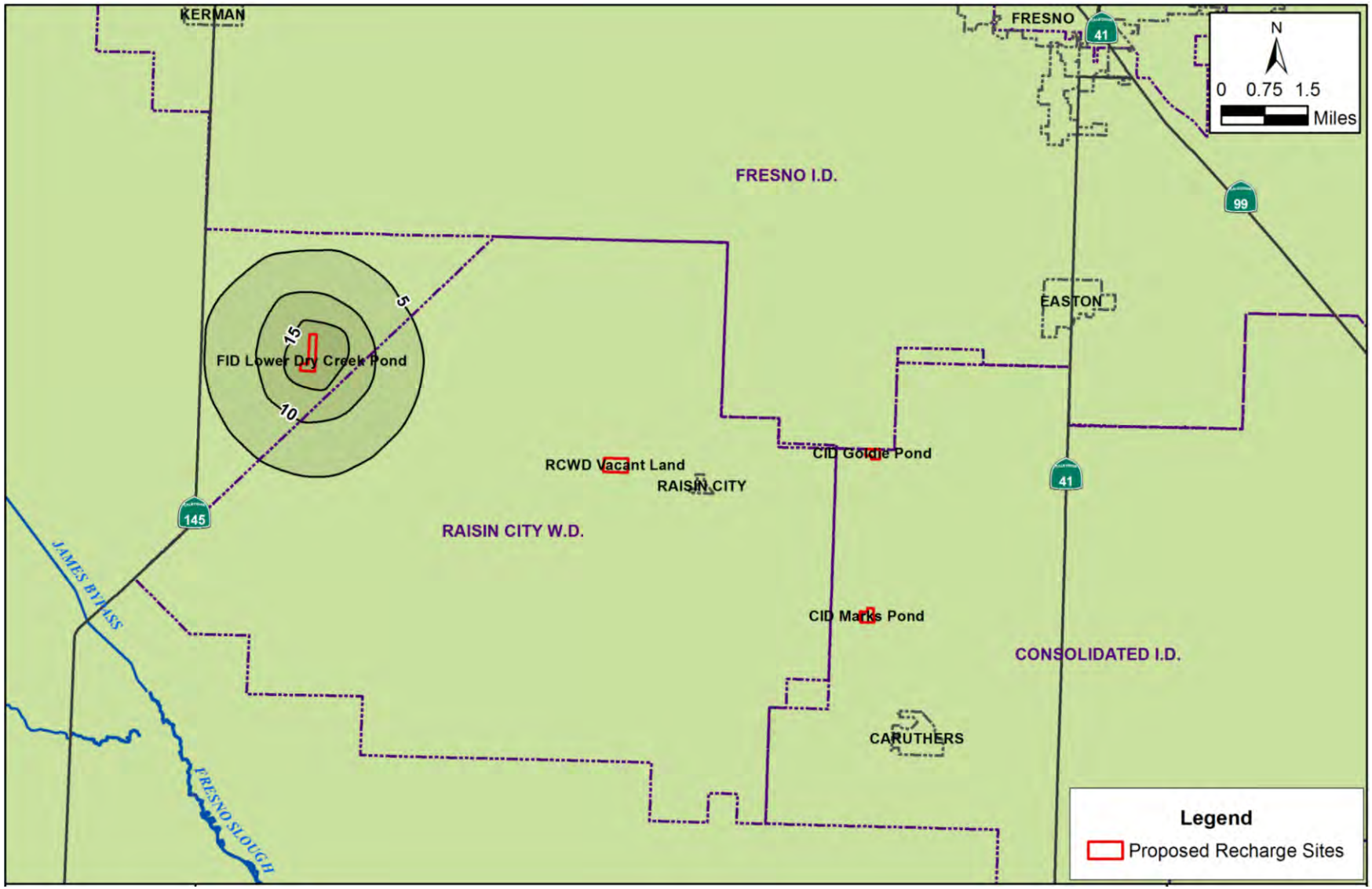


Figure 8.6 - Contour Map of Groundwater Level Increases for year 21 at Dry Creek Pond for High Recharge Scenario 2b, (feet)

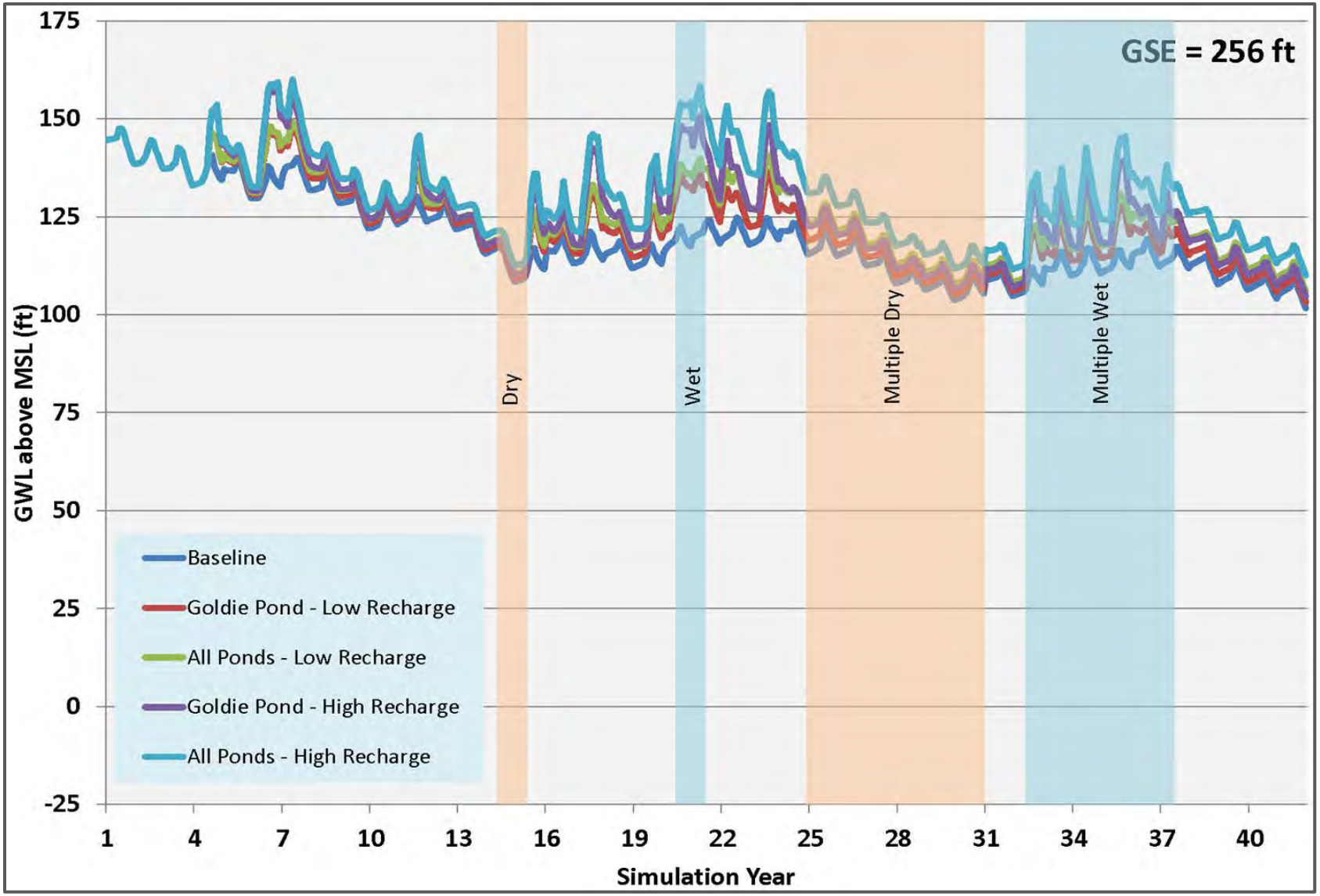


Figure 8.7 - Hydrographs of Groundwater Levels at Goldie Pond

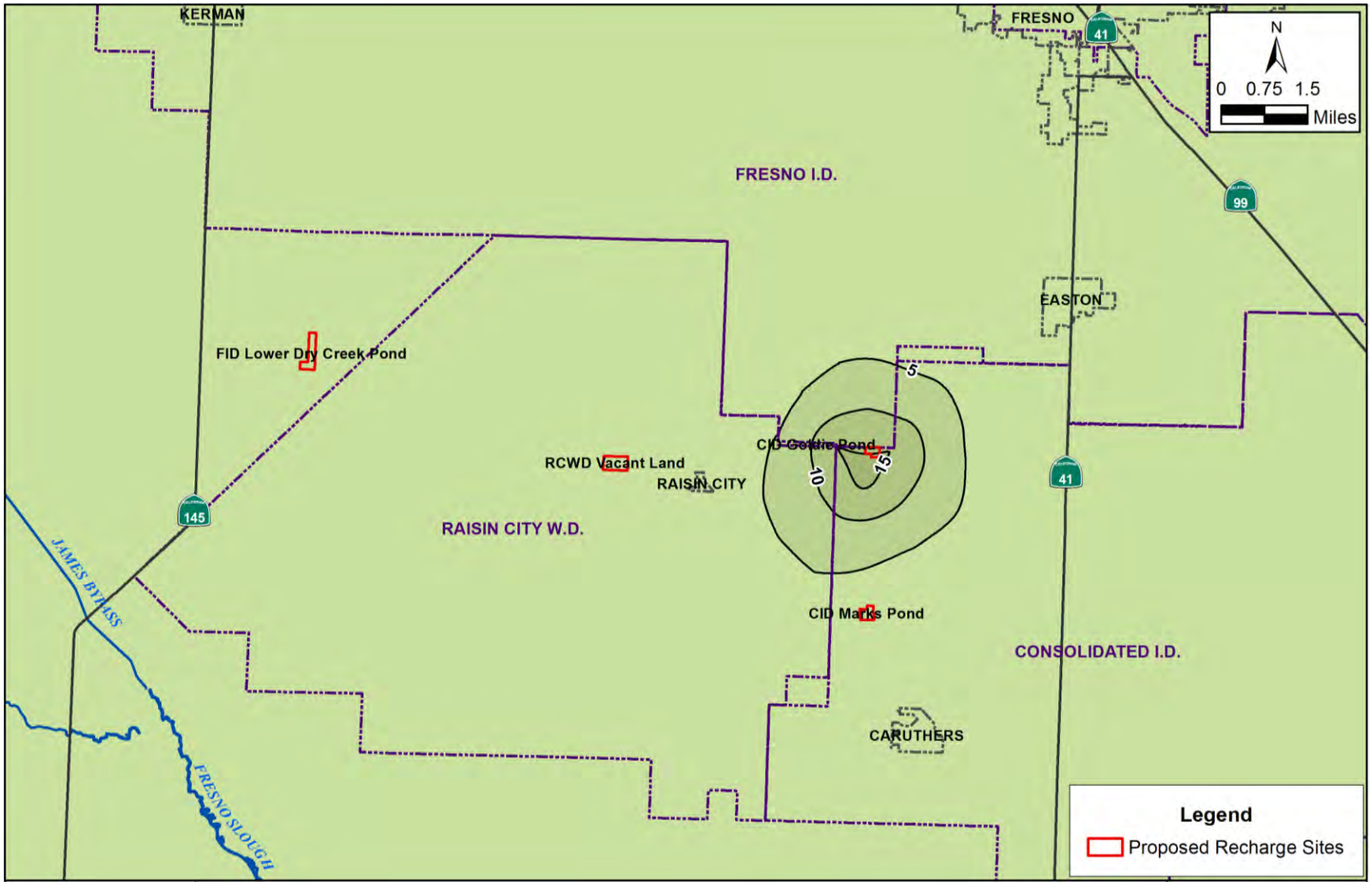


Figure 8.8 - Contour Map of Groundwater Level Increases for year 21 at Goldie Pond for Low Recharge Scenario 3a, (feet)

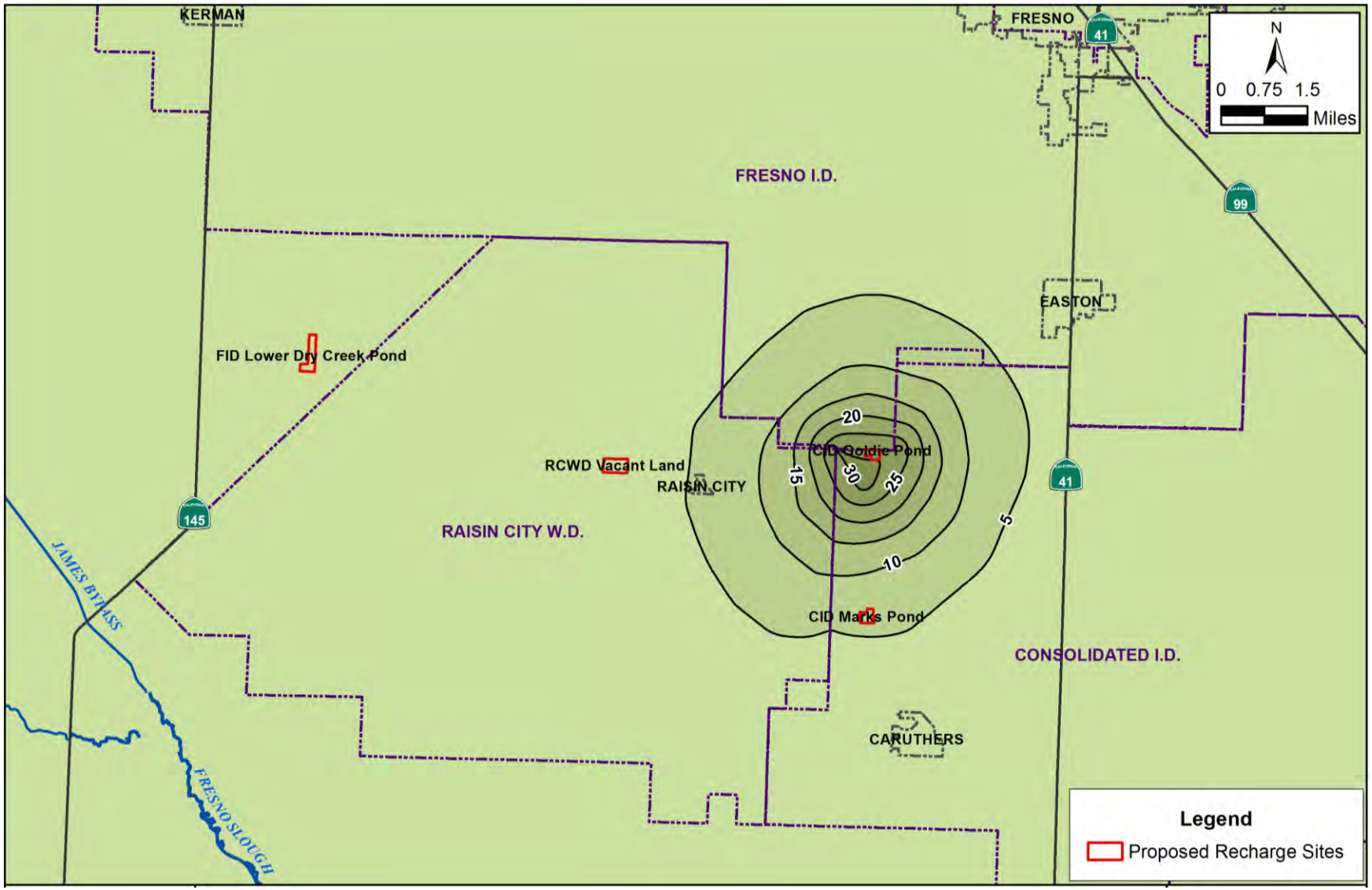


Figure 8.9 - Contour Map of Groundwater Level Increases for year 21 at Goldie Pond for High Recharge Scenario 3b, (feet)

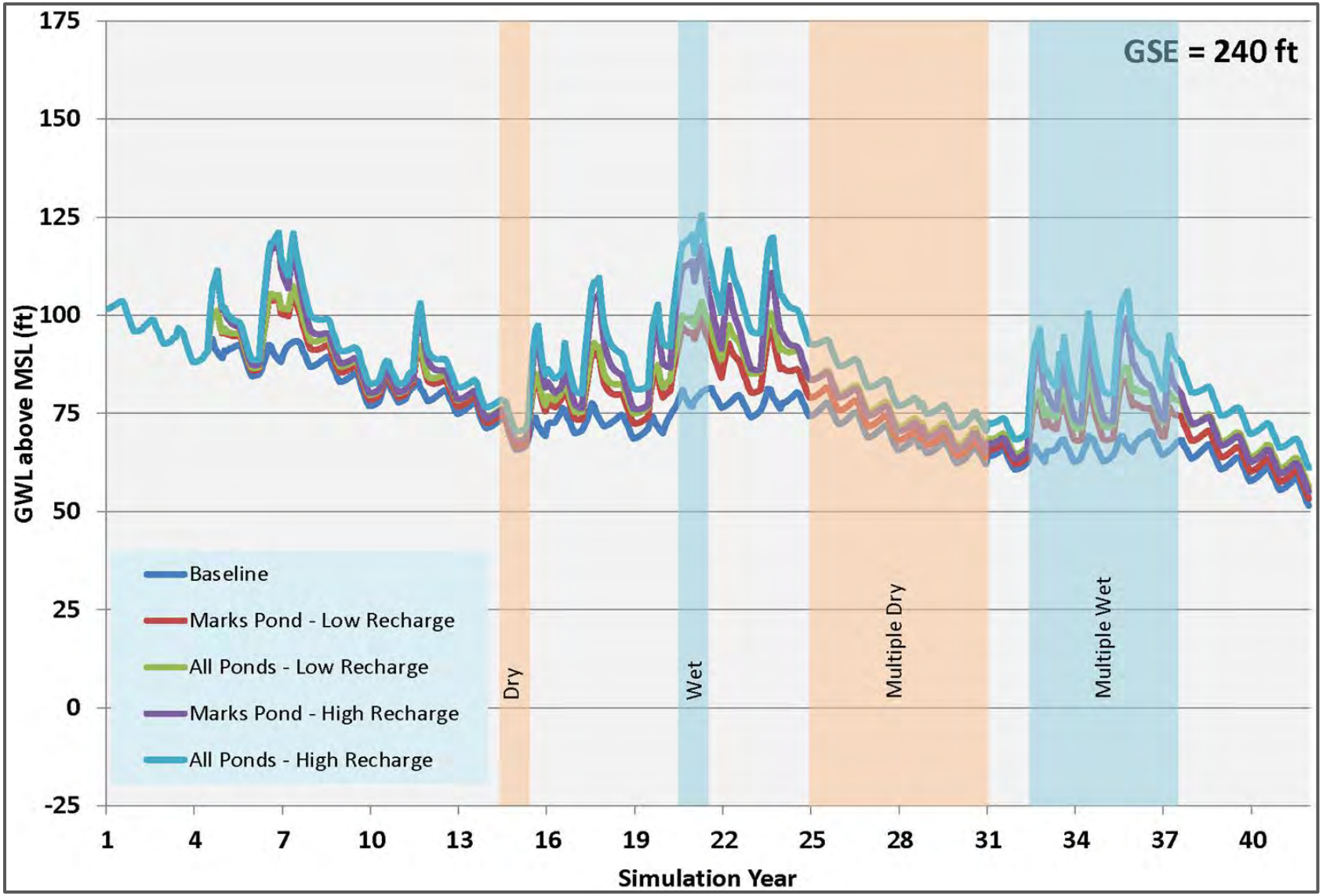


Figure 8.10 - Hydrographs of Groundwater Levels at Marks Pond

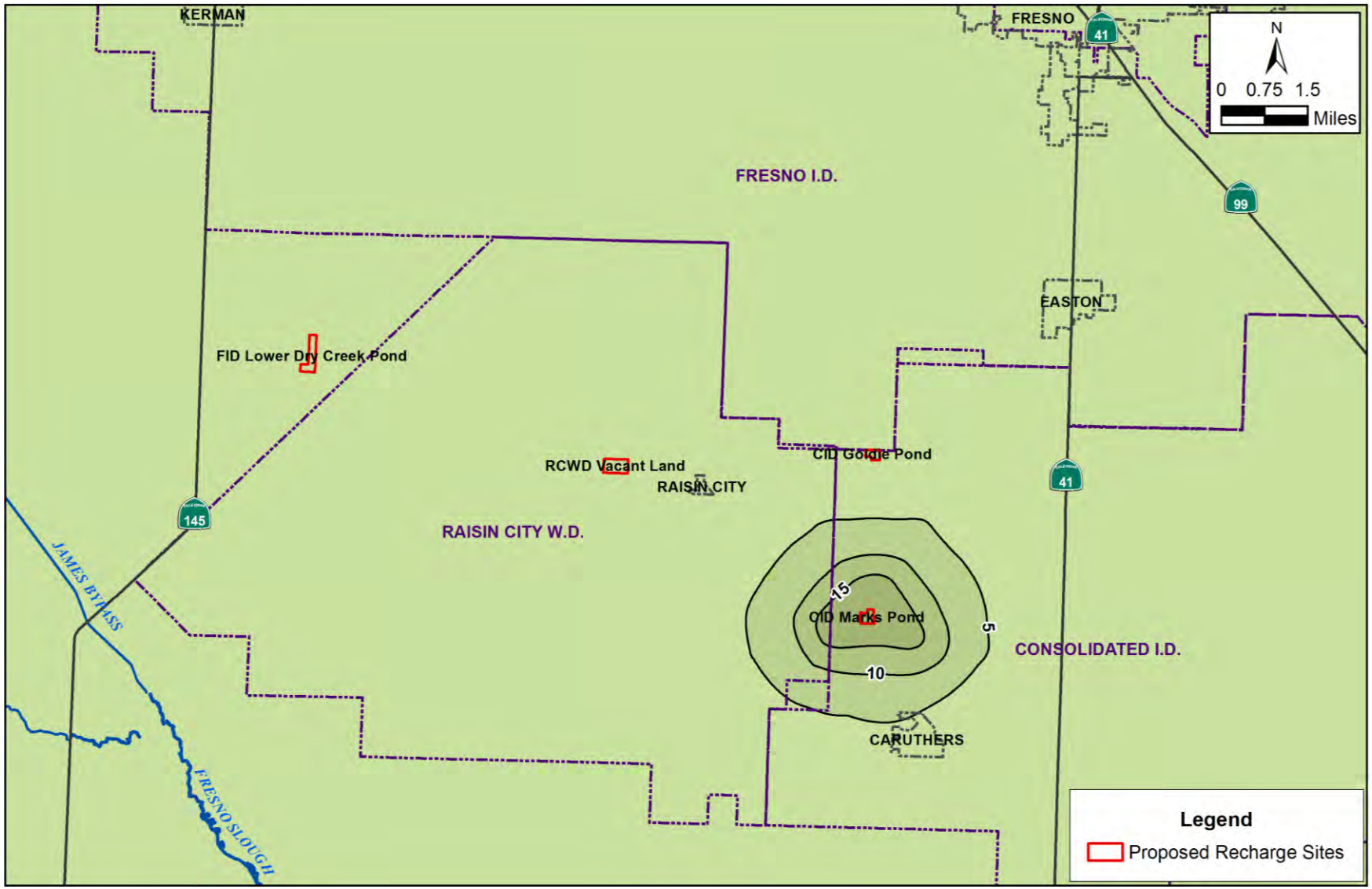


Figure 8.11 - Contour Map of Groundwater Level Increases for year 21 at Marks Pond for Low Recharge Scenario 4a, (feet)

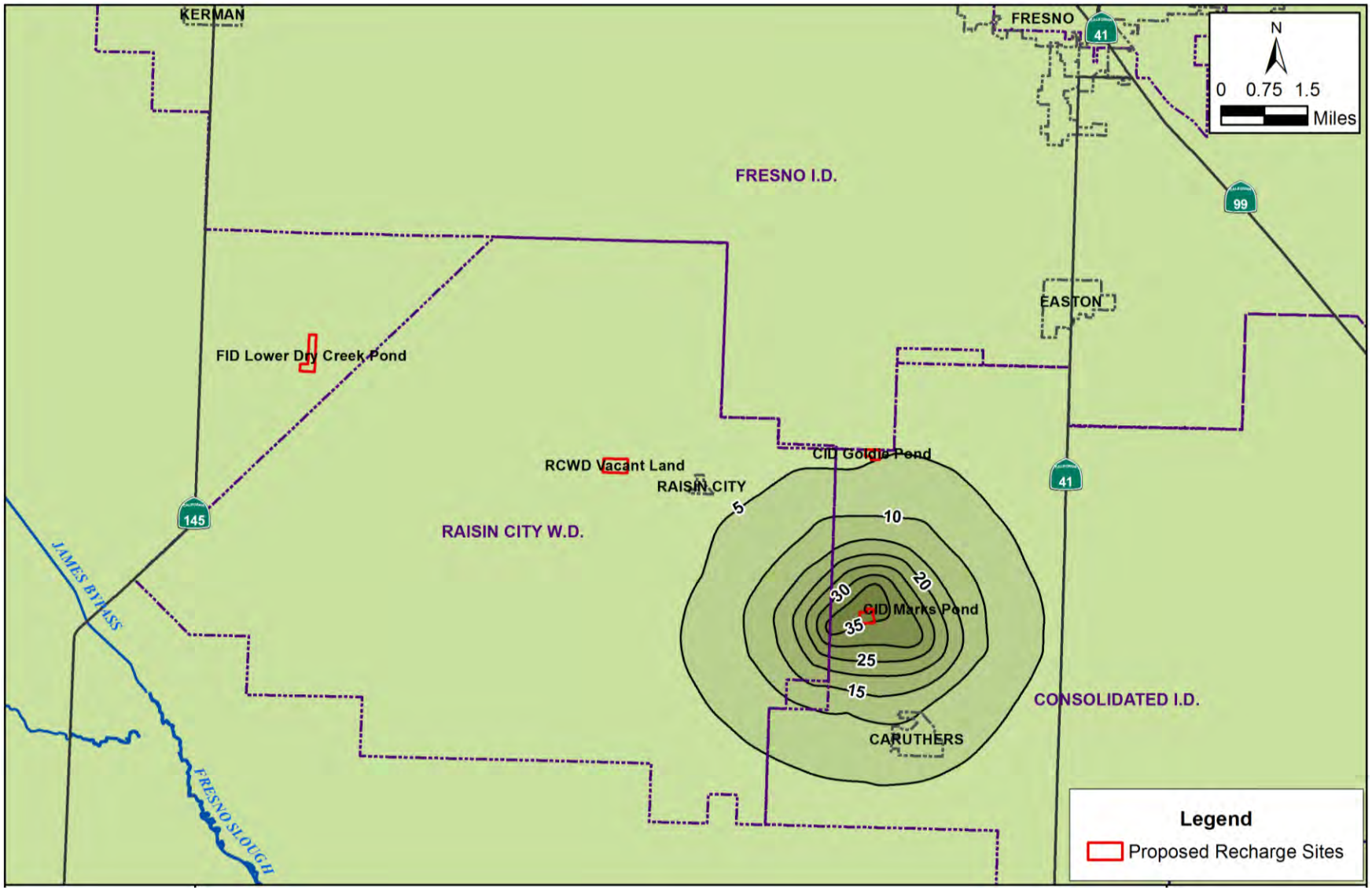


Figure 8.12 - Contour Map of Groundwater Level Increases for year 21 at Marks Pond for High Recharge Scenario 4b, (feet)

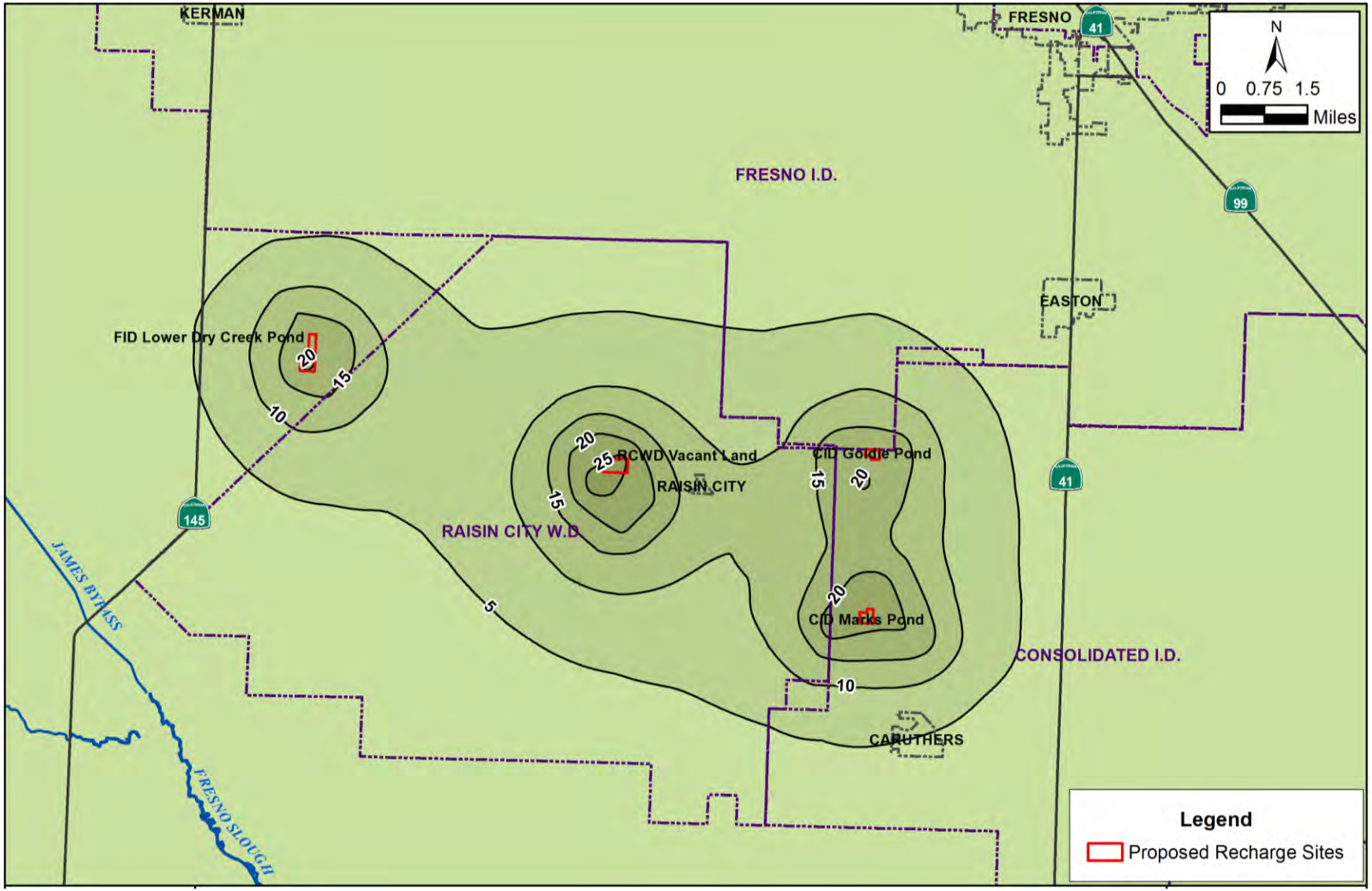


Figure 8.13 - Contour Map of Groundwater Level Increases for year 21 at All Ponds for Low Recharge Scenario 5a, (feet)

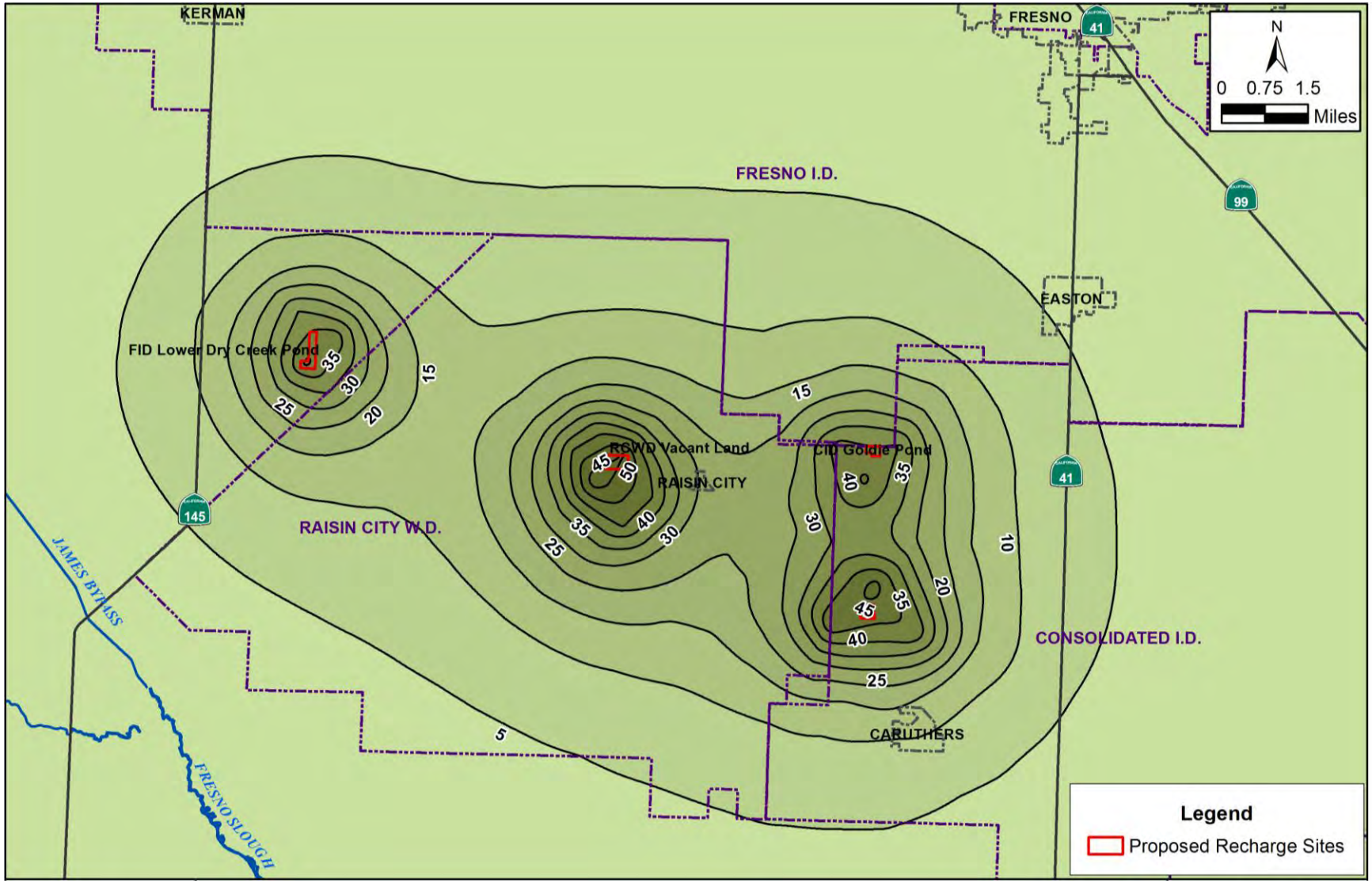


Figure 8.14 - Contour Map of Groundwater Level Increases for year 21 at All Ponds for High Recharge Scenario 5b, (feet)

APPENDIX A TEXTURAL SUMMARY OF BORING LOGS

WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	Texture_Modifier_1	Texture_Modifier_2	Texture	Color_Qualifier	Color_1	Color_2
723780	20841	0	2				Hard Pan			
723780	20842	2	7		Sandy		Loam			
723780	20843	7	12	Soft			Clay			
723780	20844	12	32	Fine			Sand			
723780	20845	32	35	Soft			Clay		Brown	
723780	20846	35	50				Sand		White	
723780	20847	50	57		Sandy		Clay		Brown	
723780	20848	57	62	Soft			Clay		Grey	
723780	20849	62	110	Coarse			Sand		Grey	
723780	20850	110	117	Soft			Clay		Grey	
723780	20851	117	125	Fine			Sand			
723780	20852	125	180	Coarse			Sand		Grey	
723780	20853	180	215	Soft			Clay		Grey	
723780	20854	215	250	Coarse			Sand		Grey	
723780	20855	250	260	Soft			Clay		Brown	
723780	20856	260	288	Soft			Clay		Grey	
723780	20857	288	301	Coarse			Sand		Grey	
723780	20858	301	307	Soft			Clay		Grey	
723780	20859	307	320	Coarse			Sand		Grey	
723780	20860	320	338	Soft			Clay		Blue	
723780	20861	338	344	Coarse			Sand		Blue	
723780	20862	344	345	Fine	Sandy		Silt		Blue	
723780	20863	345	370	Coarse			Sand		Blue	
723780	20864	370	380	Soft			Clay		Blue	
723780	20865	380	382		Sandy	Silty	Clay		Blue	
723780	20866	382	395	Soft			Clay		Blue	
723780	20867	395	400	Fine			Sand		Blue	
723780	20868	400	410		Sandy		Clay		Blue	
723780	20869	410	420	Coarse			Sand		Blue	
723780	20870	420	446	Soft			Clay		Blue	
723780	20871	446	448	Coarse			Sand		Brown	
723780	20872	448	450	Soft			Clay		Brown	
723780	20873	450	471	Coarse			Sand		Brown	
723780	20874	471	475		Silty		Silt		Blue	

WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier	exture_Modifier	Texture	Color_Qualifier	Color_1	Color_2
44961	20876	0	2				Top Soil			
44961	20877	2	6				Sand			
44961	20878	6	23	Hard			Clay			
44961	20879	23	38				Clay			
44961	20880	38	42	Hard			Clay		Red	
44961	20881	42	54	Fine			Sand		Red	
44961	20882	54	56	Soft			Clay			
44961	20883	56	58	Hard			Clay		Red	
44961	20884	58	64	Soft			Clay			
44961	20885	64	70	Hard			Clay		Red	
44961	20886	70	84	Medium			Sand			
44961	20887	84	104	Hard			Clay			
44961	20888	104	128		Sandy		Clay			
44961	20889	128	141	Coarse			Sand			
44961	20890	141	148		Clayey		Sand			
44961	20891	148	152	Coarse			Sand			
44961	20892	152	162		Sandy		Clay			
44961	20893	162	180	Hard			Clay			
44961	20894	180	184		Sandy		Clay			
44961	20895	184	185	Medium			Sand			

WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
79803	20593	0	2				Top Soil			
79803	20594	2	5				Hard Pan			
79803	20595	5	10				Sand			
79803	20596	10	16	Hard			Clay			
79803	20597	16	25		Sandy		Clay			
79803	20598	25	38				Sand			
79803	20599	38	49	Soft	Sandy		Clay			
79803	20600	49	65				Sand			
79803	20601	65	118	Cemented			Sand			
79803	20602	118	128				Sand			
79803	20603	128	216				Laminated			
79803	20604	216	236				Sand			
79803	20605	236	239		Sandy		Clay			
79803	20606	239	270	Fine			Sand			
79803	20607	270	289				Laminated			
79803	20608	289	304		Gravelly		Sand			
79803	20609	304	316				Laminated			
79803	20610	316	330	Hard			Clay		Blue	
79803	20611	330	331	Coarse			Gravel			

WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier	exture_Modifier	Texture	Color_Qualifier	Color_1	Color_2
83481	20958	0	20				Clay			
83481	20959	20	22				Sand			
83481	20960	22	43				Clay		Brown	
83481	20961	43	61				Sand			
83481	20962	61	65				Clay		grey	
83481	20963	65	73				Clay		Brown	
83481	20964	73	79				Sand			
83481	20965	79	109				Clay		Grey	
83481	20966	109	117				Sand			
83481	20967	117	168				Clay		Grey	
83481	20968	168	174	Fine			Sand			
83481	20969	174	197				Clay		Brown	
83481	20970	197	200	Medium			Sand			
83481	20971	200	218				Clay		Grey	
83481	20972	218	237	Medium			Sand			
83481	20973	237	271				Clay		Grey	
83481	20974	271	279	Medium			Sand			
83481	20975	279	281				Clay		Grey	
83481	20976	281	285	Medium			Sand			
83481	20977	285	291				Clay		Grey	
83481	20978	291	297	Medium			Sand			
83481	20979	297	304				Clay		Grey	
83481	20980	304	307	Fine			Sand			
83481	20981	307	310				Clay		Grey	
83481	20982	310	314	Medium			Sand			
83481	20983	314	319				Clay		Grey	
83481	20984	319	321	Medium			Sand			
83481	20985	321	343	Medium	Gravelly		Sand			
83481	20986	343	357				Clay		Grey	
83481	20987	357	378	Medium			Sand			
83481	20988	378	380	Fine			Sand			
83481	20989	380	398	Medium			Sand			
83481	20990	398	410				Clay		Grey	
83481	20991	410	422				Sand			
83481	20992	422	430		Sandy		Clay			
83481	20993	430	439		Gravelly		Sand			
83481	20994	439	458		Sandy		Clay		Grey	
83481	20995	458	478	Medium			Sand			
83481	20996	478	510		Sandy		Clay		Grey	

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WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
743382	21415	0	10		Sandy		Clay		Brown	
743382	21416	10	20				Clay		Green	
743382	21417	20	30				Clay			
743382	21418	30	40	Fine	Clayey		Sand			
743382	21419	40	52				Clay		Green	
743382	21420	52	56	Packed			Sand			
743382	21421	56	65		Sandy		Clay		Red	
743382	21422	65	70	Fine			Sand			
743382	21423	70	74				Sand			
743382	21424	74	116		Sandy		Clay		Brown	
743382	21425	116	119				Clay		Green	
743382	21426	119	122	Medium			Sand			
743382	21427	122	128	Medium			Sand			
743382	21428	128	131	Fine			Sand			
743382	21429	131	135				Clay		Brown	
743382	21430	135	139				Sand			
743382	21431	139	150				Clay		Red	
743382	21432	150	155	Medium			Sand			
743382	21433	155	159				Clay			
743382	21434	159	160	Medium			Sand			
743382	21435	160	165	Fine			Sand			
743382	21436	165	168	Coarse	rocky		Sand			
743382	21437	168	177				Clay		Green	
743382	21438	177	179		Sandy		Clay		Brown	
743382	21439	179	188	Coarse	Sandy		Gravel			
743382	21440	188	208	Joint			Clay			
743382	21441	208	215	Joint			Clay		Green	
743382	21442	215	223	Packed			Sand			
743382	21443	223	225				Sand			
743382	21444	225	233	Fine			Sand			
743382	21445	233	240	Medium			Sand			

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
89490	21257	0	3				Top Soil			
89490	21258	3	10				Clay		Brown	
89490	21259	10	21				Sand			
89490	21260	21	32				Clay		Brown	
89490	21261	32	38				Sand			
89490	21262	38	57				Clay		Brown	
89490	21263	57	65	Medium			Sand			
89490	21264	65	71				Clay		Brown	
89490	21265	71	89	Medium			Sand			
89490	21266	89	107				Clay		Brown	
89490	21267	107	112	Medium			Sand			
89490	21268	112	120				Clay		Brown	
89490	21269	120	146	Coarse			Sand			
89490	21270	146	151				Clay		Brown	
89490	21271	151	163	Medium			Sand			
89490	21272	163	182				Clay		Brown	
89490	21273	182	188	Medium			Sand			
89490	21274	188	200				Clay		Brown	
89490	21275	200	206	Fine			Sand			
89490	21276	206	219		Clayey		Sandstone			
89490	21277	219	226	Coarse			Sand			
89490	21278	226	237		Sandy		Clay			
89490	21279	237	253				Clay		Brown	
89490	21280	253	267	Medium			Sand			
89490	21281	267	298				Clay		Brown	
89490	21282	298	331	Medium			Sand			
89490	21283	331	350		Sandy		Clay			
89490	21284	350	367	Fine			Sand			
89490	21285	367	370		Sandy		Clay			
89490	21286	370	376	Medium			Sand			
89490	21287	376	387				Clay		Brown	
89490	21288	387	391	Medium			Sand			
89490	21289	391	407				Clay		Blue	
89490	21290	407	416	Medium			Sand			
89490	21291	416	448		Sandy		Clay		Blue	
89490	21292	448	459	Fine			Sand			
89490	21293	459	481				Clay		Blue	
89490	21294	481	493	Fine			Sand			
89490	21295	493	496		Sandy		Clay		Blue	
89490	21296	496	500	Medium			Sand			
89490	21297	500	510				Clay		Brown	
89490	21298	510	515	Medium			Sand			
89490	21299	515	526		Sandy		Clay		Brown	
89490	21300	526	530	Fine			Sand			
89490	21301	530	555				Clay		Brown	

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier	exture_Modifier	Texture	Color_Qualifier	Color_1	Color_2
89482	21332	0	7				Top Soil			
89482	21333	7	21				Sand			
89482	21334	21	47		Sandy		Clay			
89482	21335	47	59				Clay			
89482	21336	59	111		Sandy		Clay			
89482	21337	111	119				Clay		Brown	
89482	21338	119	137	Fine			Sand			
89482	21339	137	157				Clay		Brown	
89482	21340	157	187	Fine			Sand			
89482	21341	187	206				Clay		Brown	
89482	21342	206	221				Sand			
89482	21343	221	242		Sandy		Clay			
89482	21344	242	257				Sand			
89482	21345	257	261		Sandy		Clay			
89482	21346	261	280				Clay		Brown	
89482	21347	280	291	Medium			Sand			
89482	21348	291	298				Clay		Brown	
89482	21349	298	309	Coarse			Sand			
89482	21350	309	311		Sandy		Clay		Brown	
89482	21351	311	315	Medium			Sand			
89482	21352	315	338				Clay		Blue	
89482	21353	338	345	Coarse			Sand			
89482	21354	345	350				Clay		Blue	
89482	21355	350	358	Medium			Sand			
89482	21356	358	370				Clay		Blue	
89482	21357	370	378	Medium			Sand			
89482	21358	378	390				Clay		Blue	
89482	21359	390	394	Medium			Sand			
89482	21360	394	436				Clay		Brown	
89482	21361	436	442	Medium			Sand			
89482	21362	442	449		Sandy		Clay		Brown	
89482	21363	449	453	Medium			Sand			
89482	21364	453	460				Clay		Brown	
89482	21365	460	465	Medium			Sand			
89482	21366	465	471				Clay		Brown	
89482	21367	471	474	Medium			Sand			
89482	21368	474	480		Sandy		Clay		Brown	
89482	21369	480	484	Coarse			Sand			
89482	21370	484	490				Clay		Brown	
89482	21371	490	494	Medium			Sand			
89482	21372	494	498				Clay		Brown	
89482	21373	498	502	Medium			Sand			
89482	21374	502	510				Clay		Brown	
89482	21375	510	524		Gravelly		Sand			
89482	21376	524	535				Clay		Brown	

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
146572	21415	0	10		Sandy		Clay		Brown	
146572	21416	10	20				Clay		Green	
146572	21417	20	30				Clay			
146572	21418	30	40	Fine	Clayey		Sand			
146572	21419	40	52				Clay		Green	
146572	21420	52	56	Packed			Sand			
146572	21421	56	65		Sandy		Clay		Red	
146572	21422	65	70	Fine			Sand			
146572	21423	70	74				Sand			
146572	21424	74	116		Sandy		Clay		Brown	
146572	21425	116	119				Clay		Green	
146572	21426	119	122	Medium			Sand			
146572	21427	122	128	Medium			Sand			
146572	21428	128	131	Fine			Sand			
146572	21429	131	135				Clay		Brown	
146572	21430	135	139				Sand			
146572	21431	139	150				Clay		Red	
146572	21432	150	155	Medium			Sand			
146572	21433	155	159				Clay			
146572	21434	159	160	Medium			Sand			
146572	21435	160	165	Fine			Sand			
146572	21436	165	168	Coarse	rocky		Sand			
146572	21437	168	177				Clay		Green	
146572	21438	177	179		Sandy		Clay		Brown	
146572	21439	179	188	Coarse	Sandy		Gravel			
146572	21440	188	208	Joint			Clay			
146572	21441	208	215	Joint			Clay		Green	
146572	21442	215	223	Packed			Sand			
146572	21443	223	225				Sand			
146572	21444	225	233	Fine			Sand			
146572	21445	233	240	Medium			Sand			

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier	exture_Modifier	Texture	Color_Qualifier	Color_1	Color_2
85491	21014	0	2				Top Soil	Light		
85491	21015	2	6	Medium			Sand		Brown	
85491	21016	6	9	Brittle			Clay		Grey	
85491	21017	9	11	Medium			Sand		Brown	
85491	21018	11	13	Soft			Clay		Brown	
85491	21019	13	25	Medium			Sand		Brown	
85491	21020	25	41	Medium			Clay		Brown	
85491	21021	41	46	Coarse	Clayey		Sand		Brown	
85491	21022	46	50	Soft			Clay		Brown	
85491	21023	50	57	Medium			Sand		Brown	
85491	21024	57	70	Soft			Clay		Brown	
85491	21025	70	88	Coarse			Sand		Brown	
85491	21026	88	92	Hard			Clay		Grey	
85491	21027	92	99	Coarse			Sand		Brown	
85491	21028	99	115	Hard			Clay		Brown	
85491	21029	115	117	Fine			Sand		Brown	
85491	21030	117	125	Soft			Clay		Brown	
85491	21031	125	134	Brittle			Clay		Grey	
85491	21032	134	139	Medium			Sand		Brown	
85491	21033	139	152		Sandy		Clay		Brown	
85491	21034	152	161	Medium			Sand		Brown	
85491	21035	161	164	Soft			Clay		Brown	
85491	21036	164	170	Medium	Sandy		Clay			
85491	21037	170	193	Brittle			Clay		Brown	
85491	21038	193	214	Medium			Sand		Brown	
85491	21039	214	220	Soft			Clay		Brown	
85491	21040	220	224	Fine	Clayey		Sand		Brown	
85491	21041	224	235	Coarse			Sand		Grey	
85491	21042	235	242	Soft			Clay		Grey	
85491	21043	242	251	Medium			Sand		Grey	
85491	21044	251	264	Medium	Clayey		Sand			
85491	21045	264	277	Soft			Clay		Grey	
85491	21046	277	282	Medium			Sand		Grey	
85491	21047	282	321	Coarse			Sand		Grey	
85491	21048	321	325	Fine			Sand		grey	
85491	21049	325	336	Fine			Sand		Grey	
85491	21050	336	340		Sandy		Clay		Grey	
85491	21051	340	345	Soft			Clay		Blue	

15S19E29 (70468 RCWD)

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
70468	21581	0	5				Top Soil			
70468	21582	5	9	Medium			Clay			
70468	21583	9	17	Medium			Sand			
70468	21584	17	22	Medium			Clay		Brown	
70468	21585	22	40	Coarse			Sand		Brown	
70468	21586	40	47	Hard			Clay		Brown	
70468	21587	47	56	Coarse			Sand		Brown	
70468	21588	56	68	Medium			Clay		Brown	
70468	21589	68	80	Medium			Sand		Brown	
70468	21605	71	274	Coarse			Sand		Brown	
70468	21590	80	107		Sandy		Clay		Grey	
70468	21591	107	110	Coarse			Sand		Brown	
70468	21592	110	116	Medium			Clay		Brown	
70468	21593	116	123	Medium			Sand		Brown	
70468	21594	123	130	Medium	Sandy		Clay		Grey	
70468	21595	130	133	Medium			Sand		Grey	
70468	21596	133	134	Soft			Clay		Brown	
70468	21597	134	140	Fine			Sand		Brown	
70468	21598	140	144	Medium			Clay		Brown	
70468	21599	144	164	Coarse			Sand		Brown	
70468	21600	164	180	Medium			Clay		Brown	
70468	21601	180	206	Coarse			Sand		Brown	
70468	21602	206	218	Hard			Clay		Grey	
70468	21603	218	221	Medium			Sand		Brown	
70468	21604	221	271	Soft			Clay		Brown	
70468	21606	274	280	Medium			Clay		Grey	
70468	21607	280	282	Coarse			Sand		Grey	
70468	21608	282	290	Brittle			Clay		Grey	
70468	21609	290	298	Coarse			Sand		Brown	
70468	21610	298	314	Hard			Clay		Brown	
70468	21611	314	340	Fine			Sand		Brown	
70468	21612	340	360	Hard			Clay		Brown	
70468	21613	360	384	Coarse			Sand		Grey	
70468	21614	384	400	Medium	Sandy		Clay			
70468	21615	400	412	Soft			Clay		Grey	
70468	21616	412	417	Medium			Sand		Grey	
70468	21617	417	421	Soft			Clay		Grey	
70468	21618	421	426	Coarse			Sand		Grey	
70468	21619	426	432	Soft			Clay		Grey	
70468	21620	432	434	Fine			Sand		Grey	
70468	21621	434	443	Soft			Clay		Grey	
70468	21622	443	462	Fine			Sand		Brown	
70468	21623	462	469	Medium			Clay		Brown	
70468	21624	469	488	Coarse			Sand		Brown	
70468	21625	488	490	Hard			Clay		Brown	

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier	exture_Modifier	Texture	Color_Qualifier	Color_1	Color_2
192129	21486	0	2				Top Soil			
192129	21487	2	6		Sandy		Clay			
192129	21488	6	10	Hard			Clay			
192129	21489	10	17				Sand			
192129	21490	17	21				Clay			
192129	21491	21	37		Sandy		Clay			
192129	21492	37	45				Sand			
192129	21493	45	53				Clay			
192129	21494	53	60				Sand			
192129	21495	60	71		Sandy		Clay			
192129	21496	71	88				Sand		Blue	
192129	21497	88	94	Soft			Clay		Brown	
192129	21498	94	98				Sand		Brown	
192129	21499	98	103		Sandy		Clay		Blue	
192129	21500	103	113				Sand		Blue	
192129	21501	113	120				Clay		Brown	
192129	21502	120	142				Sand		Brown	
192129	21503	142	158		Sandy		Clay		Brown	
192129	21504	158	176				Sand			
192129	21505	176	180		Sandy		Clay			
192129	21506	180	185				Sand			
192129	21507	185	194	Hard			Clay		Brown	
192129	21508	194	199				Sand			
192129	21509	199	204	Hard			Clay		Grey	
192129	21510	204	223	Hard			Clay		Brown	
192129	21511	223	234	Fine			Sand			

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
335317	21469	0	4				Top Soil			
335317	21470	4	6				Hard Pan			
335317	21471	6	17	Hard			Clay			
335317	21472	17	25	Soft			Clay			
335317	21473	25	68		Sandy		Clay			
335317	21474	68	73				Sand			
335317	21475	73	126	Hard	Sandy		Clay			
335317	21476	126	133	Coarse			Sand			
335317	21477	133	139	Hard			Clay			
335317	21478	139	157	Coarse	Gravelly		Sand			
335317	21479	157	165	Hard			Clay			
335317	21480	165	170				Sand			
335317	21481	170	173	Soft	Sandy		Clay			
335317	21482	173	179	Hard			Clay			
335317	21483	179	184				Sand			
335317	21484	184	196	Hard	Sandy		Clay			
335317	21485	197	198				Sand			

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
40939	21446	0	5	Fine			Sand			
40939	21447	5	50	Coarse			Sand			
40939	21448	50	58		Sandy		Clay		Brown	
40939	21449	58	65		Sandy		Clay		Green	
40939	21450	65	88	Fine			Sand			
40939	21451	88	93	Joint			Clay		Grey	
40939	21452	93	103				Clay		Red	
40939	21453	103	106		Sandy		Clay		Brown	
40939	21454	106	115	Medium			Sand			
40939	21455	115	120				Clay		Grey	
40939	21456	120	125	Fine			Sand			
40939	21457	125	130				Clay		Green	
40939	21458	130	140	Coarse			Sand			
40939	21459	140	148	Coarse			Sand			
40939	21460	148	160				Clay		Green	
40939	21461	160	172	Coarse			Gravel			
40939	21462	172	176				Clay		Brown	
40939	21463	176	180	Coarse			Sand			
40939	21464	180	190	Coarse			Sand			
40939	21465	190	200	Medium			Sand			
40939	21466	200	212				Clay		Brown	
40939	21467	212	220	Medium			Sand			
40939	21468	220	228	Coarse			Sand			

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
24711	21686	0	20				Sand			
24711	21687	20	24	Packed			Sand			
24711	21688	24	30		Sandy		Clay		Brown	
24711	21689	30	72	Joint			Clay		Brown	
24711	21690	72	73	Medium			Sand			
24711	21691	73	84		Sandy		Clay		Brown	
24711	21692	84	100	Medium			Sand			
24711	21693	100	104	Medium			Sand			
24711	21694	104	144		Sandy		Clay		Brown	
24711	21695	144	147	Coarse	rocky		Sand			
24711	21696	147	150				Clay		Red	
24711	21697	150	170	Packed			Sand			
24711	21698	170	185				Clay		Grey	
24711	21699	185	188	Joint			Clay		Brown	
24711	21700	188	200		Sandy		Clay		Green	
24711	21701	200	220	Medium			Sand			
24711	21702	220	240	Medium			Sand			

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
86384	21795	0	4		Sandy		Top Soil		Brown	
86384	21796	4	6	Medium			Clay		Brown	
86384	21797	6	24	Coarse			Sand		Brown	
86384	21798	24	35	Soft			Clay		Brown	
86384	21799	35	63	Coarse			Sand		Brown	
86384	21800	63	70	Medium	Clayey		Sand			
86384	21801	70	81		Sandy		Clay		Brown	
86384	21802	81	87	Coarse			Sand		Brown	
86384	21803	87	92	Soft			Clay		Brown	
86384	21804	92	104	Coarse			Sand		Brown	
86384	21805	104	117		Sandy		Clay		Grey	
86384	21806	117	129	Medium			Sand		Brown	
86384	21807	129	148	Hard			Clay		Brown	
86384	21808	148	154	Coarse			Sand		Grey	
86384	21809	154	163	Brittle			Clay		Brown	
86384	21810	163	167	Coarse			Sand		Brown	
86384	21811	167	170	Coarse	Sandy		Clay		Brown	
86384	21812	170	174	Coarse			Sand		Brown	
86384	21813	174	182	Hard			Clay		Brown	
86384	21814	182	187	Medium			Sand		Brown	
86384	21815	187	200		Sandy		Clay		Brown	
86384	21816	200	208	Fine			Sand		Brown	
86384	21817	208	213	Medium			Sand		Brown	
86384	21818	213	228	Brittle			Clay		Brown	
86384	21819	228	240	Coarse			Sand		Brown	
86384	21820	240	245	Medium			Clay		Brown	
86384	21821	245	250	Fine			Sand		Brown	
86384	21822	250	255	Medium			Clay		Grey	
86384	21823	255	257	Fine			Sand		Grey	
86384	21824	257	259	Brittle			Clay		Grey	
86384	21825	259	265	Coarse			Sand		Grey	
86384	21826	265	275	Medium			Clay		Grey	

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
512111	21524	0	4		Sandy		Top Soil			
512111	21525	4	44	Fine			Sand		Brown	
512111	21526	44	48				Clay		Grey	
512111	21527	48	56	Fine			Sand		Grey	
512111	21528	56	60		Silty		Clay		Grey	Tan
512111	21529	60	76		Clayey		Sand		Grey	
512111	21530	76	83	Fine			Sand		Grey	
512111	21531	83	88		Clayey		Sand		Grey	
512111	21532	88	89				Clay		Grey	
512111	21533	89	103	Fine			Sand		Grey	
512111	21534	103	109				Clay		Grey	
512111	21535	109	122	Fine			Sand		Grey	
512111	21536	122	125		Clayey		Sand		Tan	
512111	21537	125	127	Cemented			Sand		Grey	
512111	21538	127	148	Coarse	Gravelly		Sand		Tan	
512111	21539	148	150				Clay		Grey	
512111	21540	150	157		Sandy		Clay		Tan	
512111	21541	157	162		Clayey		Sand		Brown	
512111	21542	162	170	Medium			Sand		Tan	
512111	21543	170	177		Sandy		Clay		Grey	
512111	21544	177	189	Medium			Sand		Tan	
512111	21545	189	191		Sandy		Clay		Tan	
512111	21546	191	197	Medium			Sand		Tan	
512111	21547	197	200				Clay		Grey	
512111	21548	200	212		Sandy		Clay		Red	Brown
512111	21549	212	234	Coarse	Gravelly		Sand		Tan	
512111	21550	234	237		Sandy		Clay		Grey	
512111	21551	237	243	Fine			Sand		Tan	
512111	21552	243	245		Sandy		Clay		Tan	
512111	21553	245	248	Fine			Sand		Tan	

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
48223	21935	0	11				Top Soil			
48223	21936	11	17				Clay		Grey	
48223	21937	17	31				Sand			
48223	21938	31	36	Cemented	Clayey		Sand			
48223	21939	36	64				Sand			
48223	21940	64	72				Clay		Blue	
48223	21941	72	81	Packed			Sand		Blue	
48223	21942	81	85		Sandy		Clay		Brown	
48223	21943	85	88	Coarse			Sand			
48223	21944	88	93		Sandy		Clay		Grey	
48223	21945	93	98		Sandy		Clay			
48223	21946	98	106				Clay			
48223	21947	106	114	Coarse			Sand			
48223	21948	114	117				Clay		Grey	
48223	21949	117	123	Coarse			Sand			
48223	21950	123	129	Cemented			Sand			
48223	21951	129	132	Coarse			Sand			
48223	21952	132	135				Clay		Grey	
48223	21953	135	142	Coarse			Sand			
48223	21954	142	150	Hard			Clay		Red	
48223	21955	150	157	Coarse			Sand			
48223	21956	157	166	Cemented	Clayey		Sand		Grey	
48223	21957	166	177	Coarse			Sand			
48223	21958	177	179				Clay		Grey	
48223	21959	179	181	Coarse			Sand			
48223	21960	181	183				Clay		Grey	
48223	21961	183	184	Coarse			Sand			
48223	21962	184	190				Clay		Brown	

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
87445	15227	0	4		Sandy		Top Soil			
87445	15228	4	6		Sandy		Clay		Grey	
87445	15229	6	12	Coarse			Sand		Grey	
87445	15230	12	15	Hard			Clay		Grey	
87445	15231	15	23	Coarse			Sand		Grey	
87445	15232	23	35	Soft			Clay		Grey	
87445	15233	35	47	Coarse			Sand		Grey	
87445	15234	47	53	Soft			Clay		Grey	
87445	15235	53	82	Coarse			Sand		Grey	
87445	15236	82	101	Soft			Clay		Grey	
87445	15237	101	112	Coarse			Sand		Grey	
87445	15238	112	123	Soft			Clay		Grey	
87445	15239	123	130	Coarse			Sand		Grey	
87445	15240	130	148	Soft			Clay		Grey	
87445	15241	148	153	Coarse			Sand		Grey	
87445	15242	153	171	Coarse			Sand		Grey	
87445	15243	171	175	Soft			Clay		Grey	
87445	15244	175	197	Coarse			Sand		Grey	
87445	15245	197	206	Soft			Clay		Grey	
87445	15246	206	223	Coarse			Sand		Grey	
87445	15247	223	225	Soft			Clay		Grey	

)WR_Log_Numbe	Texture_Key	Top_Depth	Bottom_Depth	Texture_Qualifier	exture_Modifier_	exture_Modifier_	Texture	Color_Qualifier	Color_1	Color_2
158607	14863	0	6		Sandy		Top Soil			
158607	14864	6	14	Soft			Clay		Grey	
158607	14865	14	19	Coarse			Sand		Grey	
158607	14866	19	27	Soft			Clay		Brown	
158607	14867	27	39	Coarse			Sand		Brown	
158607	14868	39	46	Hard			Clay		Brown	
158607	14869	46	69	Coarse			Sand		Grey	
158607	14870	69	102	Soft			Clay		Grey	
158607	14871	102	129	Coarse			Sand		Brown	
158607	14872	129	146	Soft			Clay		Grey	
158607	14873	146	167	Coarse			Sand		Grey	
158607	14874	167	208	Soft			Clay		Brown	
158607	14875	208	224	Coarse			Sand		Brown	
158607	14876	224	233	Soft			Clay		Grey	

APPENDIX B CPT RESULTS

GREGG DRILLING & TESTING, INC.
GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

May 14, 2012

WRIME, Inc.
Attn: Jim Blanke

Subject: CPT Site Investigation
Raisin City Water District, Goldie Pond Area, Marks Pond Area
California
GREGG Project Number: 12-071MA

Dear Mr. Blanke:

The following report presents the results of GREGG Drilling & Testing's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☐
4	UVOST Laser Induced Fluorescence	(UVOST)	☐
5	Groundwater Sampling	(GWS)	☐
6	Soil Sampling	(SS)	☐
7	Vapor Sampling	(VS)	☐
8	Pressuremeter Testing	(PMT)	☐
9	Vane Shear Testing	(VST)	☐
10	Dilatometer Testing	(DMT)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (925) 313-5800.

Sincerely,
GREGG Drilling & Testing, Inc.

Mary Walden
Operations Manager

950 Howe Rd • Martinez, California 94553 • (925) 313-5800 • FAX (925) 313-0302
OTHER OFFICES: LOS ANGELES • HOUSTON
www.greggdrilling.com

Cone Penetration Test Sounding Summary

-Table 1-

CPT Sounding Identification	Date	Termination Depth (Feet)	Depth of Groundwater Samples (Feet)	Depth of Soil Samples (Feet)	Depth of Pore Pressure Dissipation Tests (Feet)
2-CPT1	5/08/12	100	-	-	-
2-CPT2	5/08/12	100	-	-	-
2-CPT3	5/08/12	100	-	-	-
2-CPT4	5/07/12	100	-	-	41.3
2-CPT5	5/07/12	100	-	-	-
2-CPT6	5/08/12	100	-	-	-
3-CPT1	5/09/12	100	-	-	55.0
3-CPT2	5/09/12	100	-	-	-
3-CPT3	5/09/12	62	-	-	-
3-CPT4	5/09/12	100	-	-	-
4-CPT1	5/11/12	100	-	-	-
4-CPT2	5/10/12	100	-	-	-
4-CPT3	5/10/12	100	-	-	89.6
4-CPT4	5/10/12	100	-	-	76.3
4-CPT5	5/10/12	100	-	-	-

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Copies of ASTM Standards are available through www.astm.org

Cone Penetration Testing Procedure (CPT)

Gregg Drilling carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*. The soundings were conducted using a 20 ton capacity cone with a tip area of 15 cm^2 and a friction sleeve area of 225 cm^2. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.80.

The cone takes measurements of cone bearing (q_c), sleeve friction (f_s) and penetration pore water pressure (u_2) at 5-cm intervals during penetration to provide a nearly continuous log. CPT data reduction and interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored on disk for further analysis and reference. All CPT soundings are performed in accordance with revised (2007) ASTM standards (D 5778-07).

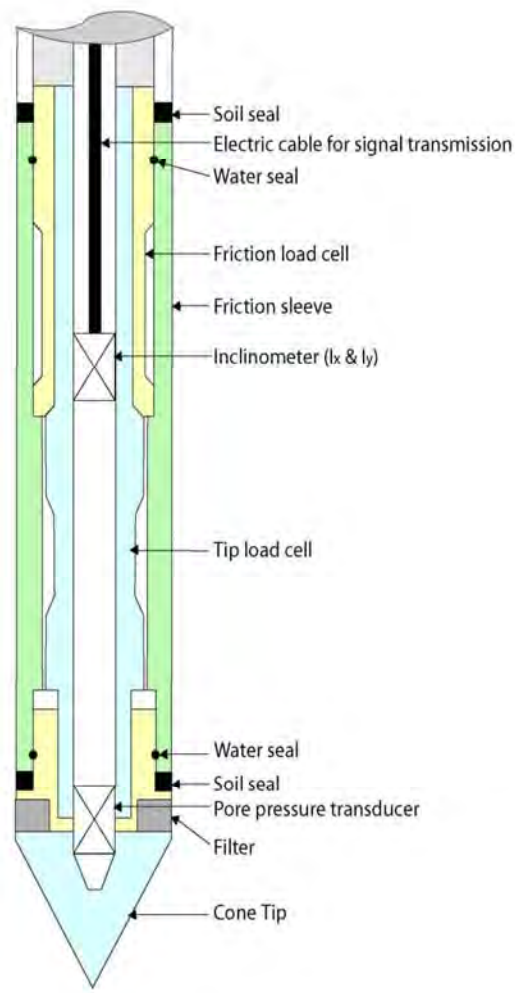


Figure CPT

The cone also contains a porous filter element located directly behind the cone tip (u_2). It consists of porous plastic and is 5.0mm thick. The filter element is used to obtain penetration pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (*PPDT's*) during appropriate pauses in penetration. It should be noted that prior to penetration, the element is fully saturated with oil under vacuum pressure to ensure accurate and fast dissipation.

The cone has the following accuracy:
1 tsf for q_c, 0.02 tsf for f_s and 0.5 psi for u_2. In soft clays, a lower capacity cone should be used for improved accuracy.

When the soundings are complete, the test holes are grouted. The grouting procedures generally consist of pushing a hollow tremie pipe with a "knock out" plug to the termination depth of the CPT hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

Cone Penetration Test (CPT) Interpretation

Gregg has recently updated their CPT interpretation and plotting software (2007). The software takes the CPT data and performs basic interpretation in terms of soil behavior type (SBT) and various geotechnical parameters using current published empirical correlations based on the comprehensive review by Lunne, Robertson and Powell (1997). The interpretation is presented in tabular format using MS Excel. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software.

The following provides a summary of the methods used for the interpretation. Many of the empirical correlations to estimate geotechnical parameters have constants that have a range of values depending on soil type, geologic origin and other factors. The software uses 'default' values that have been selected to provide, in general, conservatively low estimates of the various geotechnical parameters.

Input:

1. Units for display (Imperial or metric) (atm. pressure, pa = 0.96 tsf or 0.1 MPa)
2. Depth interval to average results,(ft or m). Data are collected at either 0.02 or 0.05m and can be averaged every 1, 3 or 5 intervals.
3. Elevation of ground surface (ft or m)
4. Depth to water table, z_w (ft or m) – input required
5. Net area ratio for cone, a (default to 0.80)
6. Relative Density constant, C_{Dr} (default to 350)
7. Young's modulus number for sands, α (default to 5)
8. Small strain shear modulus number
   a. for sands, S_G (default to 180 for SBT_n 5, 6, 7)
   b. for clays, C_G (default to 50 for SBT_n 1, 2, 3 & 4)
9. Undrained shear strength cone factor for clays, N_{kt} (default to 15)
10. Over Consolidation ratio number, k_{ocr} (default to 0.3)
11. Unit weight of water, (default to γ_w = 62.4 lb/ft^3 or 9.81 kN/m^3)

Column

1. Depth, z, (m) – CPT data is collected in meters
2. Depth (ft)
3. Cone resistance, q_c (tsf or MPa)
4. Sleeve friction, f_s (tsf or MPa)
5. Penetration pore pressure, u (psi or MPa), measured behind the cone (i.e. u_2)
6. Other – any additional data, if collected, e.g. electrical resistivity or UVIF
7. Total cone resistance, q_t (tsf or MPa) $q_t = q_c + u\,(1\text{-}a)$

8	Friction Ratio, R_f (%)	$R_f = (f_s/q_t) \times 100\%$
9	Soil Behavior Type (non-normalized), SBT	see note
10	Unit weight, γ (pcf or kN/m^3)	based on SBT, see note
11	Total overburden stress, σ_v (tsf)	$\sigma_{vo} = \gamma z$
12	Insitu pore pressure, u_o (tsf)	$u_o = \gamma_w (z - z_w)$
13	Effective overburden stress, σ'_{vo} (tsf)	$\sigma'_{vo} = \sigma_{vo} - u_o$
14	Normalized cone resistance, Q_{t1}	$Q_{t1} = (q_t - \sigma_{vo}) / \sigma'_{vo}$
15	Normalized friction ratio, F_r (%)	$F_r = f_s / (q_t - \sigma_{vo}) \times 100\%$
16	Normalized Pore Pressure ratio, B_q	$B_q = u - u_o / (q_t - \sigma_{vo})$
17	Soil Behavior Type (normalized), SBT_n	see note
18	SBT_n Index, I_c	see note
19	Normalized Cone resistance, Q_{tn} (n varies with Ic)	see note
20	Estimated permeability, k_{SBT} (cm/sec or ft/sec)	see note
21	Equivalent SPT N_{60}, blows/ft	see note
22	Equivalent SPT $(N_1)_{60}$ blows/ft	see note
23	Estimated Relative Density, D_r, (%)	see note
24	Estimated Friction Angle, ϕ', (degrees)	see note
25	Estimated Young's modulus, E_s (tsf)	see note
26	Estimated small strain Shear modulus, Go (tsf)	see note
27	Estimated Undrained shear strength, s_u (tsf)	see note
28	Estimated Undrained strength ratio	s_u/σ_v'
29	Estimated Over Consolidation ratio, OCR	see note

Notes:

1 Soil Behavior Type (non-normalized), SBT — Lunne et al. (1997)
listed below

2 Unit weight, γ either constant at 119 pcf or based on Non-normalized SBT (Lunne et al., 1997 and table below)

3 Soil Behavior Type (Normalized), SBT_n — Lunne et al. (1997)

4 SBT_n Index, I_c — $I_c = ((3.47 - \log Q_{t1})^2 + (\log F_r + 1.22)^2)^{0.5}$

5 Normalized Cone resistance, Q_{tn} (n varies with Ic)

$Q_{tn} = ((q_t - \sigma_{vo})/pa)\ (pa/(\sigma'_{vo})^n$ and recalculate I_c, then iterate:

When $I_c < 1.64$, $n = 0.5$ (clean sand)
When $I_c > 3.30$, $n = 1.0$ (clays)
When $1.64 < I_c < 3.30$, $n = (I_c - 1.64)0.3 + 0.5$
Iterate until the change in n, $\Delta n < 0.01$

6 Estimated permeability, k_{SBT} (based on Normalized SBT_n)
(Lunne et al., 1997 and table below)

7 Equivalent SPT N_{60}, blows/ft Lunne et al. (1997)

$$\frac{(q_t/p_a)}{N_{60}} = 8.5\left(1 - \frac{I_c}{4.6}\right)$$

8 Equivalent SPT $(N_1)_{60}$ blows/ft $(N_1)_{60} = N_{60}\, C_{N,}$
where $C_N = (pa/\sigma'_{vo})^{0.5}$

9 Relative Density, D_r, (%) $D_r^2 = Q_{tn} / C_{Dr}$
Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

10 Friction Angle, ϕ', (degrees) $\tan\phi' = \frac{1}{2.68}\left[\log\left(\frac{q_c}{\sigma'_{vo}}\right) + 0.29\right]$
Only SBT_n 5, 6, 7 & 8 *Show'N/A' in zones 1, 2, 3, 4 & 9*

11 Young's modulus, E_s $E_s = \alpha\, q_t$
Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

12 Small strain shear modulus, Go
a. $G_o = S_G\,(q_t\ \ \sigma'_{vo}\ pa)^{1/3}$ *For SBT_n 5, 6, 7*
b. $G_o = C_G\, q_t$ *For SBT_n 1, 2, 3& 4*
Show 'N/A' in zones 8 & 9

13 Undrained shear strength, s_u $s_u = (q_t - \sigma_{vo}) / N_{kt}$
Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

14 Over Consolidation ratio, OCR $OCR = k_{ocr}\, Q_{t1}$
Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

SBT Zones **SBT_n Zones**

The following updated and simplified SBT descriptions have been used in the software:

1	sensitive fine grained	1	sensitive fine grained
2	organic soil	2	organic soil
3	clay	3	clay
4	clay & silty clay	4	clay & silty clay
5	clay & silty clay		
6	sandy silt & clayey silt		
7	silty sand & sandy silt	5	silty sand & sandy silt
8	sand & silty sand	6	sand & silty sand
9	sand		
10	sand	7	sand

11	very dense/stiff soil*	8	very dense/stiff soil*
12	very dense/stiff soil*	9	very dense/stiff soil*

*heavily overconsolidated and/or cemented

Track when soils fall with zones of same description and print that description (i.e. if soils fall only within SBT zones 4 & 5, print 'clays & silty clays')

Estimated Permeability (see Lunne et al., 1997)

SBT_n	Permeability (ft/sec)	(m/sec)
1	$3x\ 10^{-8}$	$1x\ 10^{-8}$
2	$3x\ 10^{-7}$	$1x\ 10^{-7}$
3	$1x\ 10^{-9}$	$3x\ 10^{-10}$
4	$3x\ 10^{-8}$	$1x\ 10^{-8}$
5	$3x\ 10^{-6}$	$1x\ 10^{-6}$
6	$3x\ 10^{-4}$	$1x\ 10^{-4}$
7	$3x\ 10^{-2}$	$1x\ 10^{-2}$
8	$3x\ 10^{-6}$	$1x\ 10^{-6}$
9	$1x\ 10^{-8}$	$3x\ 10^{-9}$

Estimated Unit Weight (see Lunne et al., 1997)

SBT	Approximate Unit Weight (lb/ft^3)	(kN/m^3)
1	111.4	17.5
2	79.6	12.5
3	111.4	17.5
4	114.6	18.0
5	114.6	18.0
6	114.6	18.0
7	117.8	18.5
8	120.9	19.0
9	124.1	19.5
10	127.3	20.0
11	130.5	20.5
12	120.9	19.0

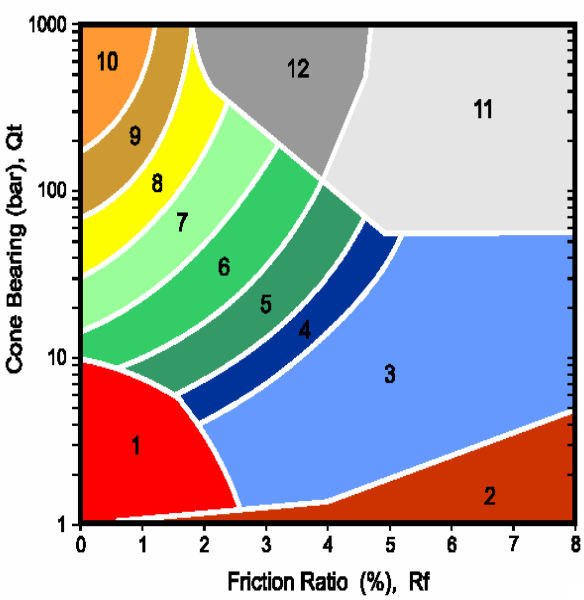
Cone Penetration Test Data & Interpretation

The Cone Penetration Test (CPT) data collected from your site are presented in graphical form in the attached report. The plots include interpreted Soil Behavior Type (SBT) based on the charts described by Robertson (1990). Typical plots display SBT based on the non-normalized charts of Robertson et al (1986). For CPT soundings extending greater than 50 feet, we recommend the use of the normalized charts of Robertson (1990) which can be displayed as SBTn, upon request. The report also includes spreadsheet output of computer calculations of basic interpretation in terms of SBT and SBTn and various geotechnical parameters using current published correlations based on the comprehensive review by Lunne, Robertson and Powell (1997), as well as recent updates by Professor Robertson. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg Drilling & Testing Inc. do not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and do not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software.

Some interpretation methods require input of the groundwater level to calculate vertical effective stress. An estimate of the in-situ groundwater level has been made based on field observations and/or CPT results, but should be verified by the user.

A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Note that it is not always possible to clearly identify a soil type based solely on q_t, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the correct soil behavior type.



(After Robertson, et al., 1986)

ZONE		SBT
1		Sensitive, fine grained
2		Organic materials
3		Clay
4		Silty clay to clay
5		Clayey silt to silty clay
6		Sandy silt to clayey silt
7		Silty sand to sandy silt
8		Sand to silty sand
9		Sand
10		Gravely sand to sand
11		Very stiff fine grained*
12		Sand to clayey sand*

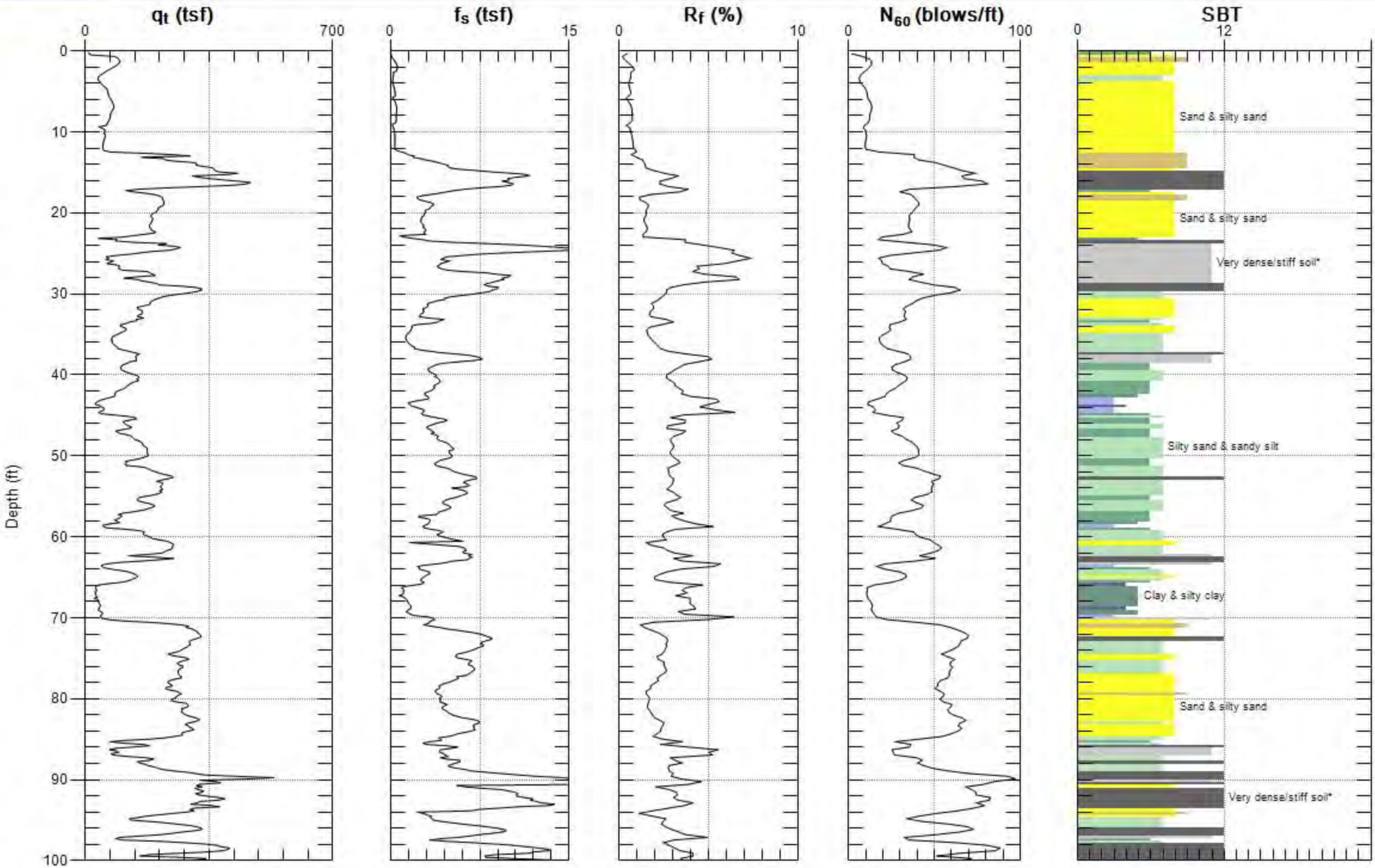
*over consolidated or cemented

Figure SBT

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt1

Engineer: J.BLANKE
Date: 5/8/2012 07:49



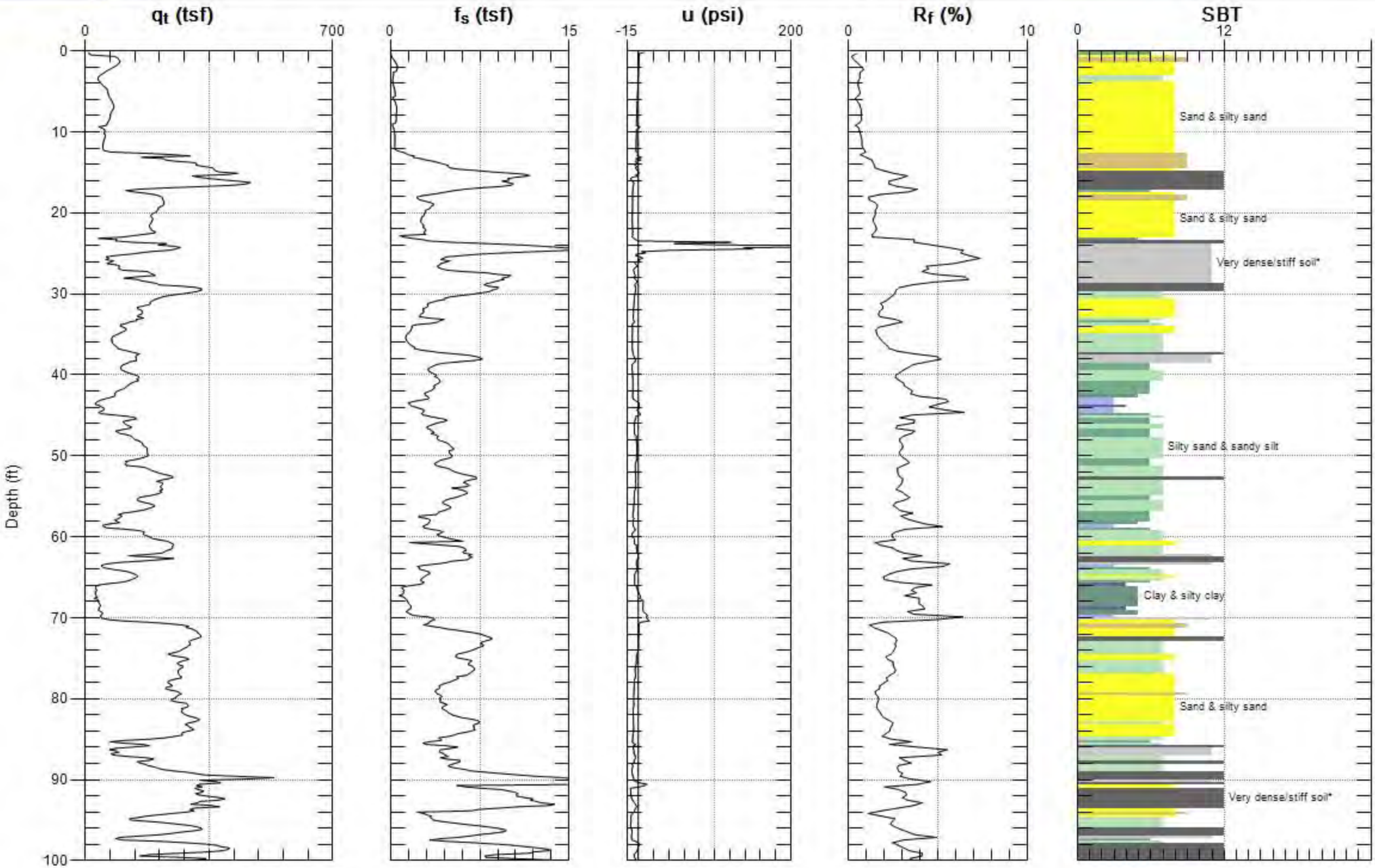
Max. Depth: 100.394 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt1

Engineer: J.BLANKE
Date: 5/8/2012 07:49



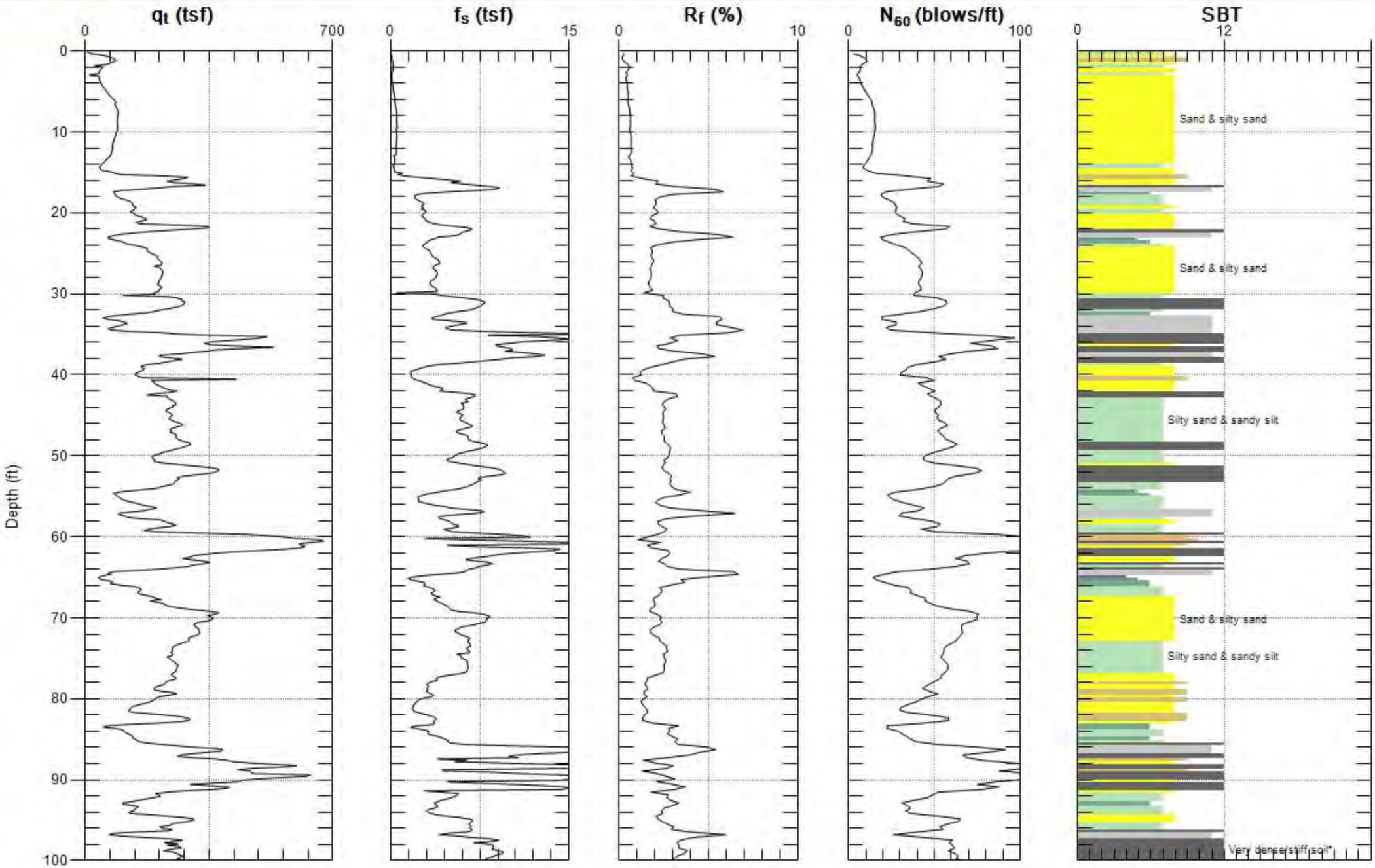
Max. Depth: 100.394 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt2

Engineer: J.BLANKE
Date: 5/8/2012 11:00



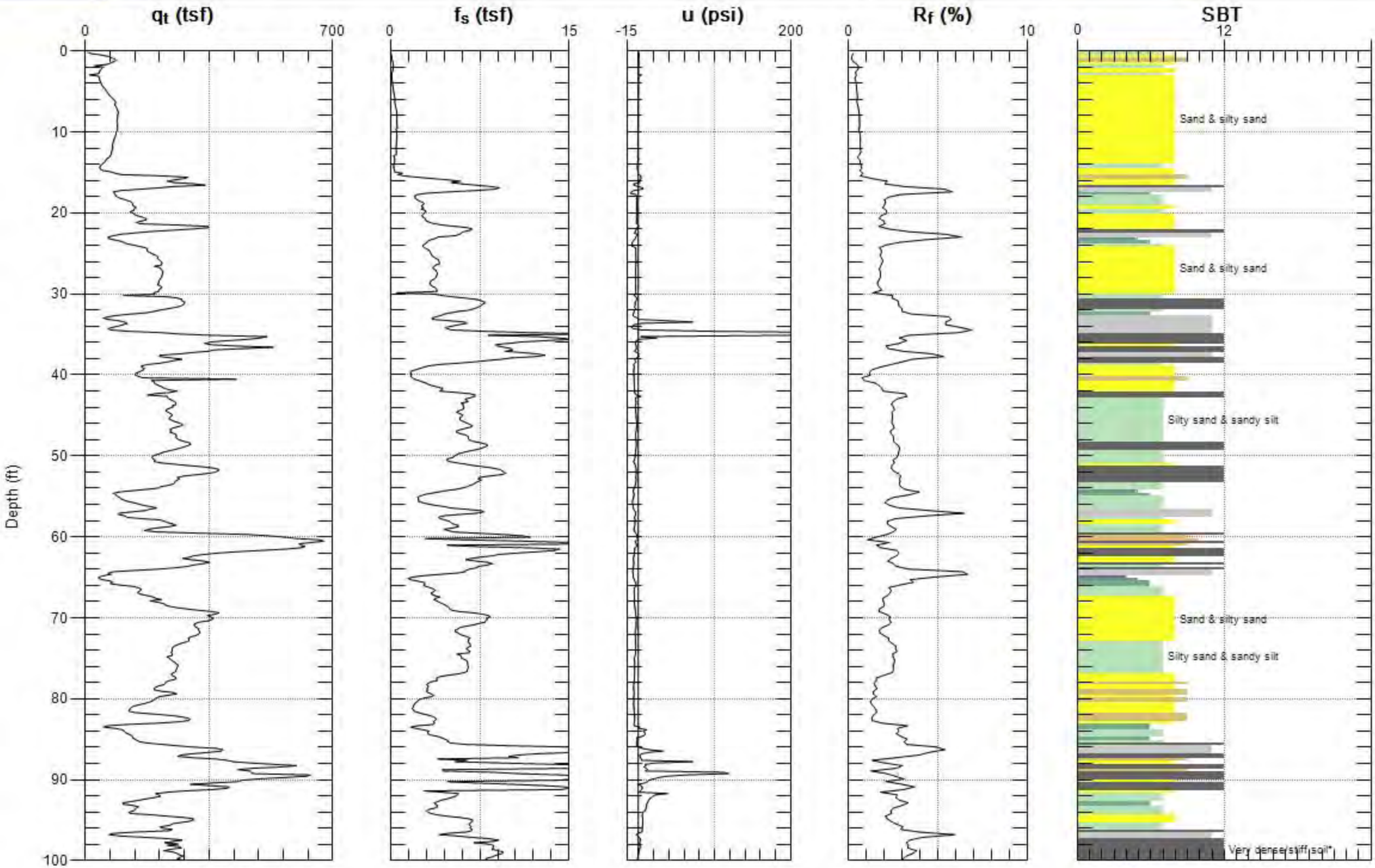
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt2

Engineer: J.BLANKE
Date: 5/8/2012 11:00



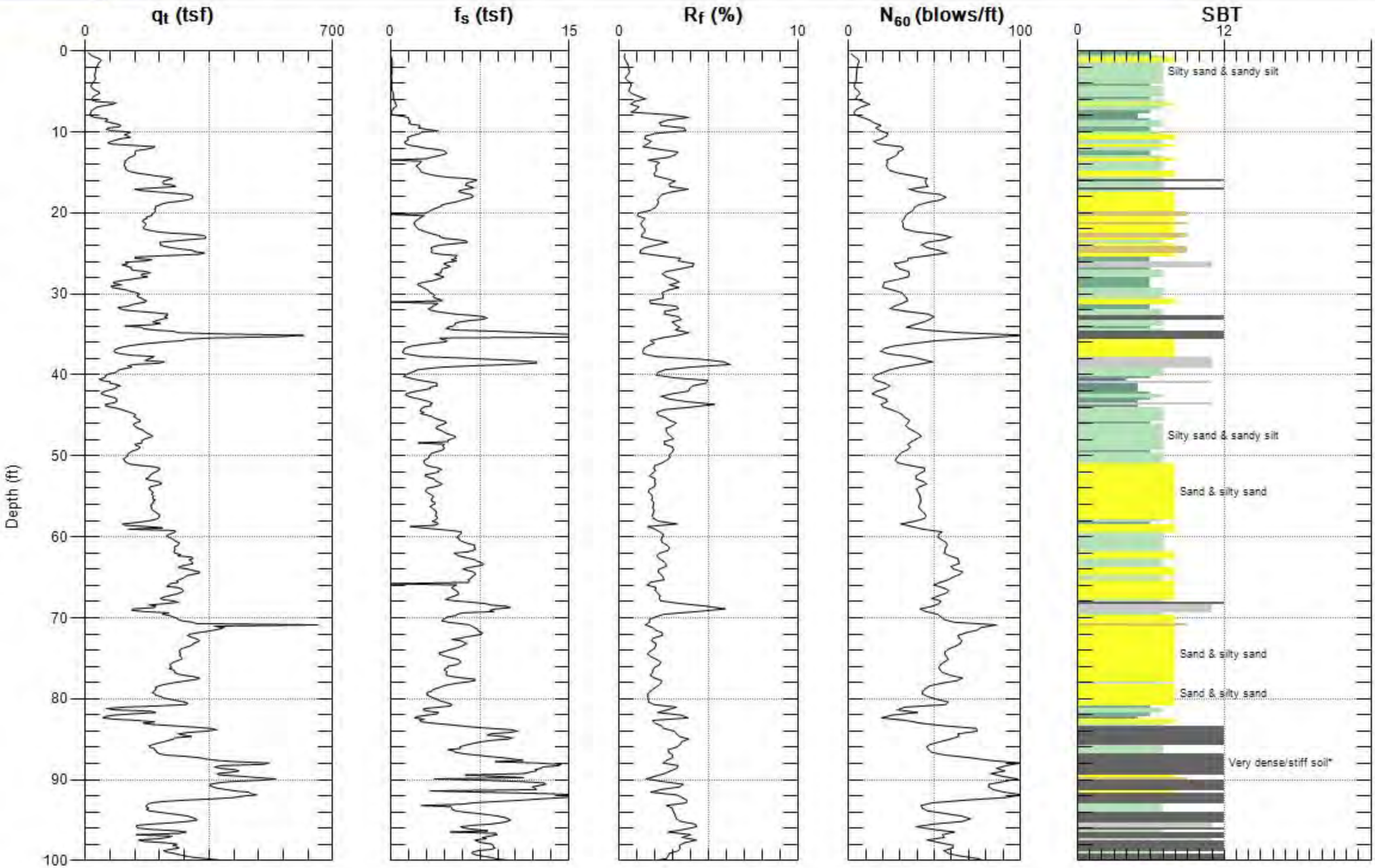
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt3

Engineer: J.BLANKE
Date: 5/8/2012 01:32



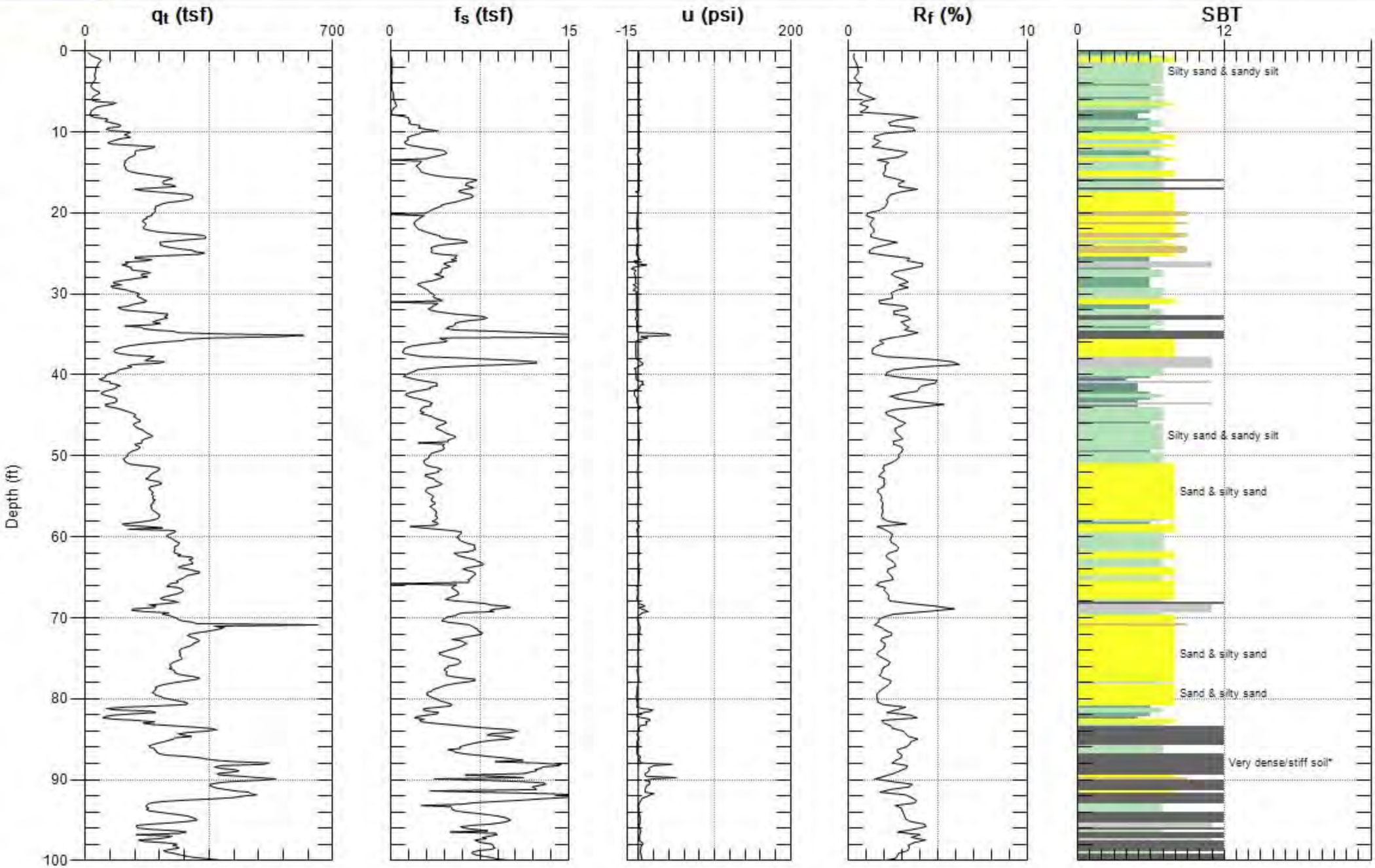
Max. Depth: 100.394 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt3

Engineer: J.BLANKE
Date: 5/8/2012 01:32



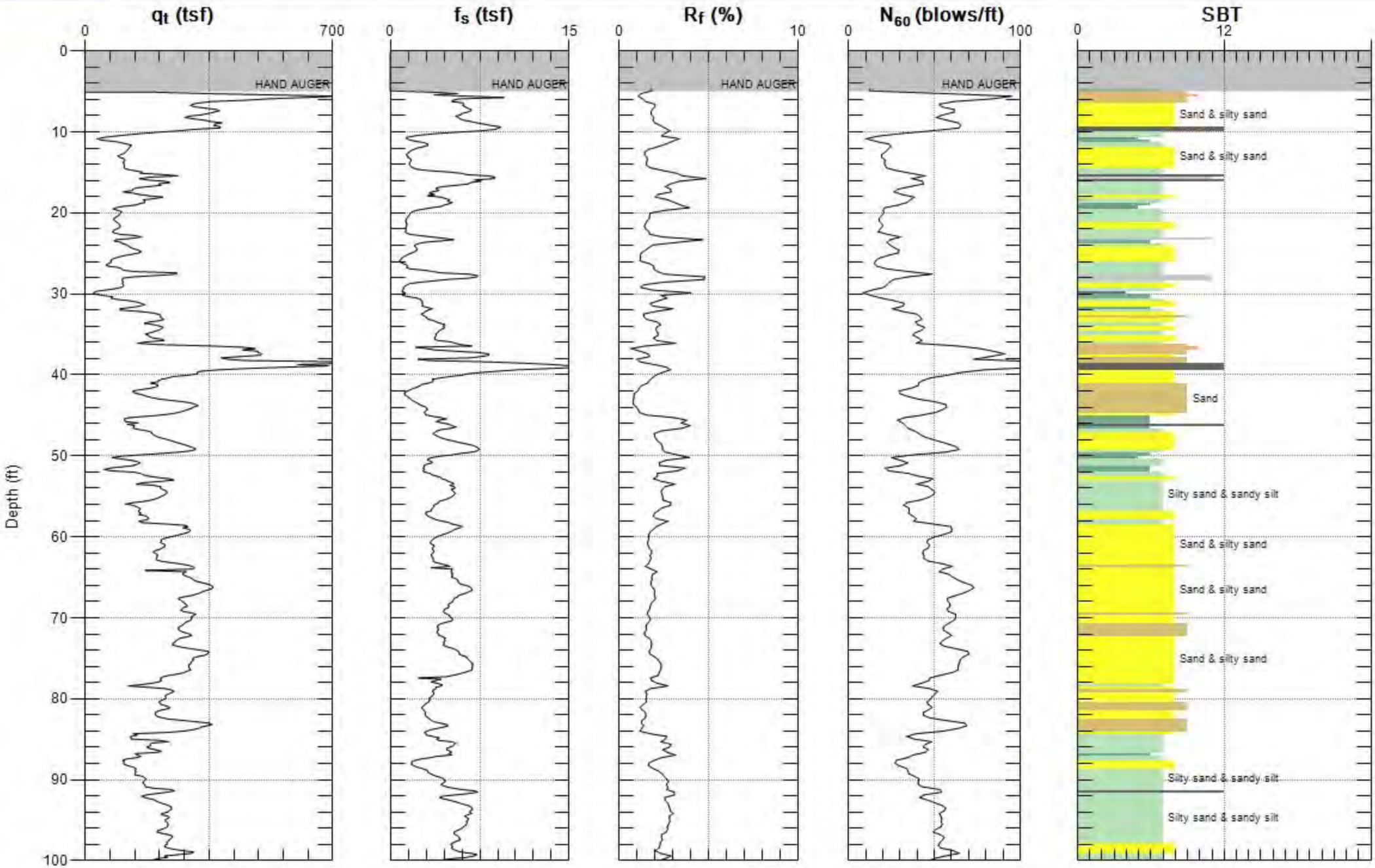
Max. Depth: 100.394 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt4

Engineer: J.BLANKE
Date: 5/7/2012 01:19



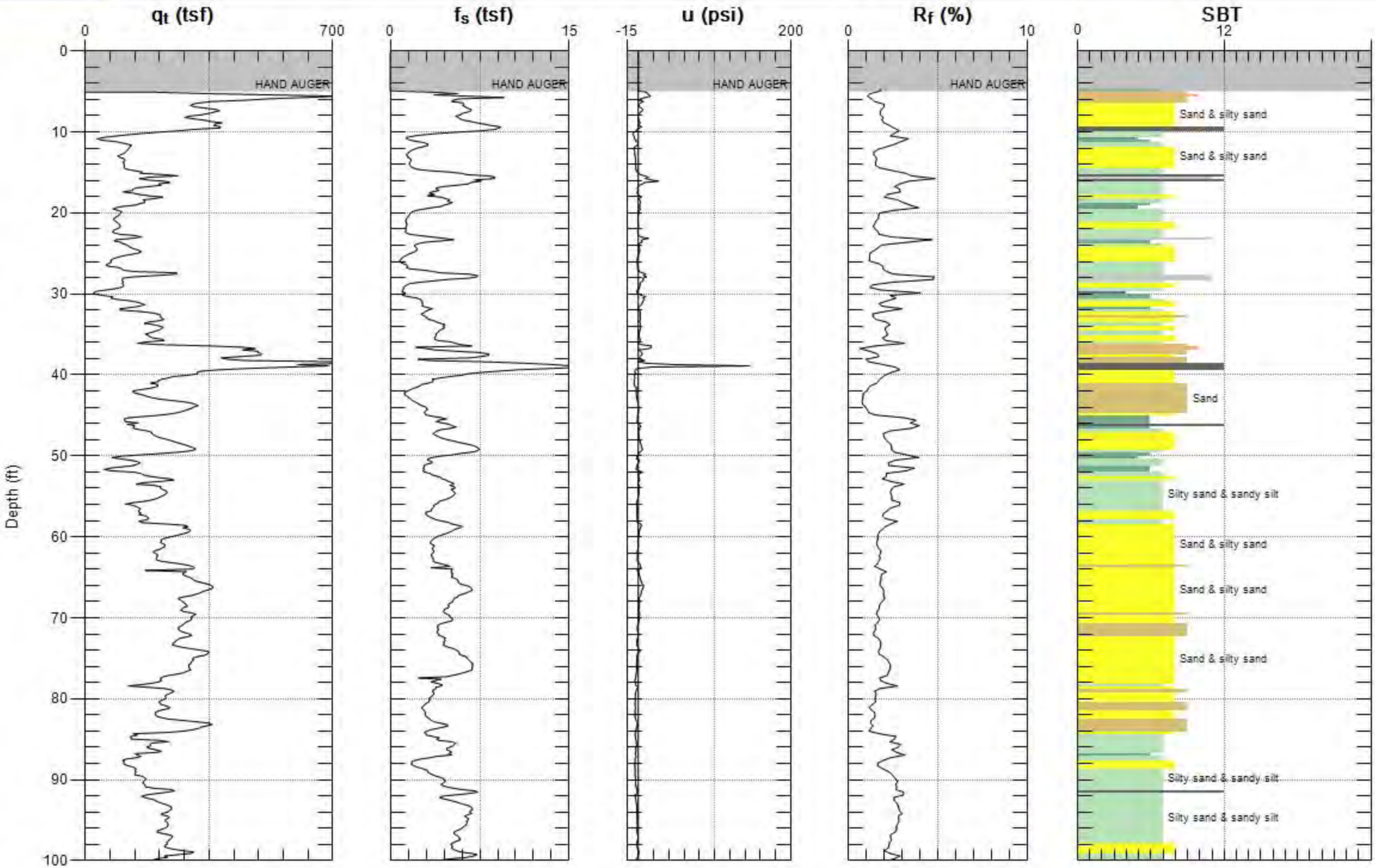
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt4

Engineer: J.BLANKE
Date: 5/7/2012 01:19



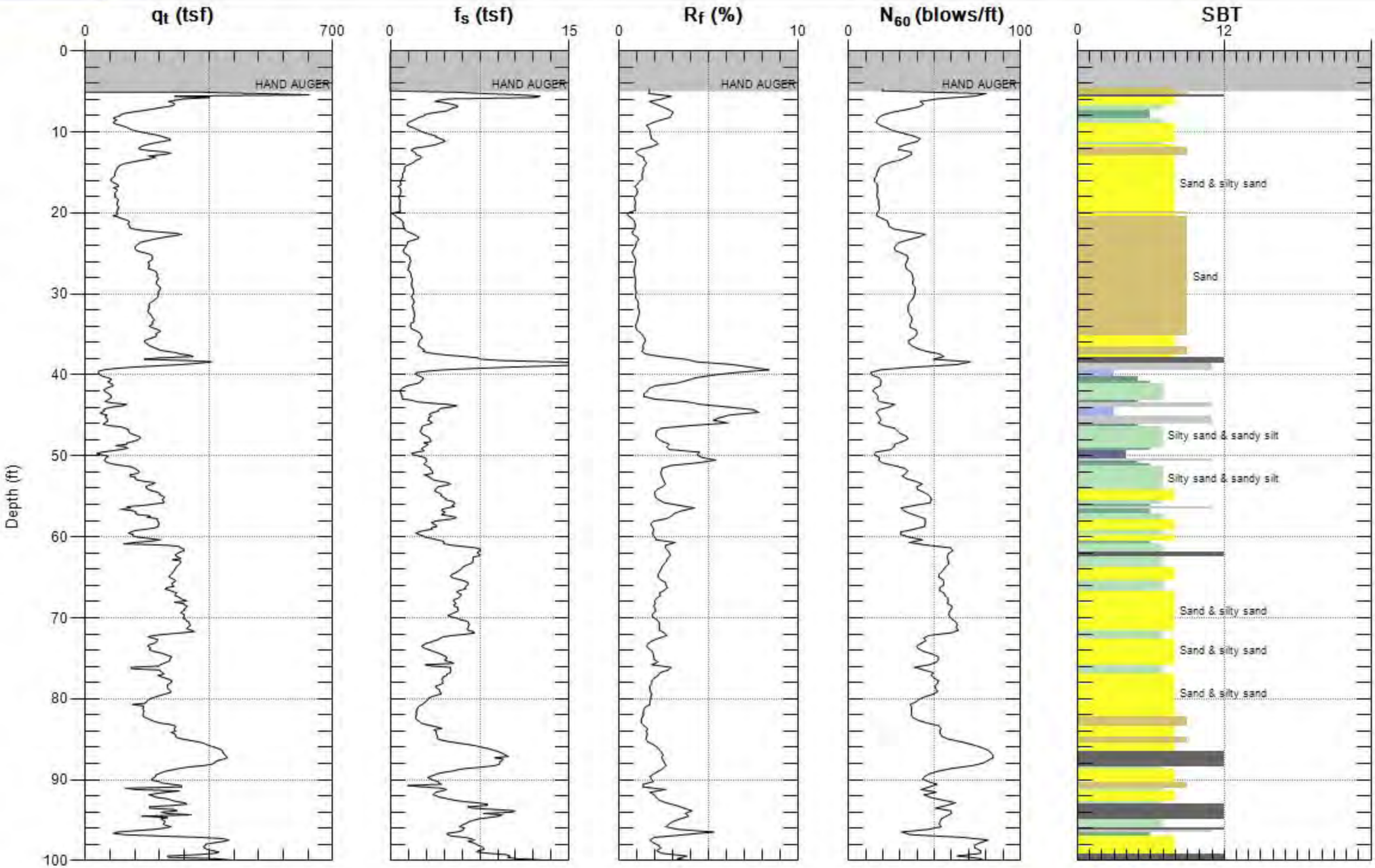
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt5

Engineer: J.BLANKE
Date: 5/7/2012 04:22



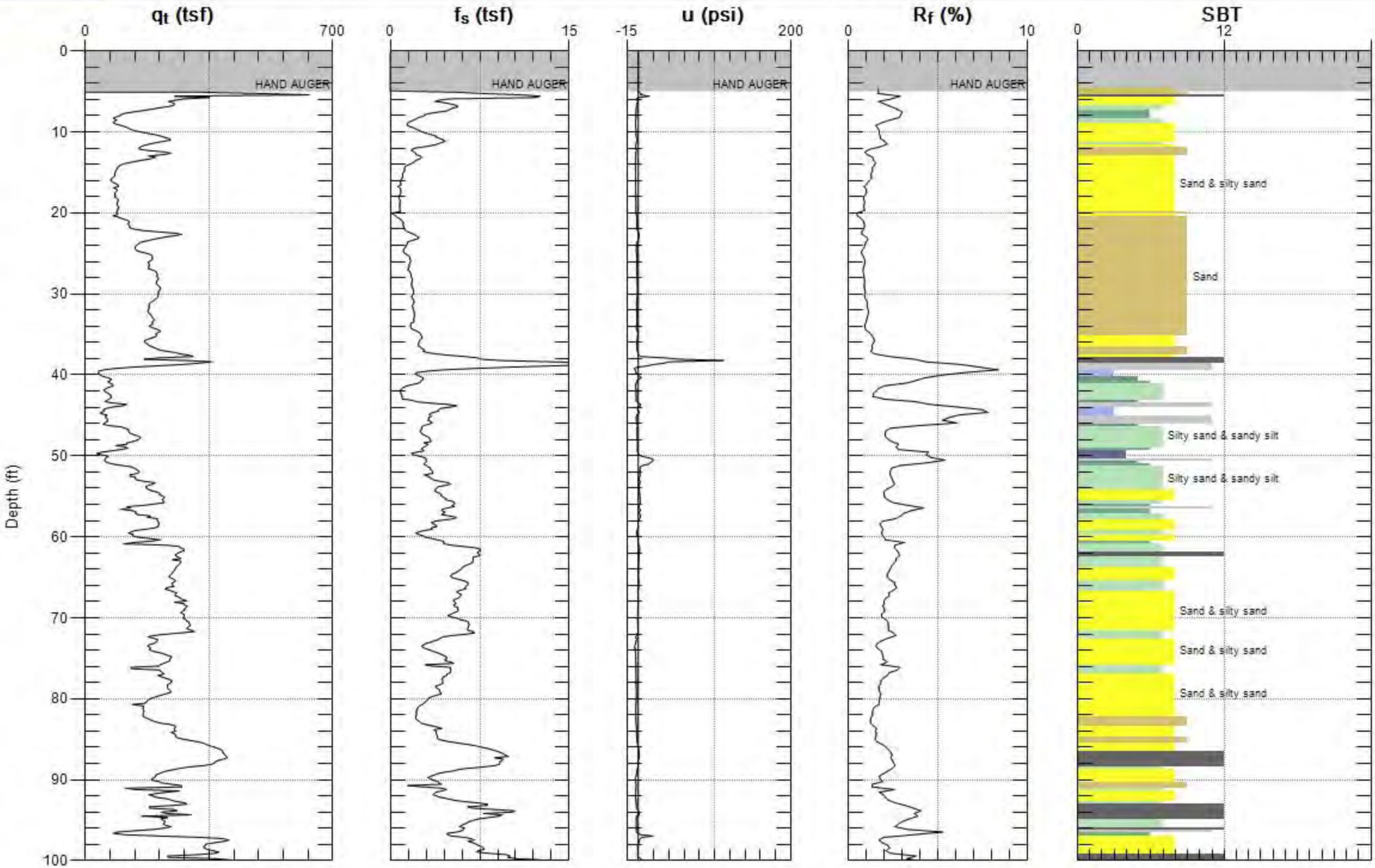
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt5

Engineer: J.BLANKE
Date: 5/7/2012 04:22



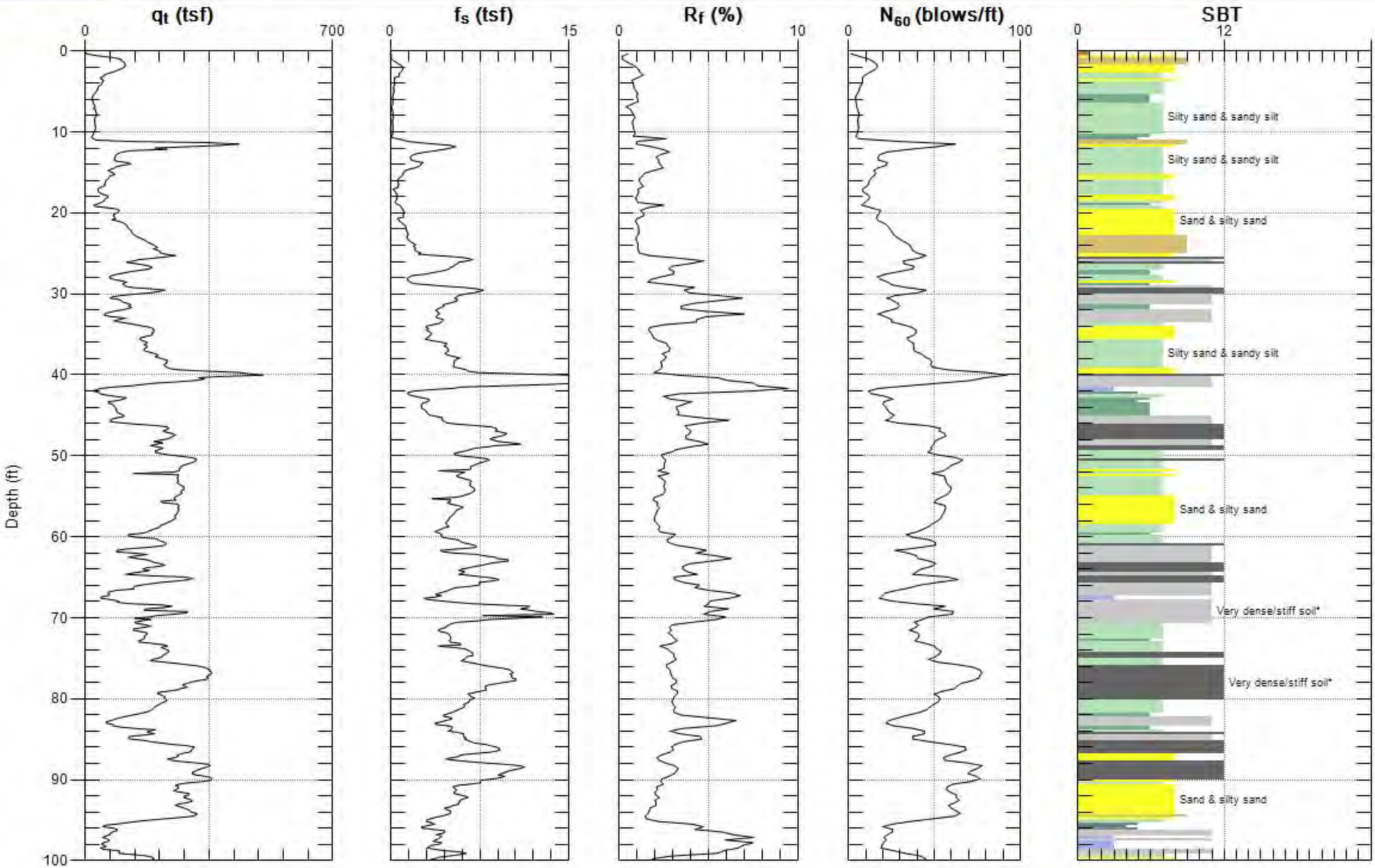
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt6

Engineer: J.BLANKE
Date: 5/8/2012 03:06



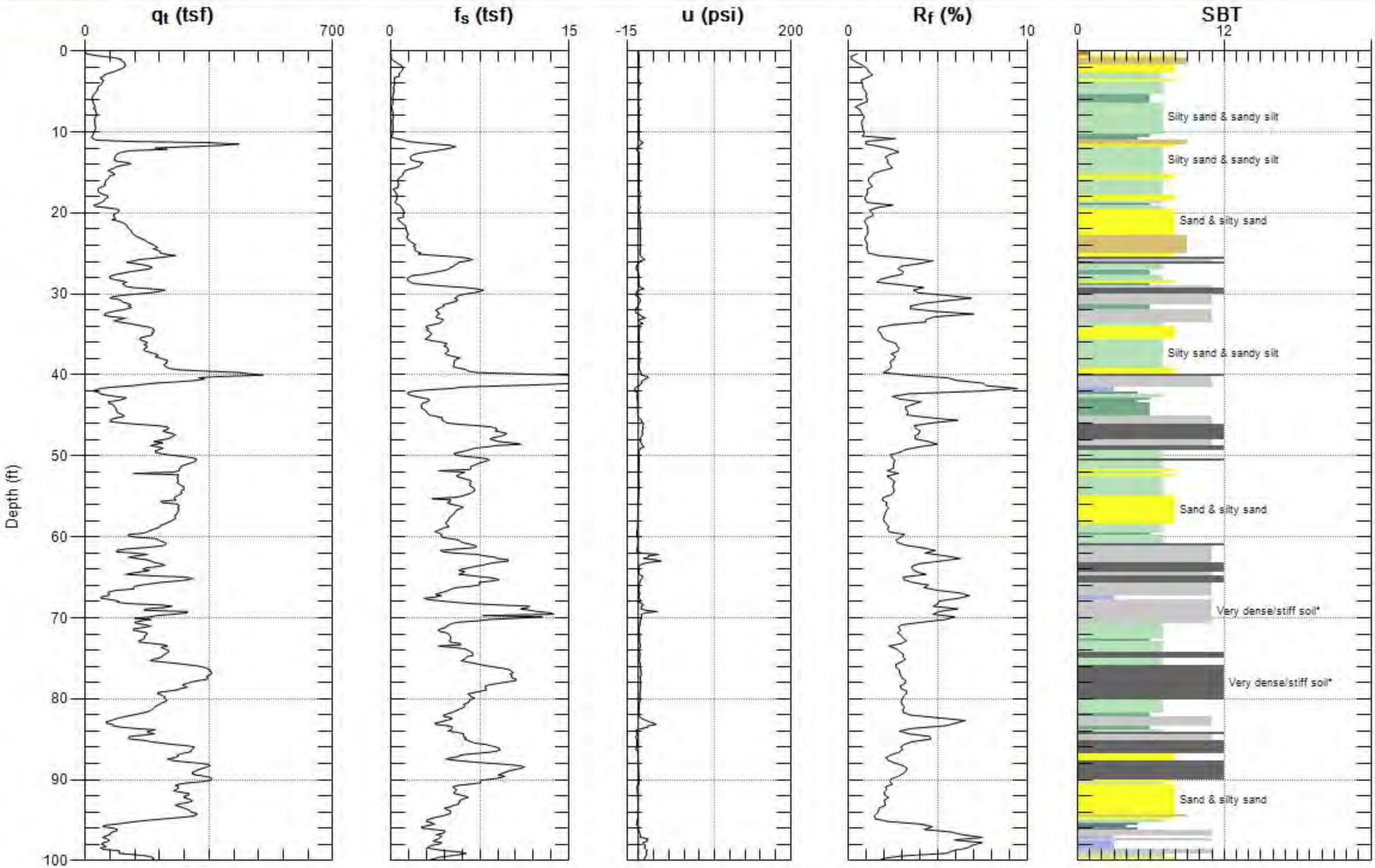
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: RAISIN CITY WATER
Sounding: 2-cpt6

Engineer: J.BLANKE
Date: 5/8/2012 03:06



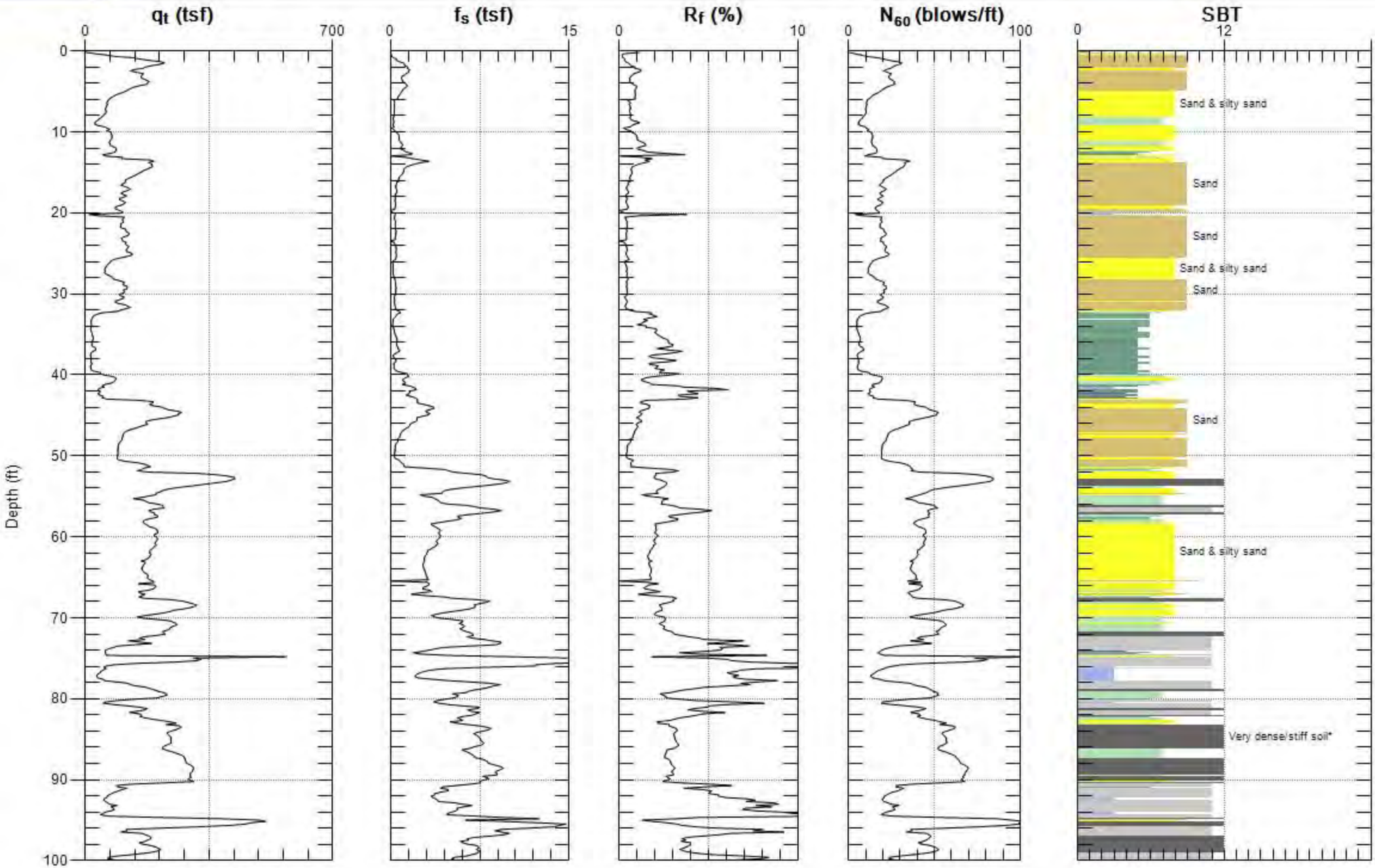
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt1

Engineer: J.BLANKE
Date: 5/9/2012 08:16



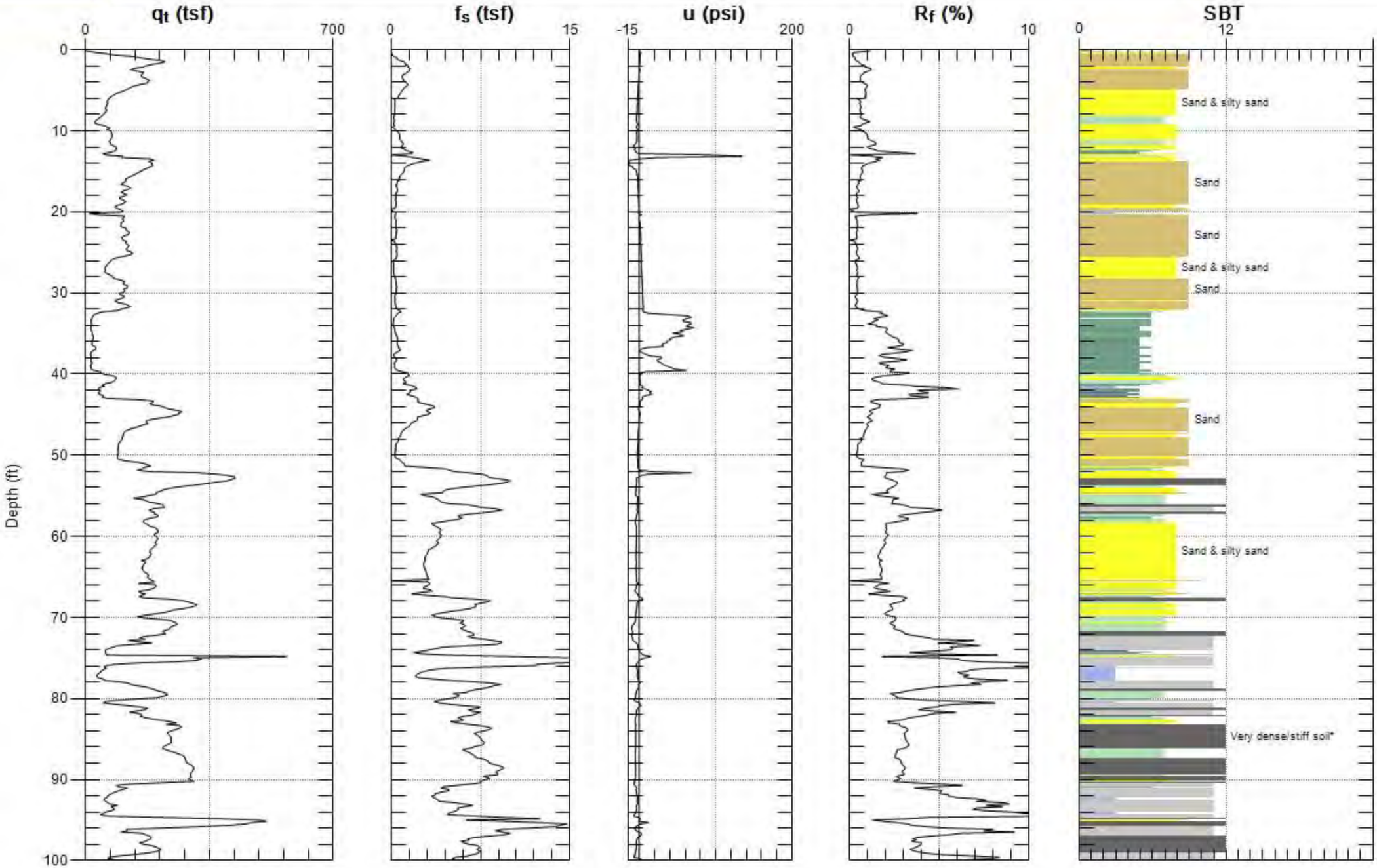
Max. Depth: 100.558 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt1

Engineer: J.BLANKE
Date: 5/9/2012 08:16



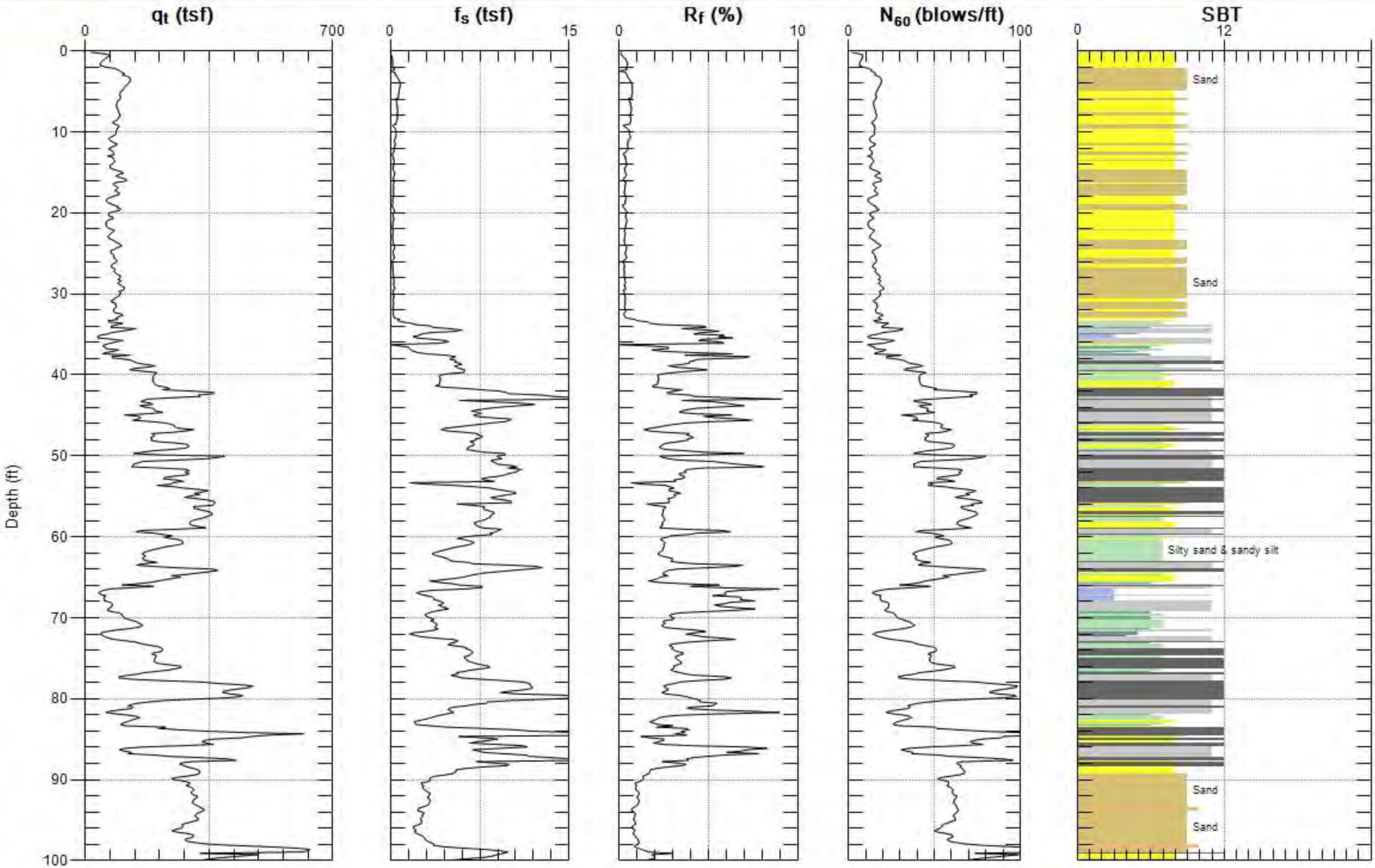
Max. Depth: 100.558 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt2

Engineer: J.BLANKE
Date: 5/9/2012 10:34



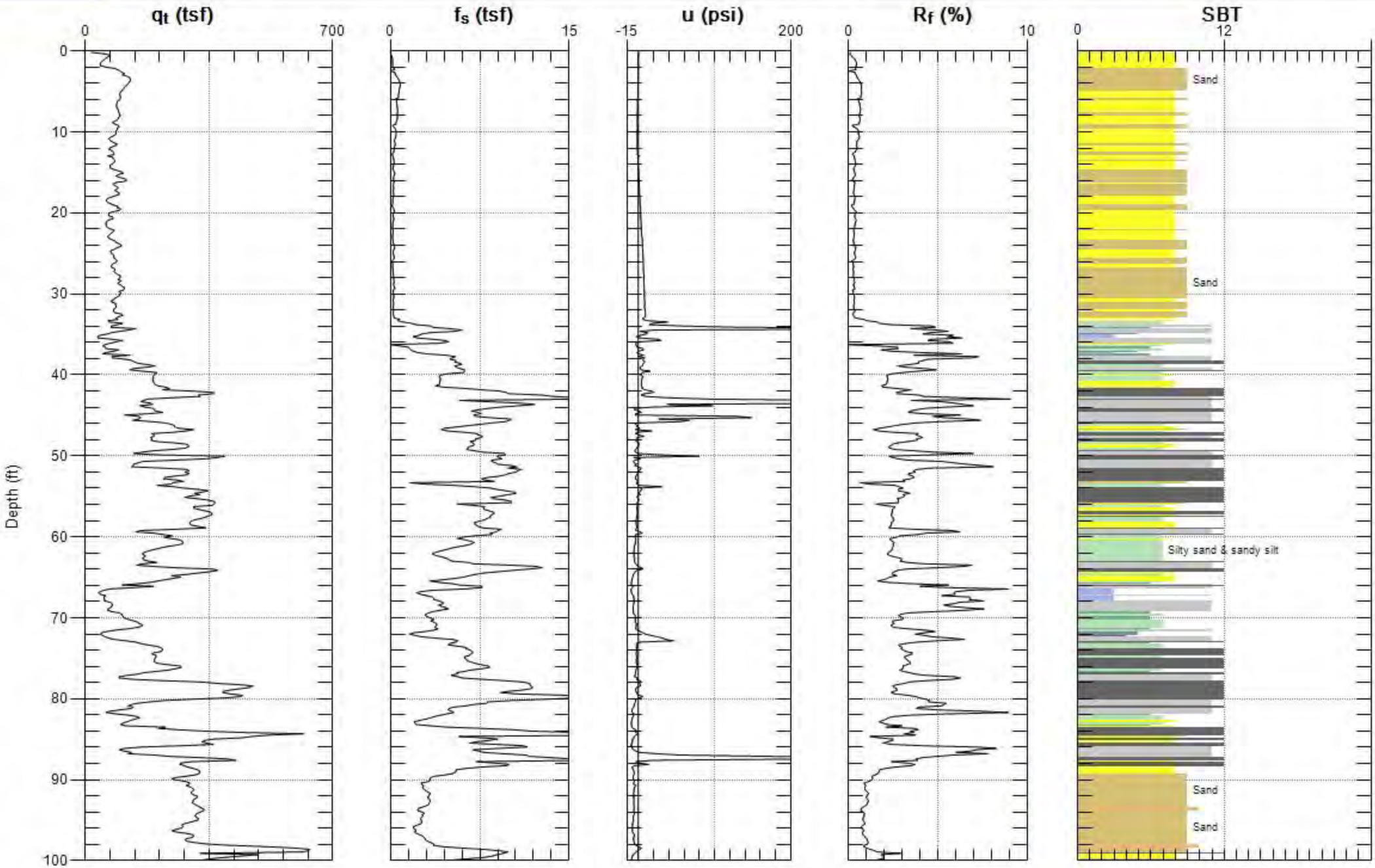
Max. Depth: 100.394 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt2

Engineer: J.BLANKE
Date: 5/9/2012 10:34



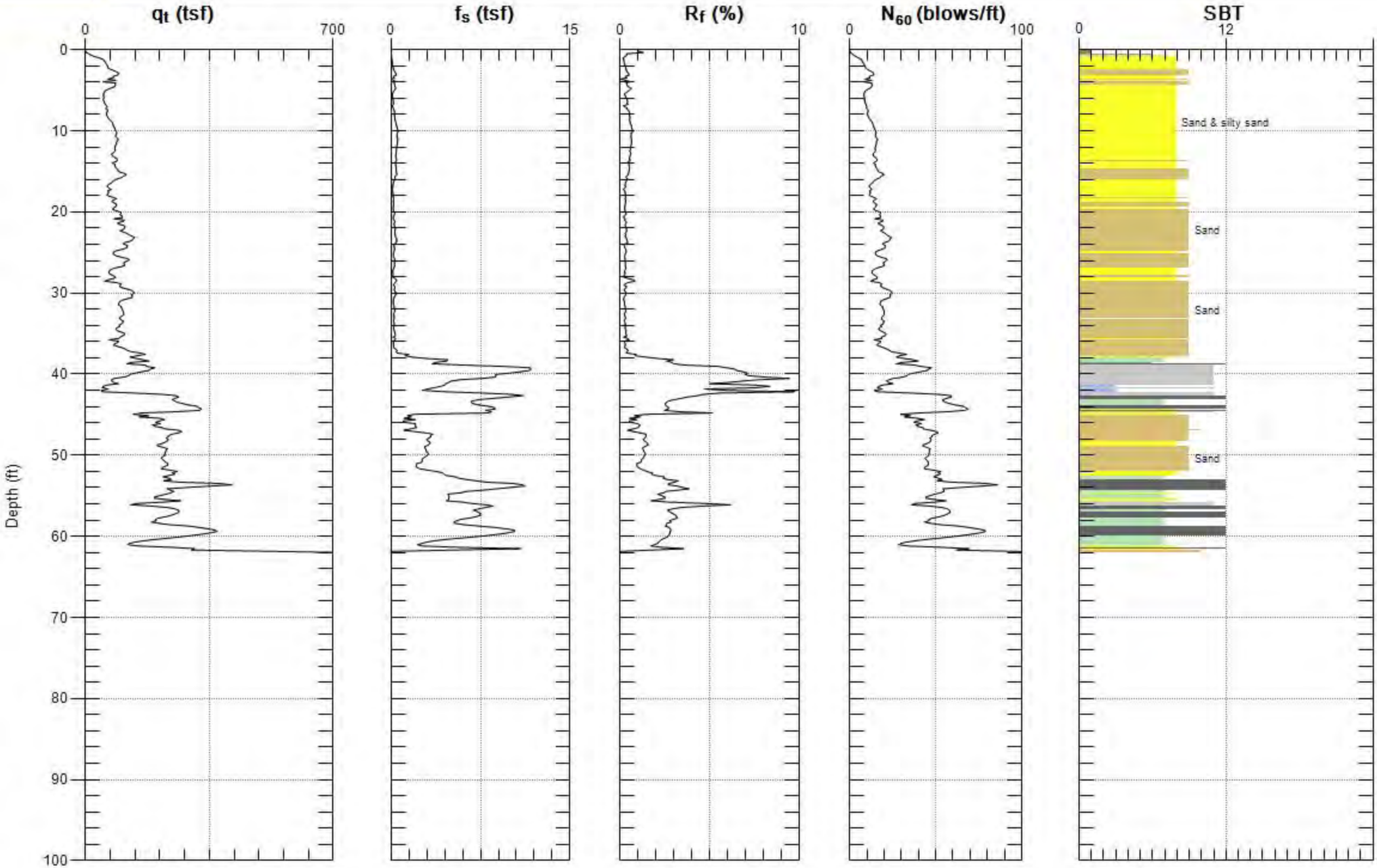
Max. Depth: 100.394 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt3

Engineer: J.BLANKE
Date: 5/9/2012 02:41



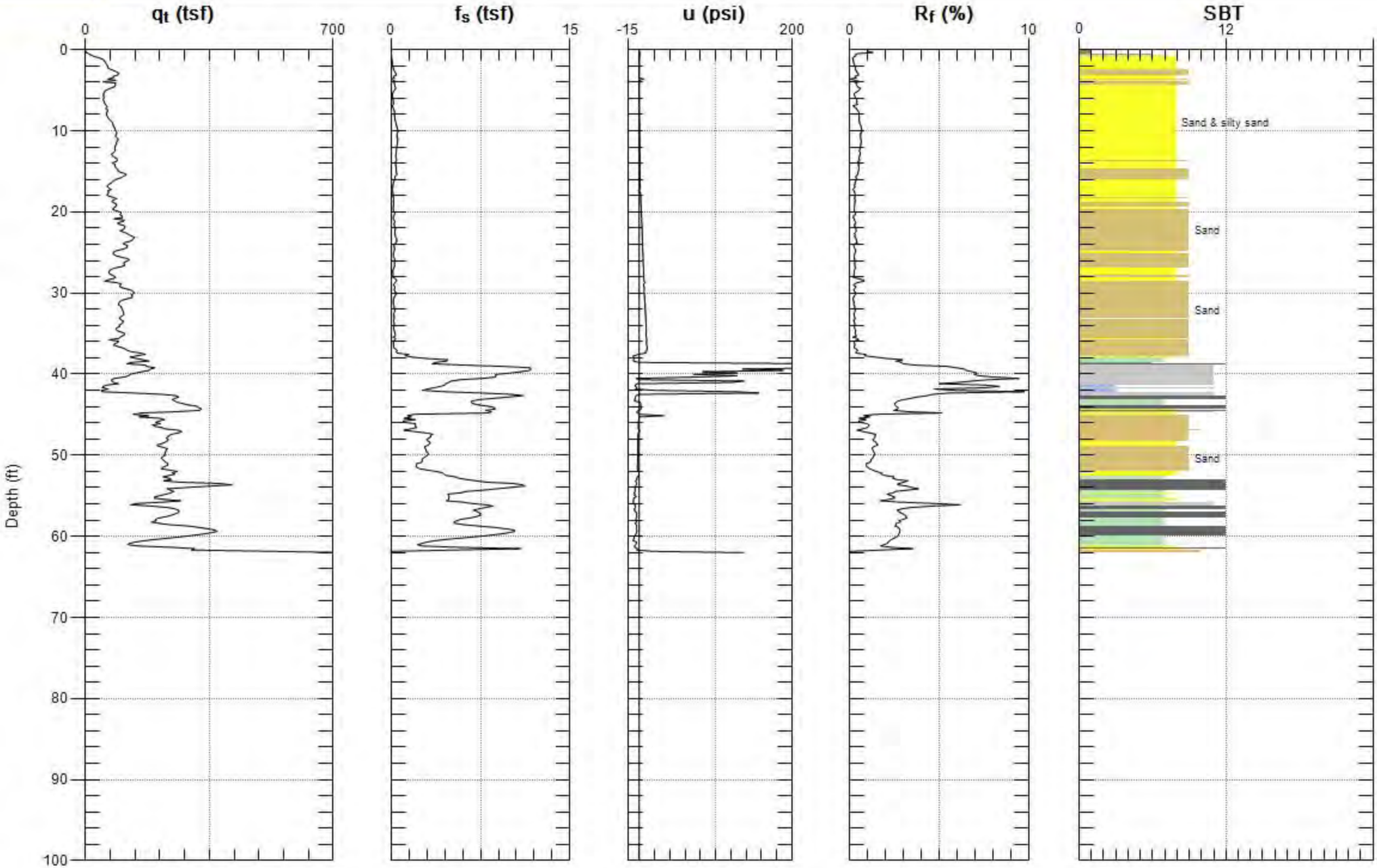
Max. Depth: 62.008 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt3

Engineer: J.BLANKE
Date: 5/9/2012 02:41



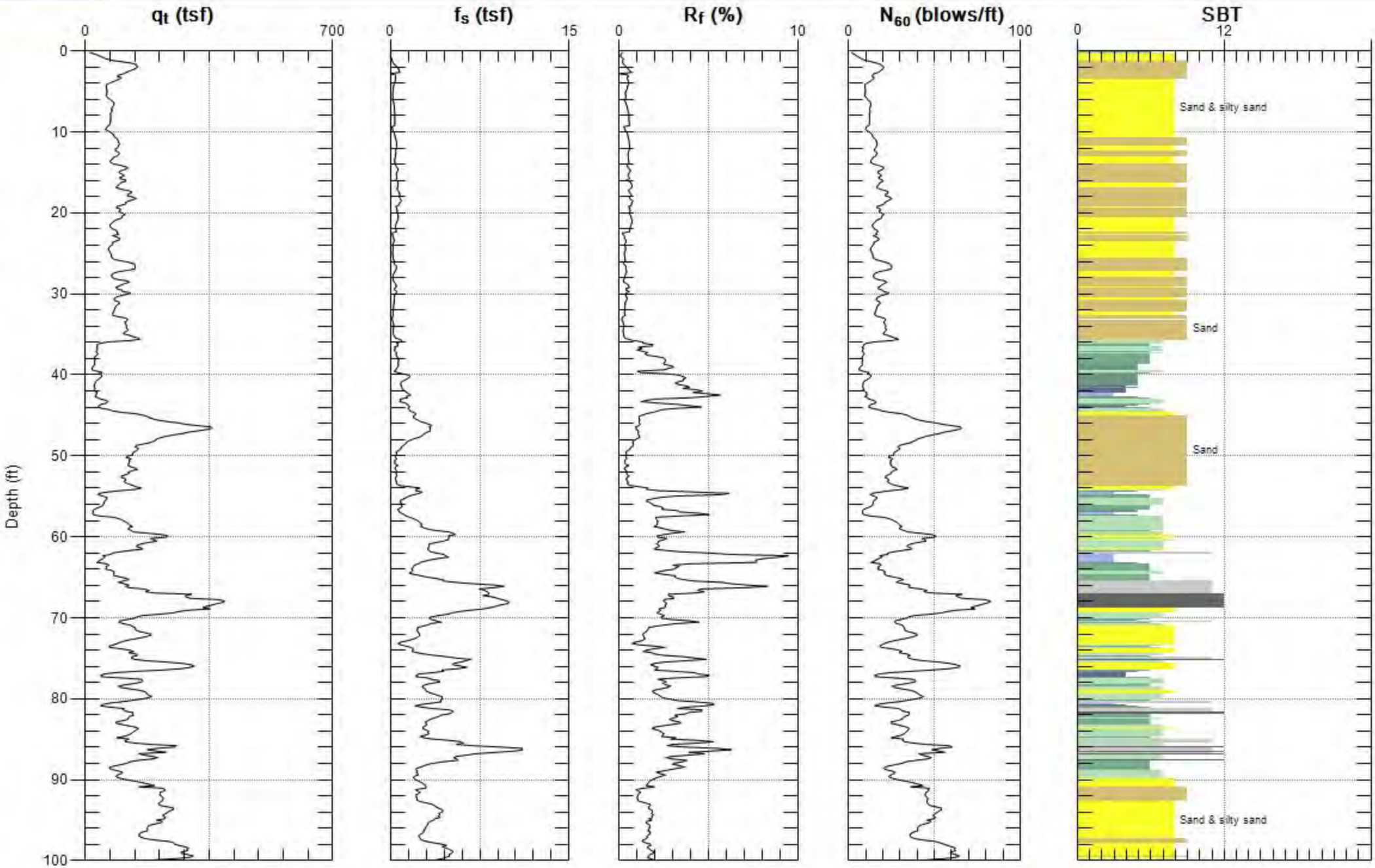
Max. Depth: 62.008 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt4

Engineer: J.BLANKE
Date: 5/9/2012 01:21



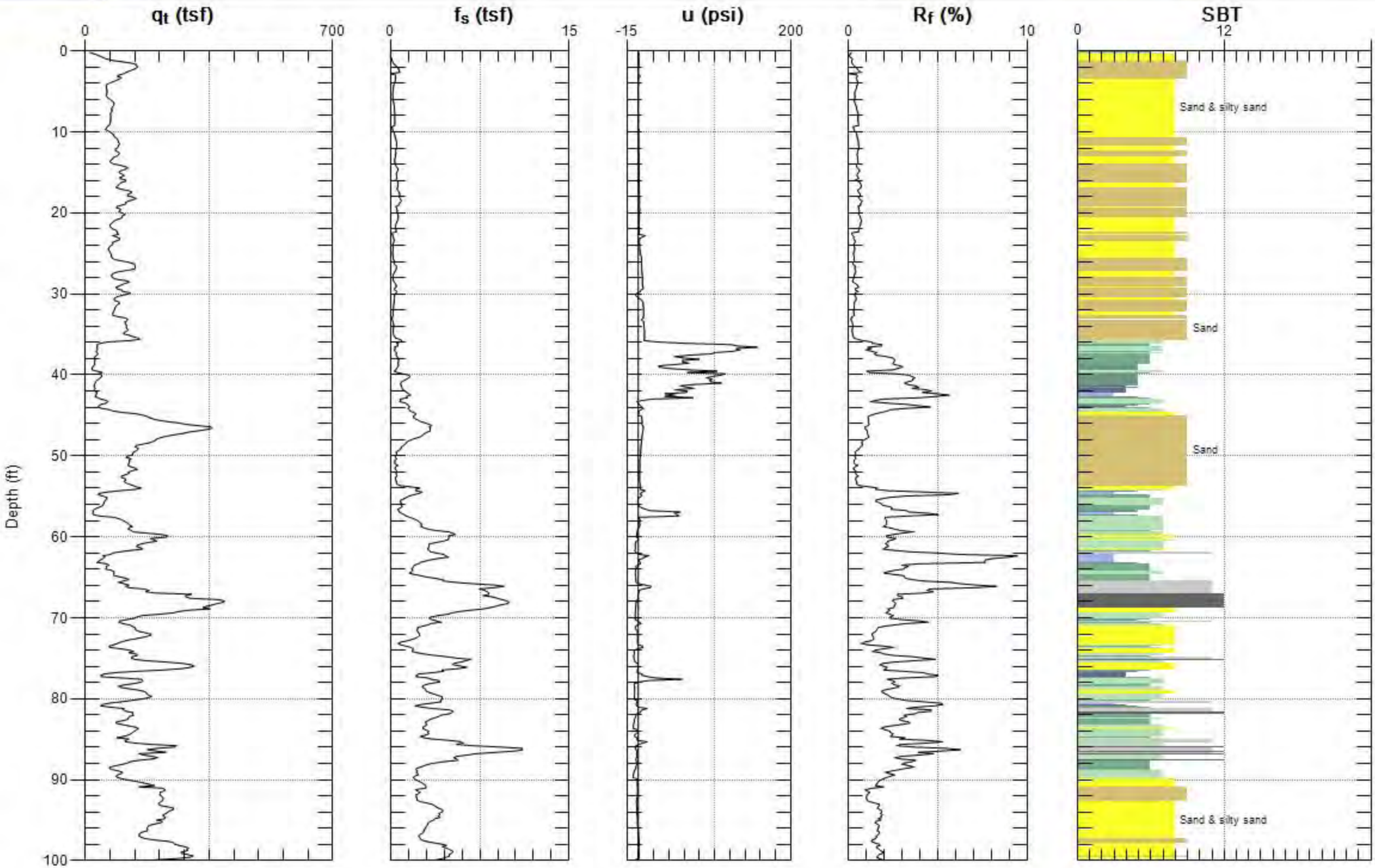
Max. Depth: 101.050 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: GOLDIE POND
Sounding: 3-cpt4

Engineer: J.BLANKE
Date: 5/9/2012 01:21



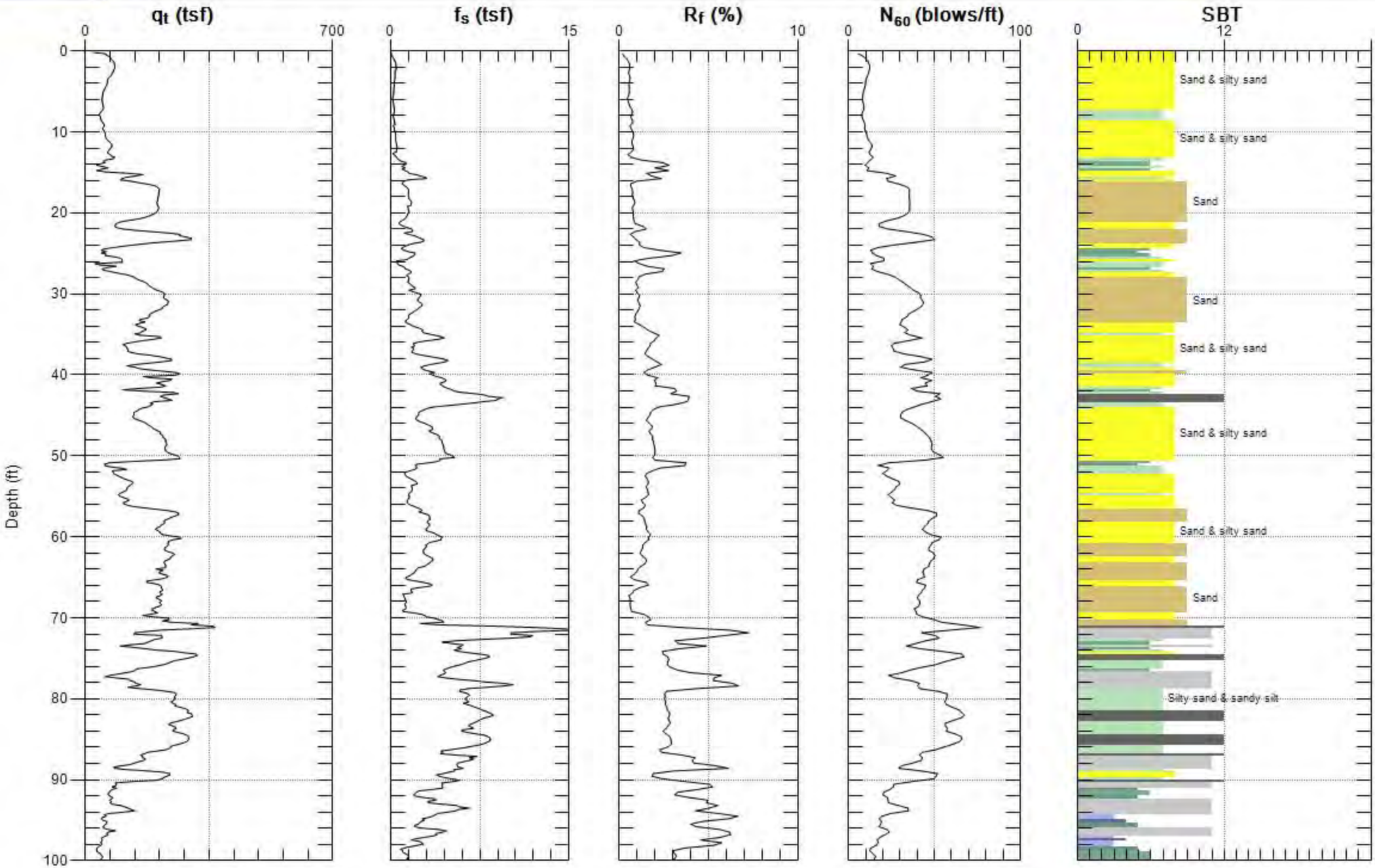
Max. Depth: 101.050 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt1

Engineer: J.BLANKE
Date: 5/11/2012 07:43



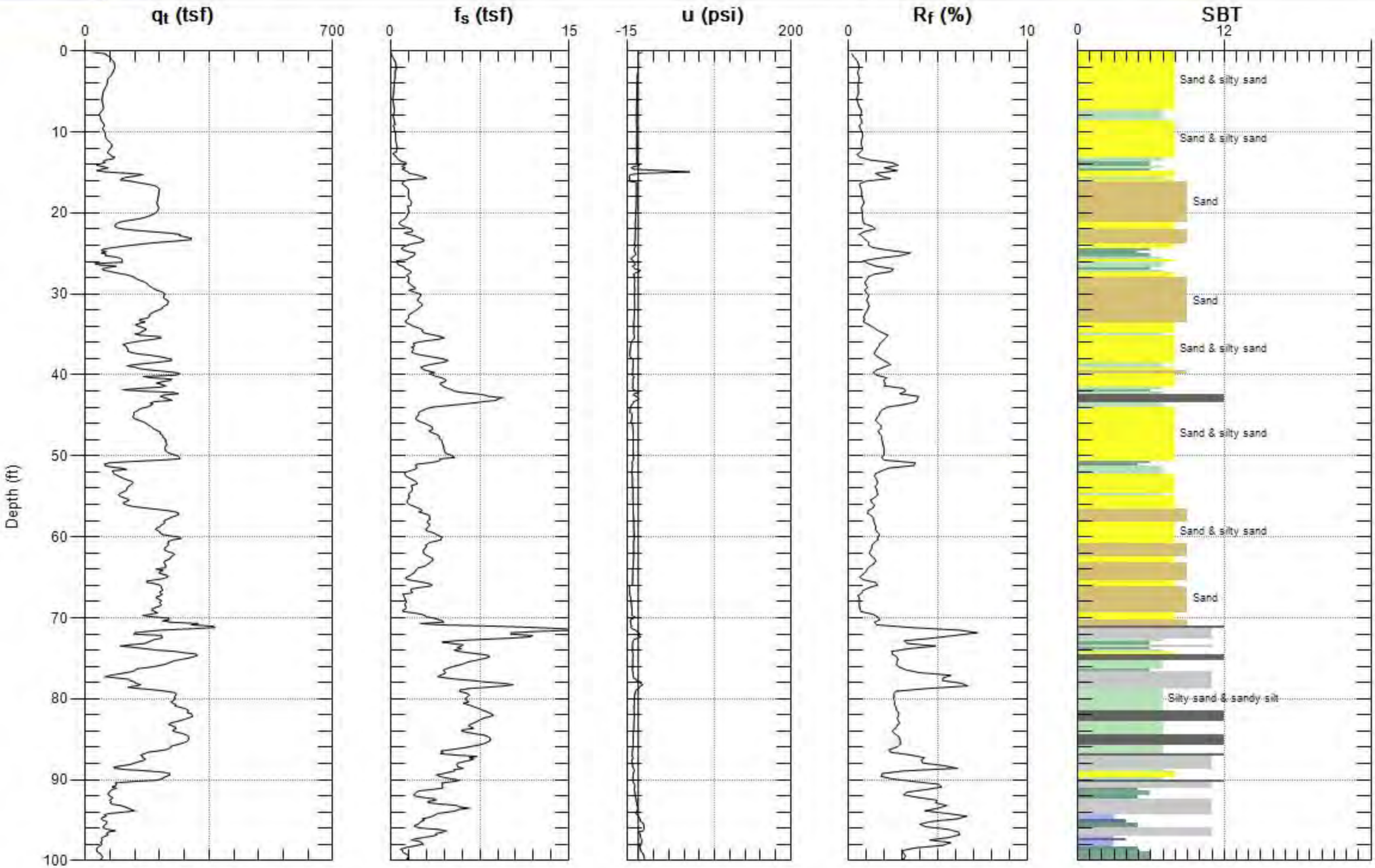
Max. Depth: 100.722 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt1

Engineer: J.BLANKE
Date: 5/11/2012 07:43



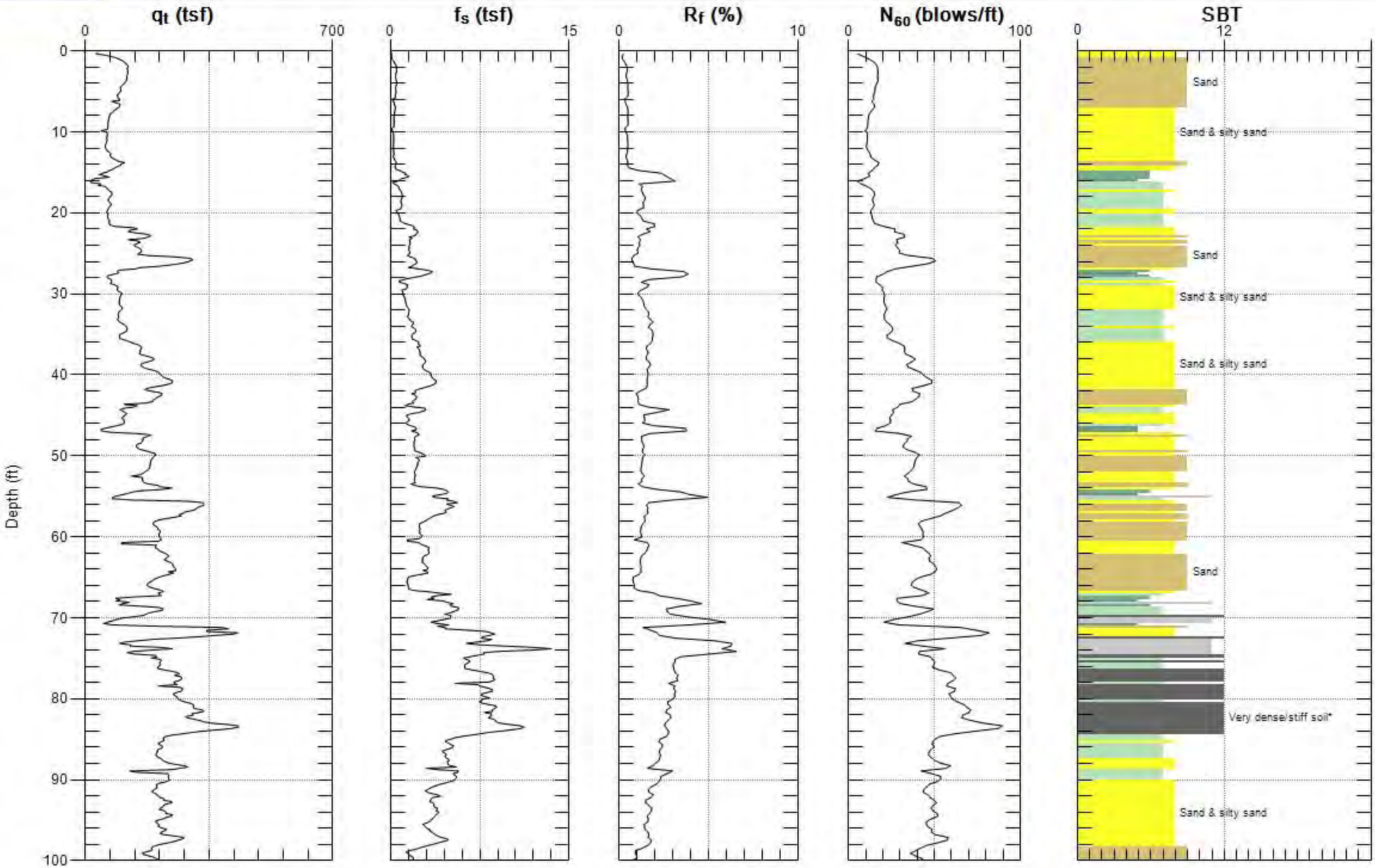
Max. Depth: 100.722 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt2

Engineer: J.BLANKE
Date: 5/10/2012 12:42



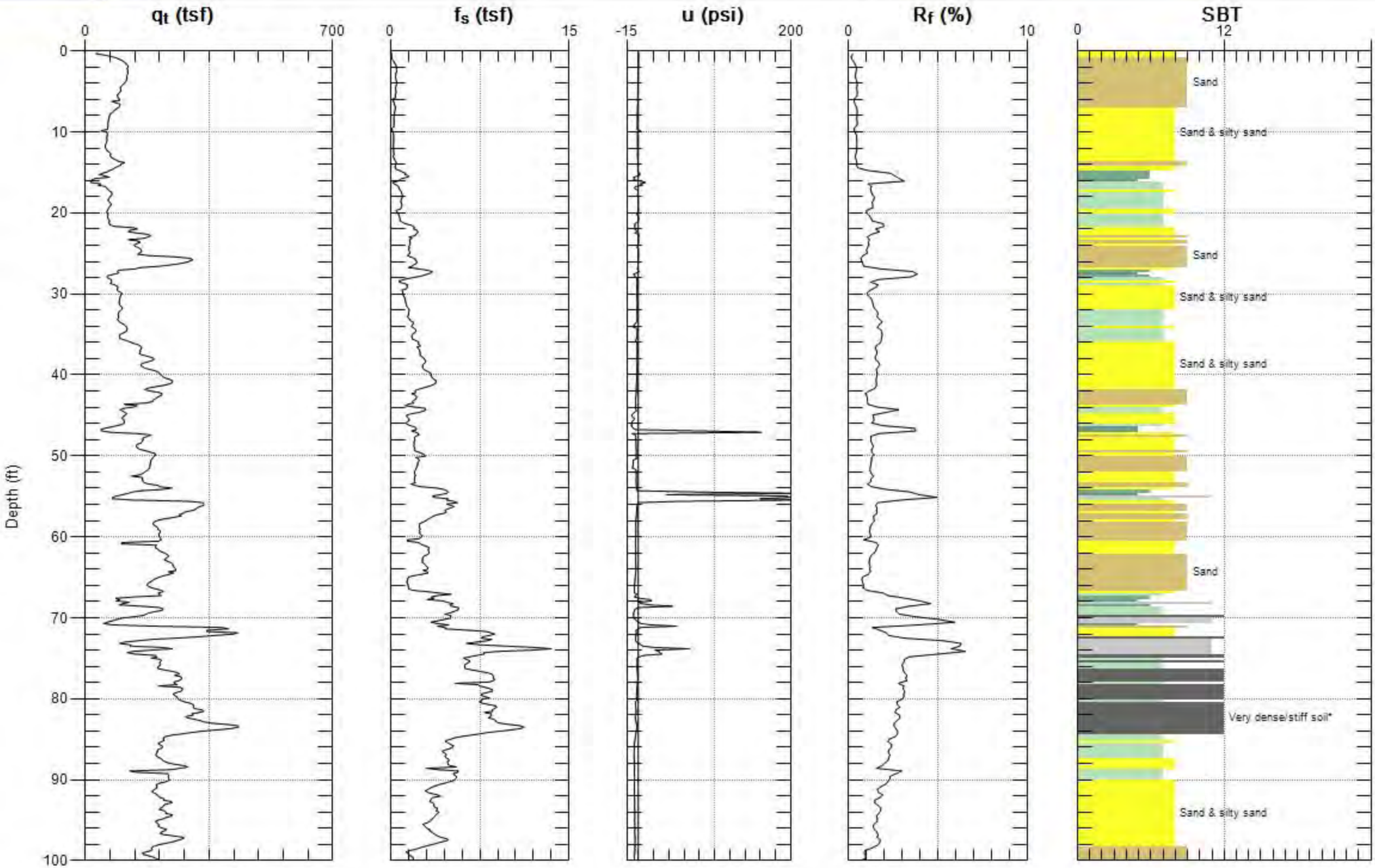
Max. Depth: 100.394 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt2

Engineer: J.BLANKE
Date: 5/10/2012 12:42



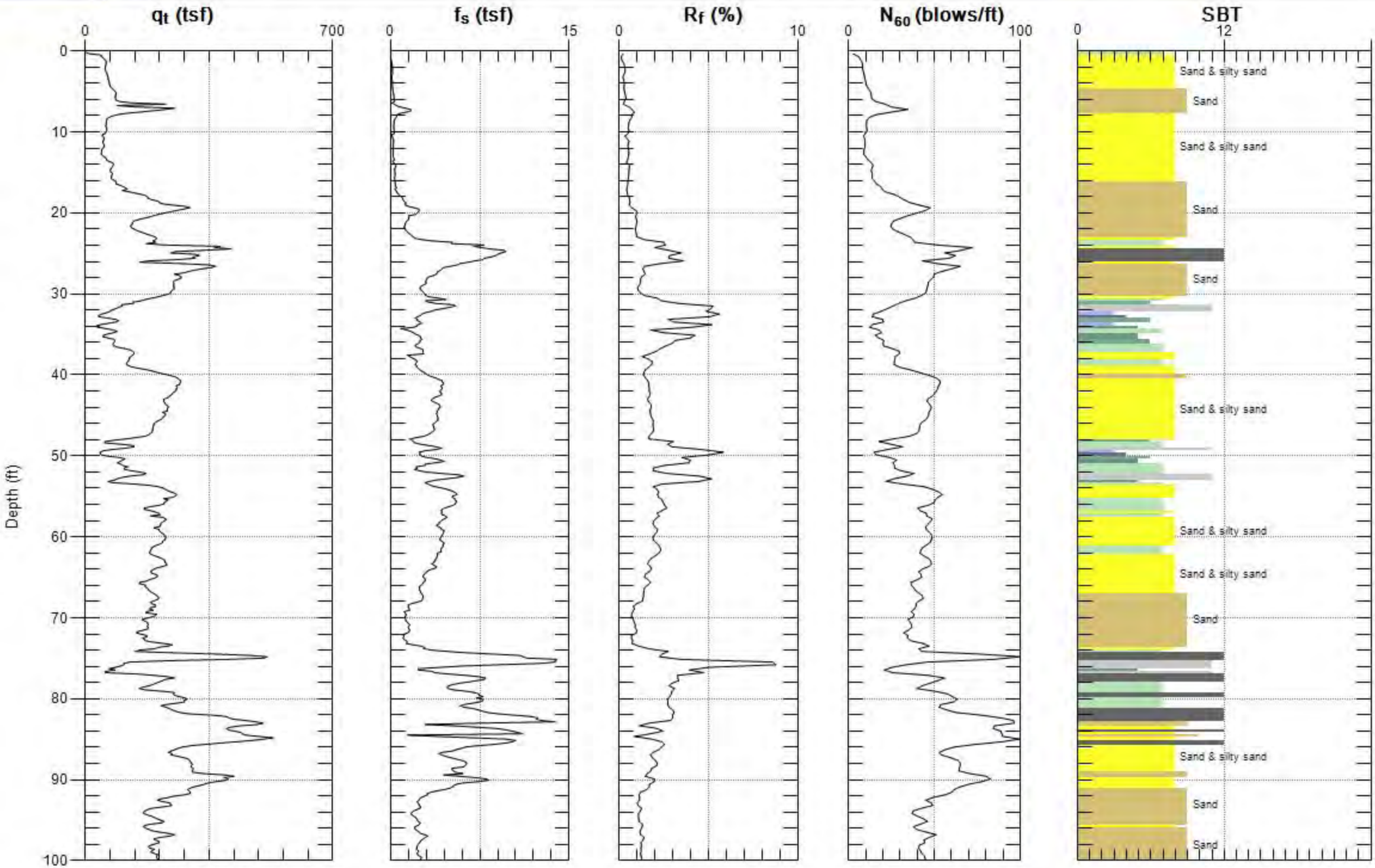
Max. Depth: 100.394 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt3

Engineer: J.BLANKE
Date: 5/10/2012 01:50



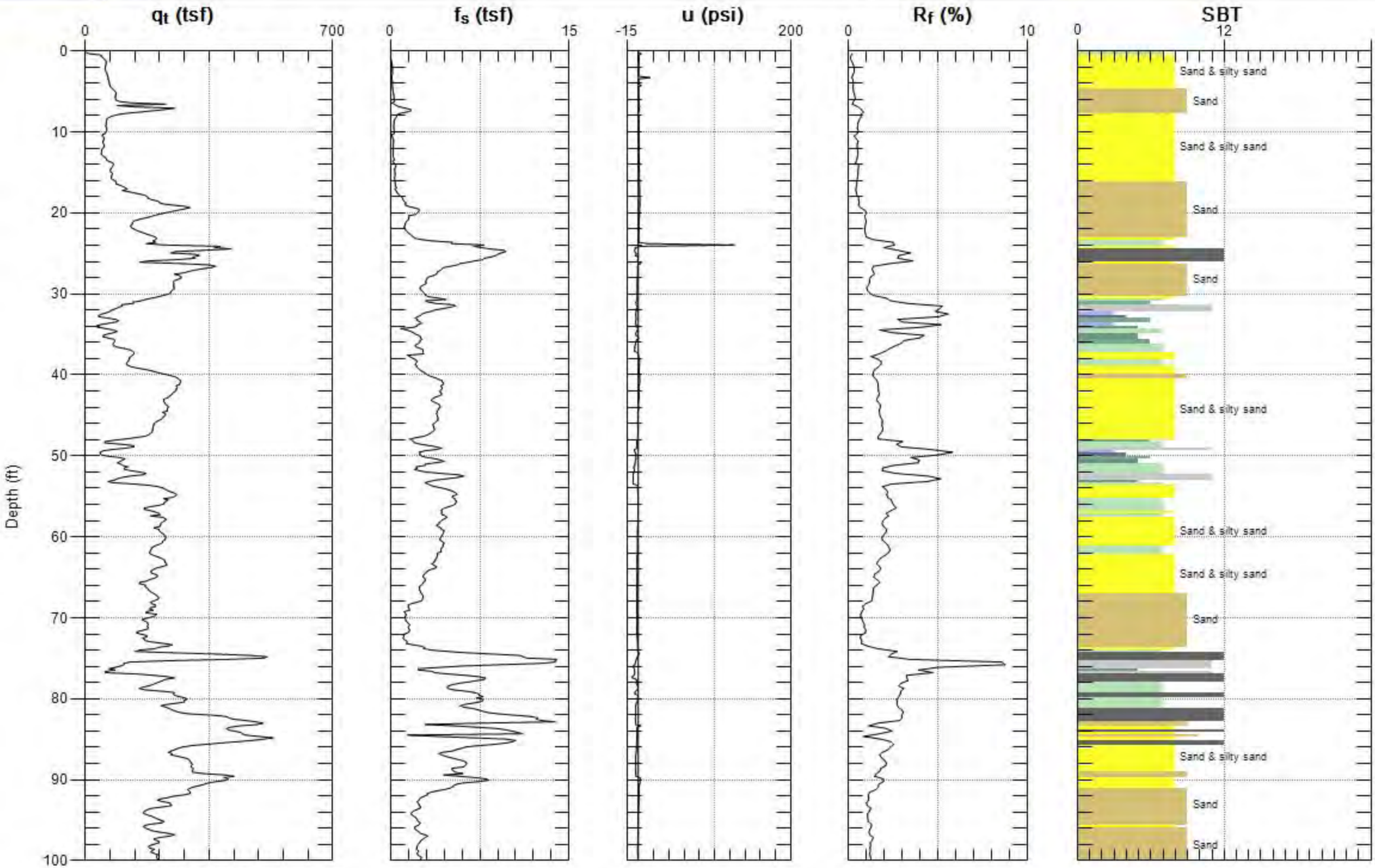
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt3

Engineer: J.BLANKE
Date: 5/10/2012 01:50



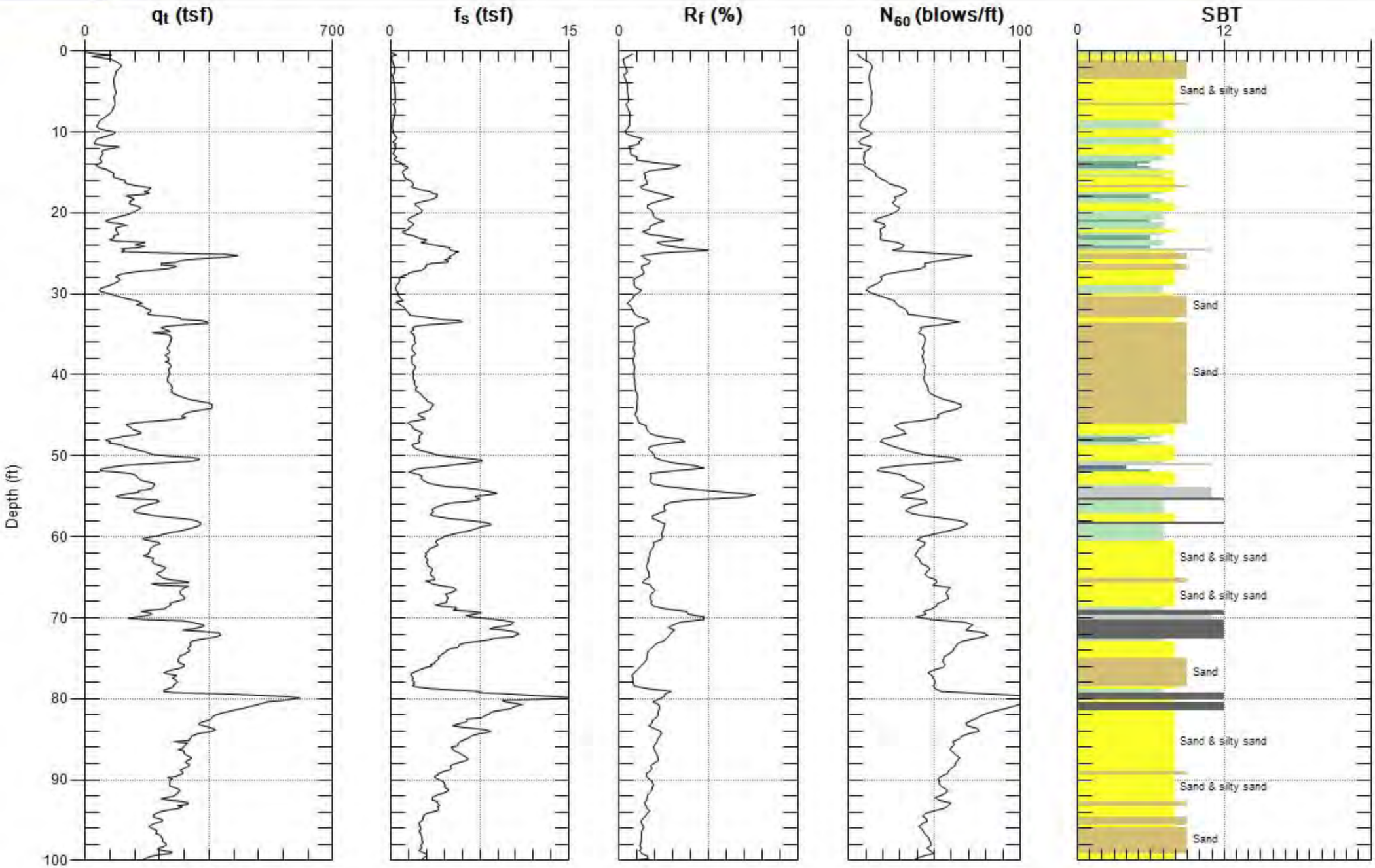
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt4

Engineer: J.BLANKE
Date: 5/10/2012 10:03



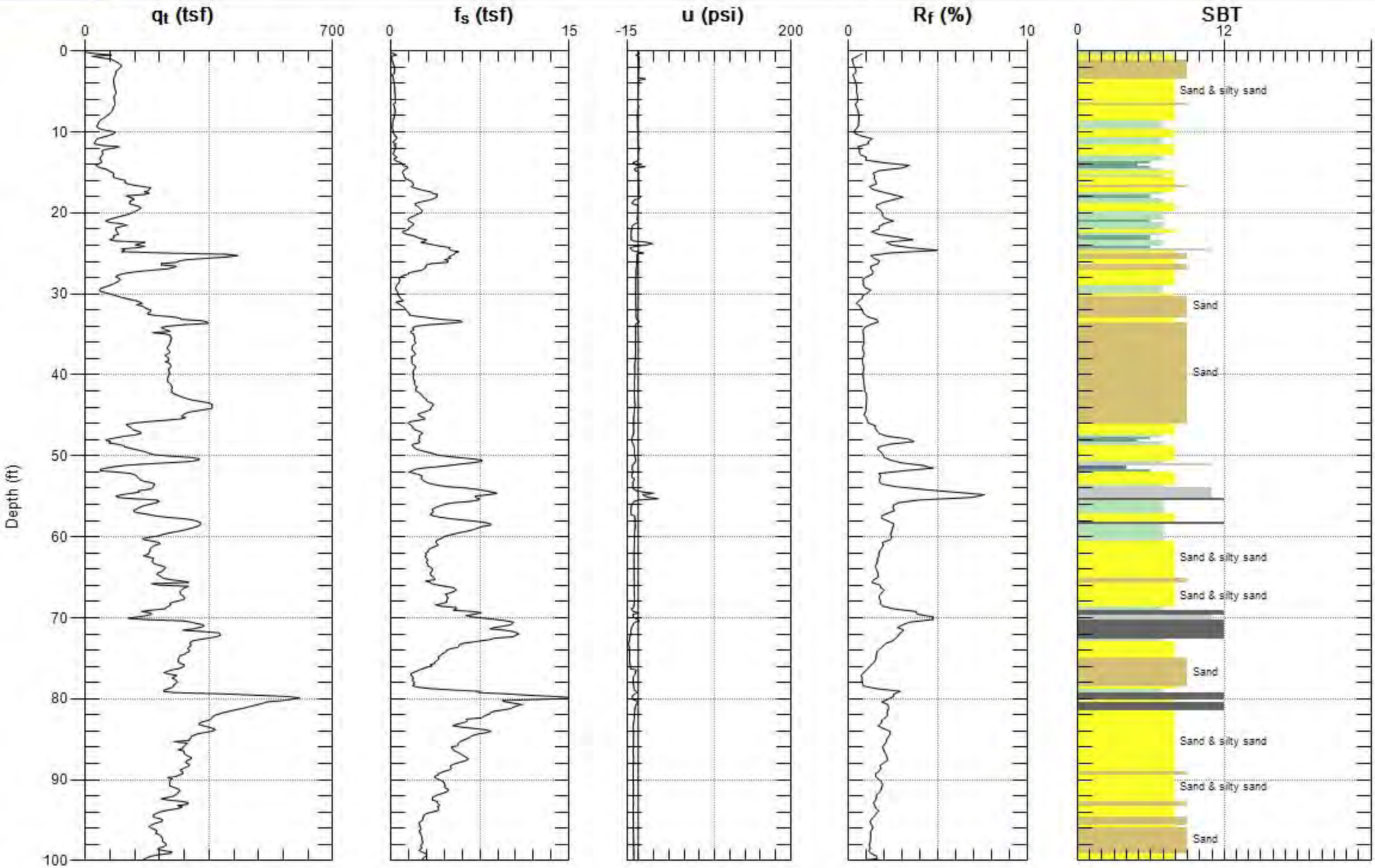
Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt4

Engineer: J.BLANKE
Date: 5/10/2012 10:03



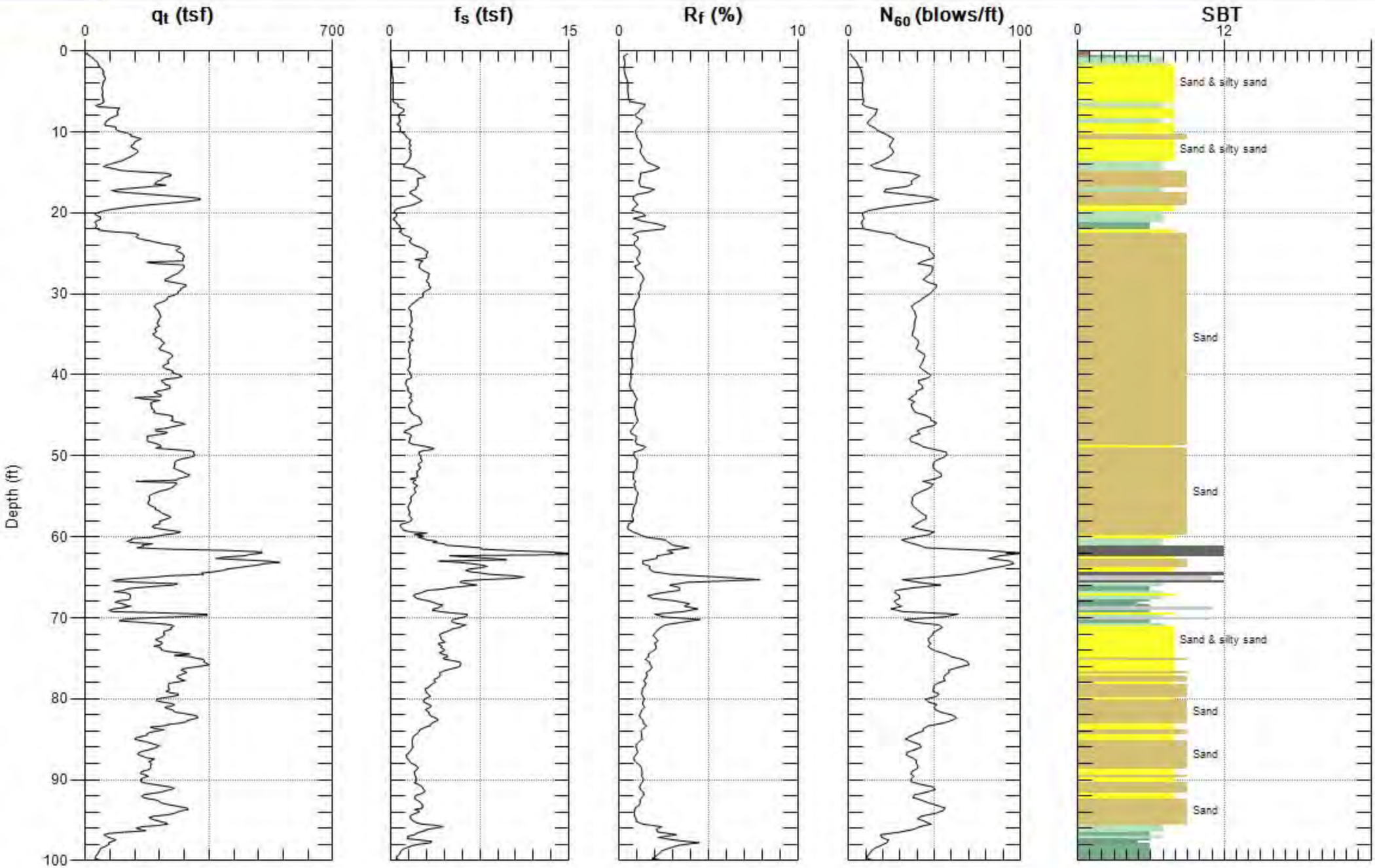
Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt5

Engineer: J.BLANKE
Date: 5/10/2012 08:02



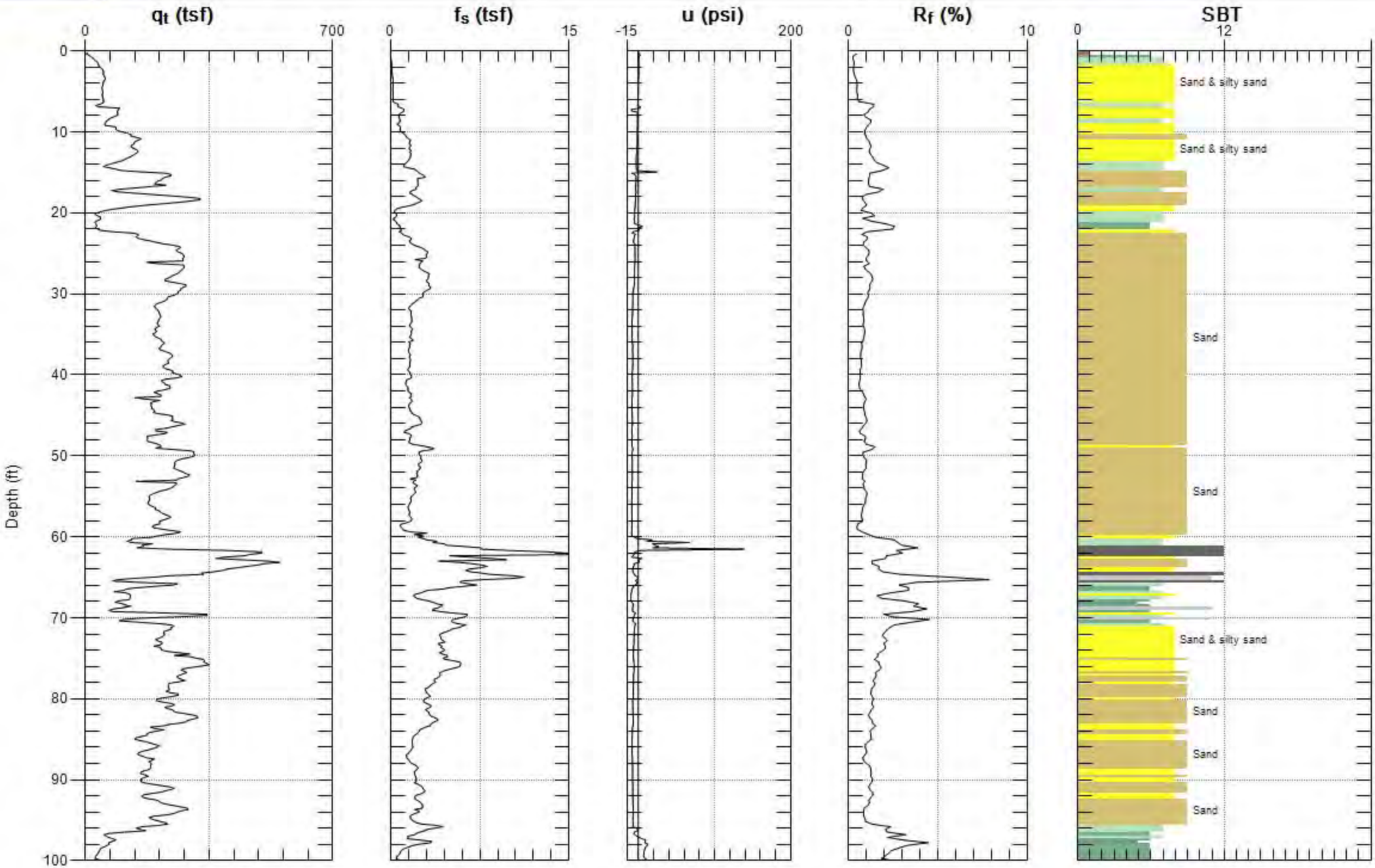
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

WRIME, INC.

Site: MARKS POND AREA
Sounding: 4-cpt5

Engineer: J.BLANKE
Date: 5/10/2012 08:02



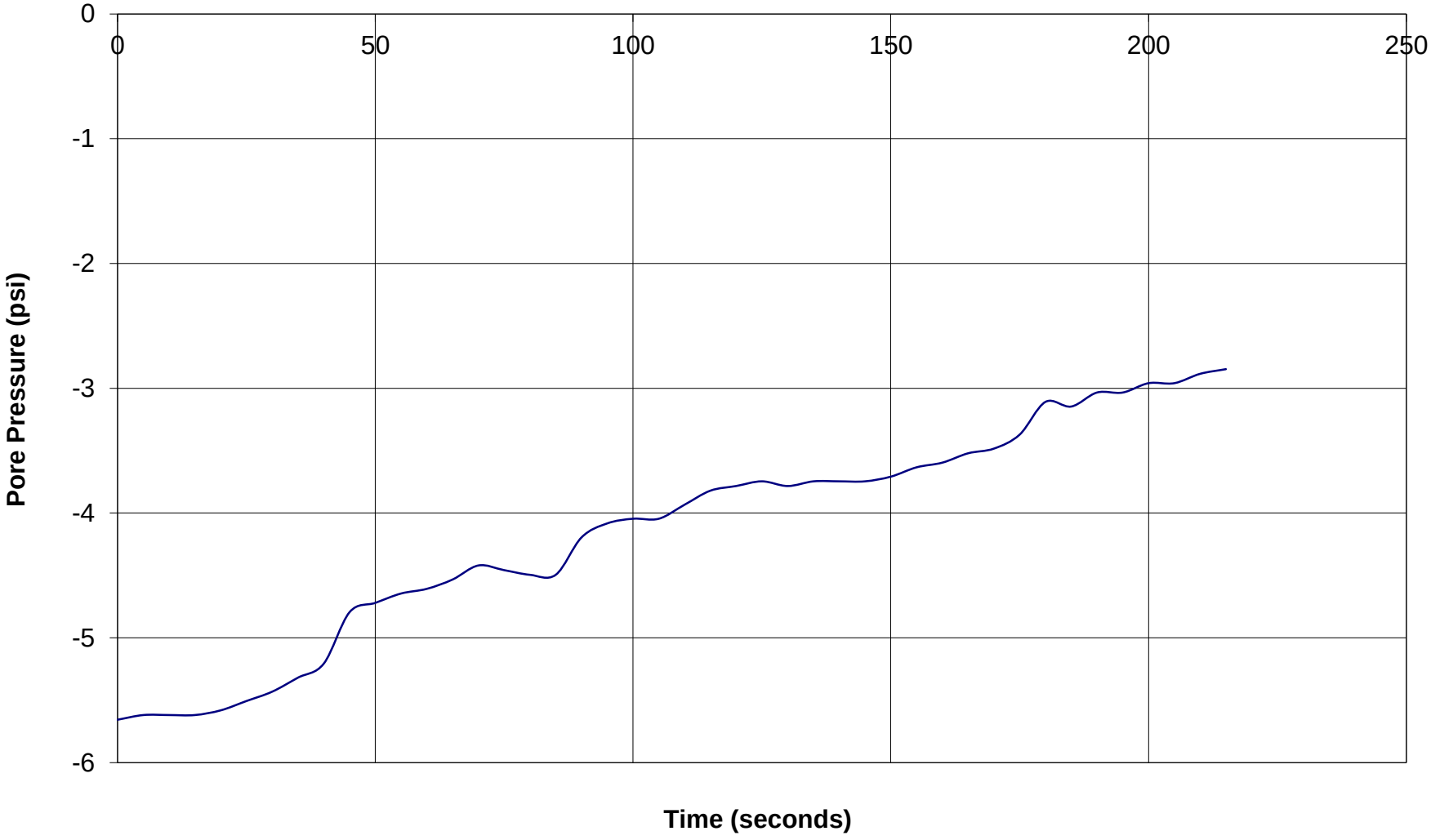
Max. Depth: 100.558 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

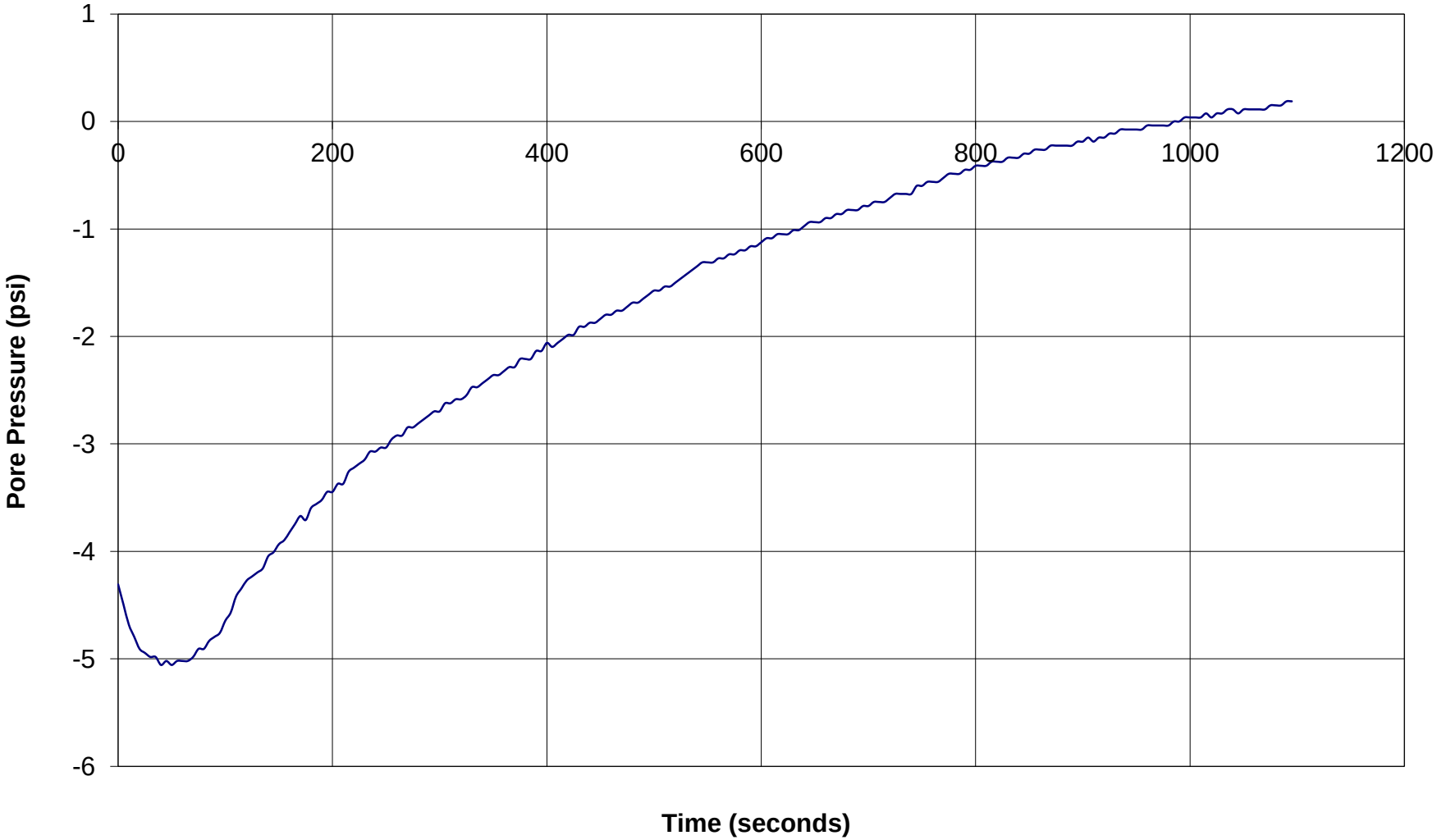
Sounding: 2-CPT4
Depth: 41.338458
Site: MARKS POND AREA
Engineer: J.BLANKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

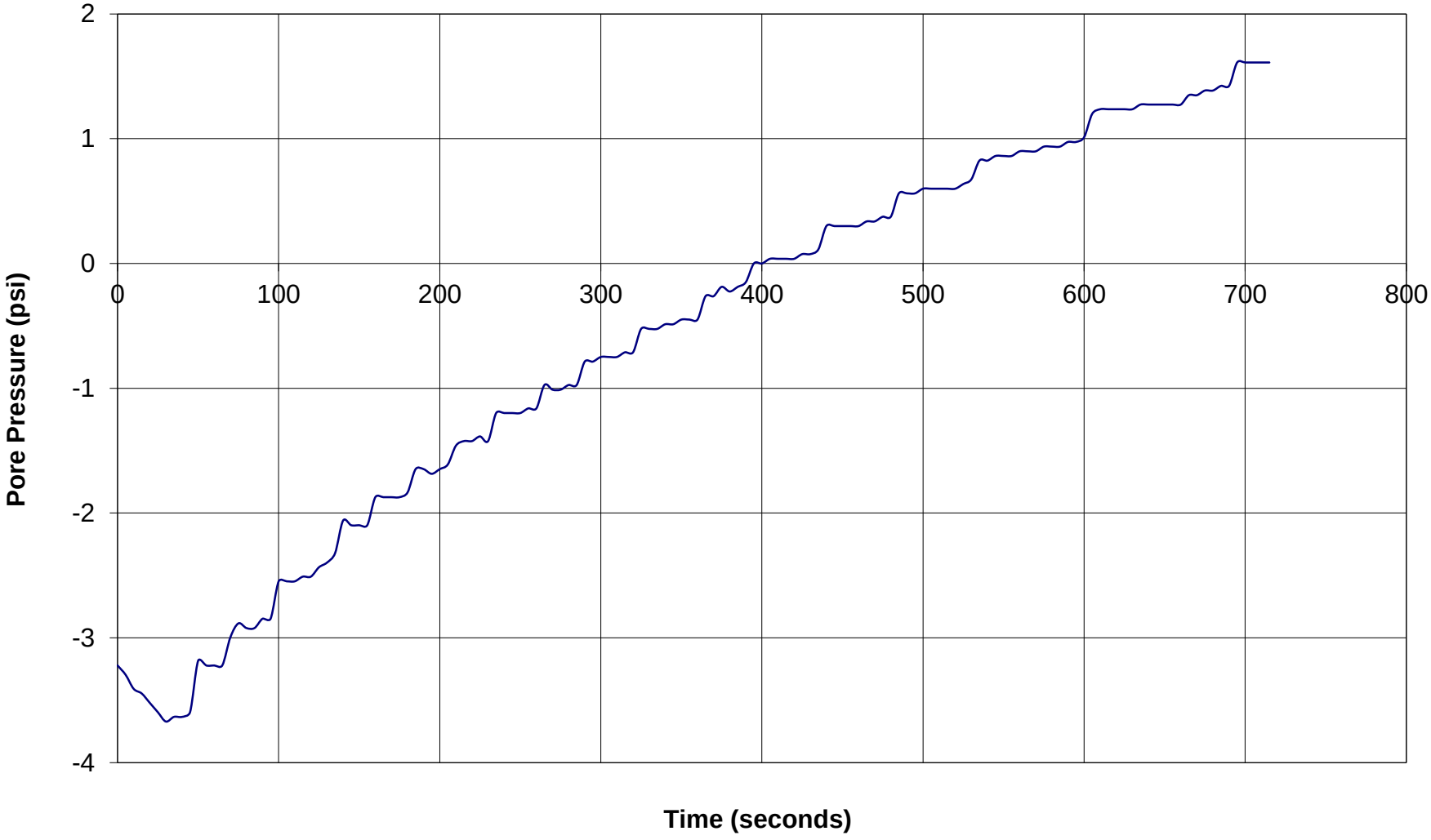
Sounding: 3-CPT1
Depth: 54.9539025
Site: MARKS POND AREA
Engineer: J.BLANKE



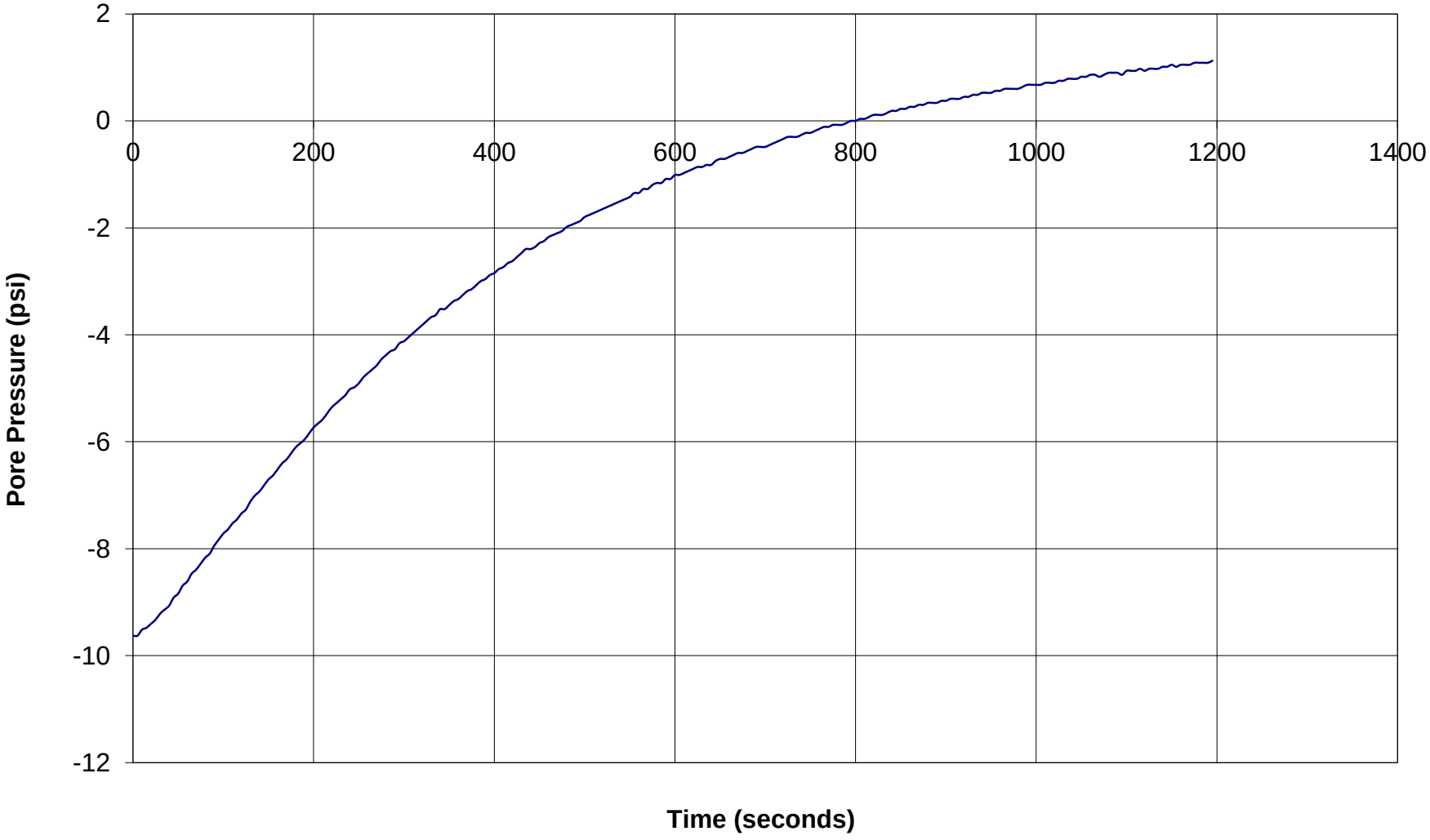
GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: 4-CPT3
Depth: 89.566659
Site: MARKS POND AREA
Engineer: J.BLANKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: 4-CPT4
Depth: 76.2792975
Site: MARKS POND AREA
Engineer: J.BLANKE