Santa Maria River Valley Groundwater Basin Fringe Area Characterization Study

July 20, 2018

Prepared for

San Luis Obispo County Flood Control and Water Conservation District

Prepared by

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July 13, 2018

County of San Luis Obispo
Public Works Department
County Government Center
976 Osos Street, Room 206
San Luis Obispo, California 93408

Attention: Mr. Dick Tzou

Re: Santa Maria River Valley Groundwater Basin Fringe Area Characterization Study, Final Report

Dear Mr. Tzou:

Pursuant to your request, we are providing for your review this Final Report of the "Santa Maria River Valley Groundwater Basin Fringe Area Study". This study was performed in response to the Request for Proposal PS-#1421, and the Notice to Proceed letter dated June 13, 2017 that was sent to GSI Water Solutions. It was performed under the terms of Contract Number 300533.06.01.

Thank you for the opportunity to assist the County with this important work.

Sincerely,

GSI WATER SOLUTIONS, INC.

Paul A. Sorensen, P.G., CHg.
Principal Hydrogeologist

Dave O'Rourke, P.G., CHg.
Supervising Hydrogeologist

CERTIFICATION OF TECHNICAL REPORTS AND MAPS
TECHNICAL REPORT

This report was prepared by the staff of GSI Water Solutions, Inc. under the direct supervision of professionals whose signatures appear on this page. We are familiar with the information submitted and believe that the information is true, accurate, and complete. We are further aware that, under California Code of Regulations, Title 25, Section 22-66015.5, “Certification” means a statement of professional opinion based upon knowledge and belief. The findings or professional opinion were prepared in accordance with generally accepted professional engineering and geologic practice.

GSI WATER SOLUTIONS, INC.

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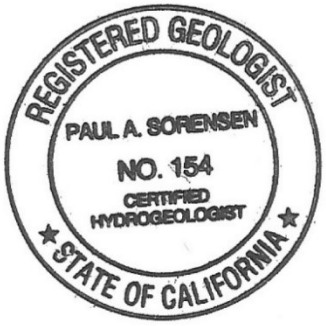

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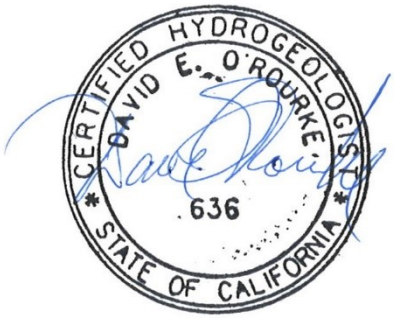

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Executive Summary

1. Introduction

This report documents the basin characterization work performed by GSI Water Solutions, Inc. (GSI), and Ramboll/Environ Inc. on behalf of the San Luis Obispo County Flood Control and Water Conservation District (District) for the Santa Maria River Valley Groundwater Basin (SMRVGB or Basin) Fringe Area characterization and basin boundary modification project (Study).

The Sustainable Groundwater Management Act (SGMA) took effect on January 1, 2015, and requires certain actions be taken in groundwater basins designated as either high or medium priority by the California Department of Water Resources (DWR). DWR identified the SMRVGB as a high priority basin; however, SGMA does not apply to a majority of the Basin that is at issue in *Santa Maria Valley Water Conservation District v. City of Santa Maria*, et al. [1] (adjudicated area), provided that certain requirements are met. The boundaries of the adjudicated area do not coincide with the Basin boundaries as documented in DWR's Interim Update to Bulletin 118 (2016). For the purposes of this Study, the areas between the Bulletin 118 Basin boundaries and the adjudicated area boundary are referred to as "Fringe Areas" (Figure 1). In order to comply with SGMA, the County of San Luis Obispo (County) and the City of Arroyo Grande formed Groundwater Sustainability Agencies (GSA) over these Fringe Areas.

The results of this Study are intended to produce a basis of knowledge for potential future use in boundary modification request(s) and/or development of a Groundwater Sustainability Plan (GSP) and related efforts for the Fringe Areas within San Luis Obispo County.

1.1 Study Areas

There are five Fringe Areas within San Luis Obispo County that are addressed in this Study (Figure 1). The following is a list of Fringe Areas from north to south:

- Pismo Creek Valley Fringe Area
- Arroyo Grande Creek Valley Fringe Area
- Nipomo Valley Fringe Area
- Southern Bluffs Fringe Area
- Ziegler Canyon Fringe Area (previously referred to as Cuyama River Valley Fringe Area)

The purpose of this Study is to perform a hydrogeologic characterization of the Fringe Areas. If a Basin Boundary Modification request (BBMR) were pursued with DWR, the characterization information could serve as supporting information for the request. However, if a BBM is not pursued or to the extent it is approved or not, the characterization information can also serve as foundational information for developing key elements required for SGMA compliance, such as a hydrogeologic conceptual model, water budget, and/or GSP for the Fringe Areas. A comprehensive analysis and characterization of the

[1] Pursuant to Water Code 10720.8(a)(18), SGMA does not apply to the adjudicated areas of the Santa Maria Valley Groundwater Basin.

Fringe Areas is key to understanding their geology and hydrogeology, and provides foundational information necessary to aid in the management of this critical resource.

1.2 Approach

In the body of this report, each Fringe Area is discussed separately, but each area is evaluated using the same categories of data and analytical approach. This Study presents a summary of the physical setting (including available information on topography, land use, water use, and hydrology), geologic setting, and hydrogeologic setting. All available published reports, private well reports, well completion reports, geologic logs, water level data, and other data were reviewed to generate a compilation of the current understanding of the hydrogeologic setting of the Fringe Areas. Crop water demand for irrigation is estimated by applying the crop demand factors in Table 1 to acreage planted in each crop type (based on DWR GIS crop acreage data from 2014).

Table 1 – Crop Demand Factors

Crop Type	Applied Water (acre-feet/acre/year)
Rotational Vegetables	2.27
Strawberries	1.38
Vines	1.08
Alfalfa	3.46
Grain	0.3
Nursery	2.02
Deciduous	2.64
Avocado/Citrus	2.86
Reference: Crop demand factors from GEI, 2013	

In addition to analysis of published data, the consultant team performed several focused field work efforts specific to this Study. Constant rate aquifer tests were performed on existing wells in Arroyo Grande Valley and Ziegler Canyon. (No appropriate wells in the Pismo Creek alluvium were identified for testing; Nipomo Valley and Southern Bluffs had no wells in the Basin materials.) New water level data were collected from several existing wells in key locations. A surface geophysical study was also performed by Ramboll/Environ in Ziegler Canyon.

1.3 Santa Maria River Valley Basin Geologic Setting

A detailed basin characterization report of the SMRVGB has been prepared previously (Fugro, 2015). A detailed description of the SMRVGB can be found in that document; however, a brief summary of the more significant features of the Basin as they relate to the Fringe Areas is presented here. Figure 2 presents a stratigraphic column displaying the formations that are most relevant to the local hydrogeology. For the purpose of this Study, the rocks in the SMRVGB Fringe Areas may be considered as two basic groups: water-bearing sediments and non-water-bearing bedrock formations. The consolidated bedrock ranges in age and composition from Jurassic-aged serpentine and marine sediments to Tertiary-aged volcanic and marine formations. Compared to the saturated sediments that comprise the Basin aquifers, the consolidated bedrock formations are not considered to be water-bearing. Although

bedding plane and/or structural fractures in these rocks may yield small amounts of water to wells, they do not represent a significant portion of the pumping in the area.

The most significant geologic structure in the Basin is the Wilmar Avenue Fault and its extensions. This fault runs approximately parallel to Highway 101 at the base of the San Luis Range. The mapped extent of these faults approximates the northeastern boundary of the SMRVGB adjudicated area. To the northeast of this fault, older formations are upthrown and exposed at the surface. To the southwest of this fault lie the sediments that comprise the SMRVGB.

The water-bearing sedimentary formations present in the adjudicated area of the SMRVGB and the adjacent Fringe Areas are briefly described below.

- ***Recent Alluvium***
  The Recent Alluvium is the mapped geologic unit composed of unconsolidated sediments of gravel, sand, silt, and clay, deposited by fluvial processes along the courses of Pismo Creek, Arroyo Grande Creek, and the Cuyama River in Ziegler Canyon. Lenses of sand and gravel are the productive strata within the Recent Alluvium. These strata have no significant lateral continuity across large areas of subsurface. Thickness of Recent Alluvium in the Study area may range from just a few feet to nearly 100 feet.

- ***Paso Robles Formation***
  The Paso Robles Formation underlies the Recent Alluvium throughout most of the SMRVGB. It is composed of poorly sorted, unconsolidated to mildly consolidated sandstone, siltstone, and claystone, with thin beds of volcanic tuff in some areas. The Paso Robles Formation was deposited in a terrestrial setting on a mildly sloping floodplain that has been faulted, uplifted, and eroded since deposition. It is extensive below recent dune sands in the SMRVGB, but is largely eroded away in the upthrown fault blocks northeast of the Wilmar Avenue Fault, present only as a few small isolated pods near the downstream extent of the Pismo Creek Valley. The Paso Robles Formation is a significant water source in the SMRVGB, but provides no water in the Fringe Areas.

- ***Pismo Formation***
  The oldest geologic water-bearing unit with significance to the hydrogeology of the Fringe Areas is the Pismo Formation, a Pliocene-aged marine sedimentary unit composed of claystone, siltstone, sandstone, and conglomerate. The Pismo Formation is exposed at the surface in the Santa Lucia Mountains northeast of the adjudicated boundary, and underlies the Paso Robles Formation, where present. There are five recognized members of the Pismo Formation (Figure 2). While all are part of the Pismo Formation, the distinct members reflect different depositional environments, and the variations in geology may affect the hydrogeologic characteristics of the strata. From the bottom (oldest) up, these are:

    - **The Edna Member**, which lies unconformably atop the Monterey Formation, and is locally bituminous (hydrocarbon-bearing) sandstone

- **The Miguelito Member**, primarily composed of thinly bedded grey or brown siltstones and claystones
- **The Gragg Member**, usually described as a medium-grained sandstone
- **The Belleview Member**, composed of interbedded fine grained sandstones and claystones
- **The Squire Member**, generally described as a medium- to coarse-grained fossiliferous sandstone of white to grey sands

It is noteworthy that municipal wells in Arroyo Grande that draw from the Pismo Formation outside of the adjudicated area are not considered to be pumping from the Basin. The Pismo Formation outside of the adjudicated area boundary is not considered to be Basin material.

- ***Careaga Formation***
  The marine sandstone that underlies the Paso Robles Formation in the SMRVGB is referred to as the Careaga Formation. The Careaga Formation is a marine sandstone similar to the Pismo Formation. It occurs only at depth in the SMRVGB, below the Paso Robles Formation. It is not mapped northeast of the Wilmar Avenue Fault, in either the Fringe Areas or the mountainous areas in between. Wells that screen the Careaga Formation inside the adjudicated area boundaries are considered to be drawing from the Basin.

The non-water-bearing bedrock formations are briefly described below.

- ***Monterey Formation***
  The Monterey Formation is a thinly bedded siliceous shale, with layers of chert in some locations. In numerous areas of San Luis Obispo County, the Monterey Formation is the source of significant oil production. An active oil field is present adjacent to and partially within the Pismo Creek Valley Fringe Area west of Price Canyon. While fractures in consolidated rock may yield small quantities of water to wells, the Monterey Formation is not considered to be water-bearing Basin materials for the purposes of this Study.

- ***Obispo Formation***
  The Obispo Formation and associated Tertiary volcanics are composed of materials associated with volcanic activity along tectonic plate margins approximately 20 to 25 million years ago. The Obispo Formation is composed of ash and other material expelled during volcanic eruptions. The Obispo Formation crops out in small exposures along the northeast side of the Wilmar Avenue Fault and its extensions. Although fractures in consolidated volcanic rock may yield small quantities of water to wells, the Obispo Formation is not considered to be water-bearing Basin materials for the purposes of this Study.

- ***Franciscan Assemblage***
  The Franciscan Assemblage contains the oldest rocks in the Basin area, ranging in age from late Jurassic through Cretaceous (150 to 66 million years ago). The rocks include a heterogeneous

collection of basalts, which have been altered through high-pressure metamorphosis associated with subduction of the oceanic crust beneath the North American Plate before the creation of the San Andreas Fault. Although fractures may yield small quantities of water to wells, the Franciscan Assemblage is not considered to be water-bearing Basin materials for the purposes of this Study.

2. Pismo Creek Valley Fringe Area

This section of the report discusses the data used to characterize the Pismo Creek Valley Fringe Area.

2.1 Physical Setting

2.1.1 Topography.

The Pismo Creek Valley Fringe Area is just over three miles long, oriented in a northeast-southwest direction, located adjacent to the northernmost extent of the adjudicated area boundary (Figures 3 and 4). Land surface elevation ranges from approximately 270 feet above mean sea level (MSL) at the upper extent of the valley to sea level at the bottom of the Fringe Area. Mountain ridges on either side of the valley rise steeply to elevations of over 400 feet on both sides.

2.1.2 Land Use.

Land use at the southern extent of this Fringe Area is municipal/residential, encompassing part of the area of the City of Pismo Beach. The northern extent of the area is adjacent to and partially encompassed by the area of an active oil production field (the Arroyo Grande Oil Field), owned and operated by Sentinel Peak Resources. Sentinel Peak Resources has applied for an aquifer exemption from the State Water Resources Control Board for the Dollie Sands of the Pismo Formation within its area of operations. Between the City of Pismo Beach and the oil field, the valley floor has few rural domestic parcels and no significant irrigated agriculture. In 2014, there were approximately 95 acres of vineyard planted on the slopes on the northwest side of the alluvial valley in the vicinity of Spanish Springs Road (DWR, 2017).

2.1.3 Water Use.

The municipal area including and adjacent to the City of Pismo Beach receives its water supply from the City's Utilities Department, which has no supply wells in the Pismo Creek Valley Fringe Area. Sentinel Peak Resources maintains a shallow well for fire protection and non-potable use; bottled water is used for potable supply. Available well completion reports indicate only a single irrigation water supply well that draws from the alluvium located in the northern half of the valley. In the southern half of the valley, three irrigation wells and a domestic well were identified from well completion reports that draw from the Pismo Formation underlying the alluvium. It is unknown whether these wells are currently active.

2.1.4 Hydrology.

Pismo Creek drains approximately 47 square miles (DWR, 2002). It flows through mountainous terrain, with small alluvial deposits occurring sporadically prior to the creek emptying into the Pacific Ocean. Pismo Creek has no long term stream gage data. There is rarely year-round flow in Pismo Creek; the channel is frequently dry during the summer months (Balance Hydrologics, 2008). The estimated average runoff for Pismo Creek for the 12-year period of 1984-1995 ranged from 140 to 200 acre-feet per year

(AFY). Sentinel Peak Resources discharges treated water into the upper reach of Pismo Creek at an average rate of 0.5 million gallons per day (MGD), or 0.77 cubic feet per second (cfs).

2.2 Geologic Setting

Figure 5 displays a geologic map (Hall, 1973) in the vicinity of the Pismo Creek Valley Fringe Area. In the northern half of the valley, various members of the Pismo Formation (i.e., Squire, Miguelito, and Edna) crop out at the surface on both sides of the valley and underlie the Recent Alluvium. In the southern half of the valley, the Pismo Formation members crop out on the eastern flank of the valley, but Monterey and Obispo Formation outcrops are exposed along the western flank of the valley. The Wilmar Avenue Fault is located at the southern extent of the valley.

Figure 6 displays a geologic cross section down the longitudinal axis of the valley. The Pismo Formation underlies the Alluvium along the entire section line. Other than the series of alluvial monitoring wells, this section shows that the wells that are used for supply draw from the Pismo Formation, not from the Alluvium. Southwest of the Wilmar Avenue Fault, the Alluvium overlies more than 100 feet of Paso Robles Formation, which in turn overlies more than 300 feet of Careaga Formation.

Figure 7 displays a geologic cross section perpendicular to the valley axis, upstream of the Wilmar Avenue Fault. This section illustrates that alluvium in the valley reaches a thickness of approximately 35 feet along this line.

A past study evaluated the presence of alluvium in the Arroyo Grande Oil Field and the potential of the alluvium as an aquifer (WZI, 2007). The findings and conclusions of the WZI investigation indicated that alluvium was not extensive or continuous in the portions of Pismo Creek through the Arroyo Grande Oil Field, and that Pismo Creek was incised into bedrock of the Edna Member of the Pismo formation. WZI concluded that the alluvium is not as extensive as previously mapped, that there was geologic and hydrogeologic separation between alluvium mapped in the north to Edna Valley and to the south in the Pismo Valley, and "no alluvial aquifer appears to be present within the Pismo Creek drainage in the area of (the oil company's) property." The WZI report is included as Appendix B.

2.3 Hydrogeologic Setting

This section of the report briefly describes the hydrogeologic setting of the Pismo Creek Valley Fringe Area, including characterization of hydraulic parameters, field work performed for this project, and estimates of underflow from the Pismo Creek Valley Fringe Area to the adjudicated area of the SMRVGB. No data were available to generate water elevation contours or long-term water level hydrographs in the Pismo Creek Valley.

2.3.1. Hydraulic Parameters

Specific yield is a measurement of the storage capacity of unconfined aquifers, expressed as dimensionless fraction representing the ratio of the volume of water draining from an unconfined aquifer to the total volume of aquifer drained. DWR presents summary data of five Alluvium wells in the Pismo Creek Valley Fringe Area with a range of specific yields from 0.06 to 0.17, with a median value of 0.12 (DWR, 2002).

No wells screened in the alluvium were available for aquifer testing for this Study. However, in 1999, six alluvial monitoring wells were installed in the northern portion of the Pismo Creek Valley (Fugro, 2009). Summary information and data from pumping tests on these wells are included in Table 2, below. Reported transmissivity values range from 127 to 1,101 square feet/day (ft^2/day), or 950 to 8,235 gallons per day per foot (gpd/ft). Associated estimates of hydraulic conductivity range from 18 to 120 feet/day.

Table 2 –Pismo Creek Valley Alluvium Data

Parameter	Well #1	Well #4	Well #7	Well #9	Well #10	Well #11	Average
Transmissivity [1] (ft2/day)	590	1,101	127	230	154	218	403
Hydraulic Conductivity [1] (ft/day)	75	120	18	38	26	20	50
1/4/18 Depth to Water [2] (ft)	31.29	13.00	11.40	16.21	14.72	36.95	NA
1/4/18 Saturated Thickness [2] (ft)	27.71	30.00	24.60	22.79	24.28	38.05	NA

1) Data from Fugro, 2009.
2) Field data collected by GSI staff

Fugro estimated the total amount of groundwater in storage in the Pismo Creek Alluvium at 500 to 600 acre-feet (Fugro, 2009).

2.3.2 Water Levels

GSI staff measured depth to water in the six Pismo Creek Valley alluvial monitoring wells on January 4, 2018. The measured depth to water and calculated saturated thickness are included in Table 2. Saturated thickness in the six wells ranges from 22.79 feet to 38.05 feet. It is important to note that these wells are immediately downstream of the point where Sentinel Peak Resources discharges treated water into the creek; therefore, it is likely that groundwater is locally recharged in this area.

2.3.3 Outflow to Santa Maria Valley Groundwater Basin

The volume of subsurface outflow from the Pismo Creek Valley Fringe Area to the adjudicated area of the SMRVGB through the alluvial sediments was calculated, as follows:

$Q = K*i*A$, where

Q = Groundwater Underflow (L^3)

K = Hydraulic conductivity (L/T)

i = Hydraulic Gradient (ft/ft, dimensionless)

A = Area of flow (L^2)

For hydraulic conductivity, a value of 50 ft/day is used. This is the average of the values from the aquifer tests performed on the alluvial wells presented in Table 2.

Hydraulic gradient was estimated by measuring the gradient of the land surface of the stream channel at the bottom of the valley from the USGS topographic map, under the assumption that the gradient of the groundwater surface is comparable to the gradient of the thalweg of the stream. This value is 0.003.

The cross-sectional area of flow was estimated at the bottom of the alluvial valley, where map distance across the valley neck is approximately 1,000 feet. Little data exists to estimate the saturated thickness in the alluvium, but cross section A-A' (Figure 6) suggests that the total thickness of alluvium across the neck of the valley is about 35 to 50 feet. During times when Pismo Creek is flowing, it can be assumed that the full thickness of alluvium is saturated. There are no data to indicate alluvium water levels in this area when the creek is not flowing. However, a conservative assumption is that the full thickness is saturated year round. Thus, with saturated thickness estimated at 50 feet and a length of 1,000 feet, the cross-sectional area of flow is estimated at 50,000 square feet. Therefore,

Q = (50 feet/day)*(0.0031)*(50,000 square feet)

Q = 63 AFY

The calculated flux volume of 63 AFY is comparable to the DWR estimates of underflow from the Pismo Creek Alluvium that ranged from 30 to 320 AFY, with an average of 100 AFY (DWR, 2002). DWR estimated total annual inflow to the SMRVGB ranging from 10,000 to 82,400 AFY, with a long-term average of 29,200 AFY (DWR, 2002). A Pismo Creek Valley underflow estimate of 63 AFY accounts for less than 0.22% of total inflow to the Basin.

3 Arroyo Grande Creek Valley Fringe Area

This section of the report discusses the data used to characterize the Arroyo Grande Creek Valley Fringe Area.

3.1. Physical Setting

3.1.1 Topography

The Arroyo Grande Creek Valley is approximately seven miles long, oriented in a northeast-southwest direction, extending from Lopez Dam to the adjudicated area boundary (approximately coincident with the Wilmar Avenue Fault and Highway 101). The tributary valley of Tar Springs Creek is about three miles long, oriented east-west, and joins Arroyo Grande Creek about three miles upstream of Highway 101 (Figures 8 and 9). Land surface of Arroyo Grande Creek valley extends from an altitude of about 380 feet MSL at the base of Lopez Dam to about 100 ft MSL at the bottom of the valley. Tar Springs Creek Valley extends from an altitude of about 360 ft MSL to 160 ft MSL at the confluence with Arroyo Grande Creek. Mountain ridges on the north side of the valley rise steeply to elevations of over 1500 feet MSL near Lopez Dam (Figure 9).

3.1.2 Land Use

The predominant land use throughout most of the valley is irrigated agriculture (Figure 8). In 2014, approximately 1,800 acres (DWR, 2017) in or adjacent to the 3,030 acres of alluvium is planted in various crops. The southern extent of the valley is within the boundaries of the City of Arroyo Grande, and is largely municipal/residential.

3.1.3 Water Use

The municipal area including and adjacent to the City of Arroyo Grande receives its water supply from the City's Utilities Department; the City's supply portfolio includes surface water from Lopez Lake, State Water allocations, and groundwater. The irrigated areas upstream of the City rely on groundwater from wells tapping both the alluvial aquifer and the underlying Pismo Formation. Estimated crop demand for the irrigated area is approximately 3,790 acre-feet per year. As noted previously, the City of Arroyo Grande has municipal wells that draw from the Pismo Formation adjacent to the valley, and these extractions, though recorded, are not counted against withdrawals from the adjudicated area; thus, the Pismo Formation outside of the adjudicated area boundary is not considered to be Basin sediments.

3.1.4 Hydrology

Arroyo Grande Creek and its tributaries drain an area of approximately 190 square miles. Lopez Reservoir, which impounds about 70 square miles of the upper watershed, was completed in 1969 with a capacity of 52,500 acre-feet. Its annual dependable yield is 8,730 acre-feet, of which, 4,530 acre-feet are allocated for pipeline delivery and 4,200 acre-feet are reserved for downstream releases. Lopez Lake provides drinking water for Arroyo Grande, Grover Beach, Pismo Beach, Oceano, and Avila Beach. It also provides groundwater recharge, water for irrigation, and flood control. Downstream releases from the reservoir recharge the underlying alluvial aquifer.

3.2. Geologic Setting

Figure 10 displays the geologic maps (Dibblee, 2006b, c, d, e) in the vicinity of the Arroyo Grande Creek Valley. The Pismo Formation is exposed at the surface in the hills of the San Luis Range to the west of the main part of the valley, and in much of the area between Arroyo Grande Valley and Tar Springs Creek Valley. To the southeast of the Arroyo Grande/Tar Creek Springs Valley, the Monterey Formation crops out. The Edna Fault Zone and the Huasna Fault Zone cross the northern extent of the Arroyo Grande Valley; as a result, faulted and folded rocks of the Monterey Formation and Franciscan Assemblage crop out in the area northeast of the valley.

Figure 11 displays geologic cross section C-C' down the longitudinal axis of Arroyo Grande Creek Valley. Recent Alluvium is present at the surface along the entire section line. The Wilmar Avenue Fault lies at the southwest end of the valley, and juxtaposes the sediments of the SMRVGB against the non-Basin Monterey Formation. The Pismo Formation underlies the Recent Alluvium in the central area of the section line. The geologic map indicates a synclinal structure in the Pismo. Where present, the Pismo Formation may supply wells, in addition to the Alluvium. The Edna Fault Zone trends across the valley, and cuts off the Pismo sediments; it appears that Pismo sediments that were previously deposited on the upthrown block were eroded away prior to deposition of the Recent Alluvium.

Figure 12 displays geologic cross section D-D' perpendicularly across the valley axis, about ½ mile upstream of the Wilmar Avenue Fault. This section displays a maximum of 90 feet of Recent Alluvium directly on top of Monterey Formation. The Pismo Formation crops out in the hills on the west side of the valley, and provides water to wells in the area. The Monterey Formation crops out in the hills east of the valley. A small pod of Paso Robles Formation is exposed at the surface on the eastern extent of this section.

3.3. Hydrogeologic Setting

This section of the report briefly describes the hydrogeologic setting of the Arroyo Grande Creek Valley Fringe Area, including discussion of hydraulic parameters, field work performed for this project, hydrographs, and estimates of underflow from the Arroyo Grande Valley to the SMRVGB.

3.3.1 Hydraulic Parameters

Specific yield is a parameter that describes the volume of water that will drain by gravity from a given soil mass to the volume of that soil, expressed as a dimensionless fration. DWR reported specific yield values for eight Alluvium wells in the Arroyo Grande Valley ranging from 0.09 to 0.21, with a median value of 0.12 (DWR, 2002).

DWR reported a single hydraulic conductivity estimate of 270 ft/day for Arroyo Grande Valley Subbasin Alluvium based on aquifer test data, a range of 1.2 to 12 ft/day based on pump efficiency tests, and a range of 22 to 775 ft/day based on lithologic correlation (DWR, 2002).

Two constant rate aquifer tests were performed for this Study on alluvial wells in Arroyo Grande Valley. The locations of the tests are presented on Figure 8. Results indicate that one well had a transmissivity of 90,000 gpd/ft, and a corresponding hydraulic conductivity of 252 ft/day (Table 3). The other well test yielded a transmissivity estimate of 15,000 gpd/ft with a corresponding hydraulic conductivity value of 19 ft/day (Table 3). Time-drawdown graphs from these aquifer tests are included in Appendix C.

DWR estimated that the total amount of groundwater in storage in the Arroyo Grande Valley Subbasin ranged from 8,000 to 10,000 acre-feet between the years 1975 and 1995 (DWR, 2002).

Table 3 – Aquifer Test Data Summary

Well ID	Area	Date	Saturated Thickness (ft)	Transmissivity (gpd/ft)	Hydraulic Conductivity (ft/day)
Huasna Rd Well	Arroyo Grande	12/5/17	48	90,000	252
Biddle Domestic	Arroyo Grande	11/1/17	104	15,000	19
Well #1 Propane	Ziegler Canyon	10/13/17	54	33,000	82
Well #3 Propane	Ziegler Canyon	10/20/17	77	18,000	31

Tantara Well	Ziegler Canyon	1/15/17	60	24,000	54
Notes: Aquifer tests performed by GSI Water Solutions, Inc.					

3.3.2 Potentiometric Surface and Hydrographs

DWRpresented groundwater elevation contours for the Arroyo Grande Valley for Spring 1975, 1985, and 1995 (DWR, 2002). The Spring 1995 map is re-created on Figure 13. Water level elevations are greater than 300 feet MSL in the upper reach of the valley, and decline to less than 100 feet at the bottom of the valley, under a gradient of approximately 0.009 throughout the valley.

Figure 14 presents hydrographs for two wells in the Arroyo Grande Creek Valley Fringe Area, along with a time series of annual downstream releases from Lake Lopez. Water levels in these wells do not display any significant variation other than would be expected due to seasonal variations. These hydrographs clearly display the stabilizing effect that the downstream releases from Lopez Reservoir have on groundwater elevations in the Arroyo Grande Valley.

3.3.3 Outflow to Santa Maria Basin

The quantity of groundwater underflow leaving the alluvial aquifer of the Arroyo Grande Creek Valley is calculated as previously described. This estimate is limited to flow in the Recent Alluvium.

A hydraulic conductivity estimate of 136 ft/day is applied; this is an average of the values from the aquifer tests performed on the alluvial wells.

Hydraulic gradient was estimated by measuring the gradient of the groundwater elevation contours presented in Figure 13. This value is 0.009.

Area of flow was estimated as a rectangle across the bottom of the alluvial valley. The map distance across the neck at the bottom of the valley is approximately 3,000 feet. Saturated thickness in the alluvium is estimated at 65 feet based on information in well completion reports. Thus, the area of flow is estimated at 195,000 square feet. Therefore,

Q = (136 ft/day)*(0.009)*(195,000 square feet)

Q = 2,000 AFY

DWR reported estimated subsurface outflows from the Arroyo Grande Creek Valley Subbasin ranging from 420 to 4,200 AFY, with a geometric mean of 1,300 AFY (DWR, 2002). DWR's estimates are comparable to the estimate calculated herein. DWR estimates the average total recharge to the SMRVGB as 29,200 AFY (DWR, 2002). The Arroyo Grande Creek Valley underflow estimate presented herein accounts for 6.8% of total average inflow for SMRVGB.

4 Nipomo Valley Fringe Area

This section of the report discusses the data used to characterize the the Nipomo Valley Fringe Area.

4.1. Physical Setting

4.1.1 Topography

The Nipomo Valley is approximately seven miles long, oriented in a northwest-southeast direction, adjacent to the adjudicated Basin boundary northeast of Highway 101 (Figures 15 and 16). Nipomo Creek, a tributary of the Santa Maria River, is approximately coincident with the adjudicated boundary. The area of the Nipomo Valley Fringe Area is 5,450 acres (8.5 square miles) based on the Bulletin 118 Basin boundary. Land surface of Nipomo Valley extends from an altitude of about 600 feet MSL at along the northeastern extent to about 300-350 ft MSL along the course of Nipomo Creek. Temettate Ridge, which is located less than a mile to the northeast of the area, has an elevation of approximately 1500-1600 feet MSL.

4.1.2 Land Use

The town of Nipomo is located in the southern portion of the area, but the predominant land use throughout most of the valley is irrigated agriculture of various crops (Figure 15). Approximately 2,370 acres in or adjacent to the Nipomo Mesa Fringe Area is irrigated.

4.1.3 Water Use

The town of Nipomo is served by Nipomo Community Services District. Irrigation water is supplied from wells located within the Nipomo Valley Fringe Area that draw from the bedrock of the Monterey Formation. Based on the factors presented in Table 1, estimated crop demand is approximately 4,076 AFY.

4.1.4 Hydrology

A series of small seasonal creeks tributary to Nipomo Creek that originate along the slopes southwest of Temettate Ridge flow through the valley. There are no significant engineered water infrastructure such as reservoirs or canals in the valley. Long term average annual precipitation in the valley is about 16 inches (DWR, 2002).

4.2. Geologic Setting

Figure 17 displays the geologic map (Dibblee, 2006b, 2006c) in the vicinity of the Nipomo Valley Fringe Area. The most significant geologic formation to note is the Older Alluvium. The basin boundary appears to have been drawn to include the outcrops of the uplifted Older Alluvium. This formation is comprised of alluvial sediments consisting of sands, silts, clays, and gravels that have been uplifted on the upthrown fault block northeast of the Wilmar Avenue Fault and Santa Maria River Fault. Because they are elevated above the Recent Alluvium, they are largely hydraulically disconnected from the aquifers in the SMRVGB. A small outcrop of Paso Robles Formation is present at the northern end of the valley. The bedrock of the Obispo and Monterey Formations crop out to the northeast of the valley, and underlie the Older Alluvium.

Figure 18 displays cross section E-E' oriented down the long axis of the Nipomo Valley, parallel to Nipomo Creek and the Wilmar/Santa Maria River Faults. The cross section displays the fact that almost none of the wells that supply water to the irrigated fields draw from the Older Alluvium. (A single exception is a shallow well evident at the extreme southeast extent of the section line.) Nearly all draw from the bedrock of the Monterey and Obispo Formations.

Figure 19 displays a geologic cross section that cuts across the Wilmar Avenue Fault. This section again displays the fact that the wells in the Nipomo Valley draw from the Monterey/Obispo Formations and not from the Older Alluvium. This section also displays the fact that the fault displacement along the Wilmar Avenue and Santa Maria River Faults places the bedrock of the Monterey Formation against the accumulated sediments of the SMRVGB. Actual contours of potentiometric surface in the bedrock wells are difficult to interpret due to the fact that they are screened at different intervals, and to the fact that the fracture systems that largely control groundwater flow in the bedrock are not well understood. However, due to the significantly less productive water-bearing properties of the bedrock compared to the Basin sediments, it appears that there is limited outflow from the Monterey Formation bedrock to the Basin sediments.

4.3. Hydrogeologic Setting

This section of the report briefly describes the hydrogeologic setting of the Nipomo Valley Fringe Area, including characterization of the description of water-bearing sediments and non-water-bearing bedrock, water level maps, and hydrographs.

4.3.1 Hydrogeologic Units

The cross sections in Figures 18 and 19 indicate that the Older Alluvium unit in the Nipomo Valley is not an aquifer. Although the potentiometric surface of the groundwater in the wells screening underlying Monterey/Obispo Formations may rise into the lowest portion of the Older Alluvium, the Older Alluvium itself is not saturated, and does not yield significant quantities of water to wells.

4.3.2 Potentiometric Surface and Hydrographs

As part of the study of the Nipomo Mesa, DWR (2002) presents groundwater elevation maps for Spring 1975, 1985, and 1995 that include the area of Nipomo Valley. The contours for Spring 1995 are re-created and presented in Figure 20. It is important to note that these contours reflect conditions in bedrock wells drawing from the Monterey Formation, and not in the Basin sediments or the Older Alluvium. In addition, the closely spaced contours near the fault indicate a significant steepening of the potentiometric surface gradient in this area.

Figure 21 presents a series of groundwater elevation hydrographs for wells in the Nipomo Valley that are screened in the Monterey Formation. The well at the highest elevation displays stable water levels. The two wells at the lower elevations display temporary water level declines associated with multi-year drought cycles the drought since the 1970s. However, water levels in these wells appear to recover to approximately pre-drought levels when the drought ends (although full recovery from the recent 2011-2016 drought is not yet apparent in the graphed data).

5 Southern Bluffs Fringe Area

This section of the report discusses the data used to characterize the Southern Bluffs Fringe Area.

5.1. Physical Setting

5.1.1 Topography

The Southern Bluffs Fringe Area is located immediately southeast of the Nipomo Valley, adjacent to the Santa Maria River, northeast of the adjudicated basin boundary. It is approximately seven miles long, about 1.5 miles wide at its widest point, oriented in a northwest-southeast direction, and is adjacent to the adjudicated Basin boundary northeast of Santa Maria River. Figure 22 presents an aerial photograph, and Figure 23 presents a topographic map of the area. Land surface of the Southern Bluffs Fringe Area ranges from an altitude of about 400 to 750 feet MSL at along the northeastern extent to about 230-350 ft MSL along the course of Santa Maria River. The area of the Southern Bluffs Fringe Area is about 4,060 acres (6.3 square miles).

5.1.2 Land Use

The area encompassed by the northern third of the Southern Bluffs Fringe Area is largely vacant; small areas are currently used for agriculture as shown in Figure 22. Much of the southern area is used for irrigated agriculture, primarily avocados and citrus. In 2014, approximately 2,100 acres (DWR, 2017) in or adjacent to the Fringe Area were used for agriculture.

5.1.3 Water Use

There are very few wells in the Southern Bluffs. The town of Nipomo is served by Nipomo Community Services District. Irrigation supply comes from wells located within the Fringe Area that draw from the bedrock of the Monterey Formation. Based on the factors presented in Table 1, estimated crop demand is approximately 5,147 AFY.

5.1.4 Hydrology

There is no significant engineered water infrastructure such as reservoirs or canals in the Fringe Area. Long term average annual precipitation in the valley is about 14 inches.

5.2. Geologic Setting

Figure 24 displays the geologic map (Dibblee, 1994, 2006a, 2006b) in the vicinity of the Southern Bluffs Fringe Area. The most significant geologic formation to note is the Orcutt Formation. The Bulletin 118 basin boundary appears to have been drawn to approximate the outcrops of the Orcutt Formation. This formation is very similar to the Older Alluvium unit in the Nipomo Valley. It consists of alluvial sediments consisting of sands, silts, clays, and gravels that have been uplifted on the upthrown fault block northeast of the Santa Maria River Fault. Because they are elevated above the land surface of the Basin, they are largely hydraulically disconnected from the aquifers in the SMRVGB. The Franciscan Assemblage is exposed at the surface to the northeast of most of the Southern Bluffs Fringe Area, and underlies the Orcutt Formation in much of the area. This section also displays the fact that the fault displacement along the Santa Maria River Faults juxtaposes the bedrock of the Franciscan Assemblage against the accumulated sediments of the SMRVGB.

Figure 25 displays cross section G-G' oriented down the long axis of the Southern Bluffs, parallel to the Santa Maria River. There are relatively few wells to use as data points in the Southern Bluffs. This cross section displays a geologic setting similar to the Nipomo Valley. There is a relatively thin veneer of highly dissected Orcutt Formation on top of the bedrock of the Franciscan Formation. The cross section displays the fact that almost none of the wells that supply water to the irrigated fields draw from the Orcutt. (A single exception is evident in one of the small creeks that dissect the area.) Nearly all draw from the bedrock of the Monterey Formation or Franciscan Assemblage.

Figure 26 displays geologic cross section H-H' oriented northeast-southwest that traverses the Santa Maria River Fault. This section again displays the fact that the wells in the Southern Bluffs draw from the bedrock formations and not from the Orcutt Formation. This cross section also displays a geologic setting similar to the Nipomo Valley. The displacement along the Santa Maria River Fault places the bedrock of the Franciscan Group against the accumulated sediments of the SMRVGB. Contours of potentiometric surface in the bedrock wells are difficult to interpret due to the fact that they are screened at different intervals, and to the fact that the fracture systems that largely control groundwater flow in the bedrock are not well understood. However, due to the significantly less productive water-bearing properties of the bedrock compared to the Basin sediments, it appears that there is limited outflow from the Franciscan Assemblage. bedrock to the Basin sediments.

Figure 27 presents a conceptual cross section I-I' across the Santa Maria River Fault. This section displays many of the same geologic relationships as section H-H', but more clearly displays the prominent bluffs visible from Highway 101.

5.3. Hydrogeologic Setting

The cross sections in Figures 25 and 26 indicate that the Orcutt Formation unit in the Southern Bluffs Fringe Area is not an aquifer. Almost no wells draw from this unit, with the exception of a small shallow well tapping local creek alluvium, which is likely recharged directly from local stream flow. The few other existing wells in the Southern Bluffs Fringe Area draw from bedrock formations, either Monterey or Franciscan. Although the potentiometric surface of the groundwater in the underlying bedrock Formations may rise into the lowest portion of the Orcutt Formation, the Orcutt Formation itself is not saturated, and does not yield significant quantities of water to wells.

6 Ziegler Canyon Fringe Area

This section of the report discusses the data used to characterize the Ziegler Canyon Fringe Area. This area was originally referred to as the Cuyama River Valley Fringe Area; the local name of Ziegler Canyon was adopted to avoid confusion with the Cuyama River Valley Groundwater Basin.

6.1 Physical Setting

6.1.1 Topography

The Ziegler Canyon Fringe Area straddles the border between San Luis Obispo and Santa Barbara Counties (Figures 28 and 29). It is a north-south oriented narrow alluvial valley of the Cuyama River that extends approximately 6 miles from Twitchell Dam at the upstream end to the adjudicated Basin

boundary at the downstream end. It is less than a mile wide at its widest point. Land surface ranges from an altitude of about 500 feet MSL at the base of Twitchell Dam to about 370 ft MSL at the base of the valley. Slopes rise steeply on both sides of the canyon to elevations of over 1,000 ft MSL on both sides. The area of the Ziegler Canyon Fringe Area based on the Bulletin 118 boundaries is 1,570 acres (2.5 square miles).

6.1.2 Land Use

Three landowners own the entire area of Ziegler Canyon. Land use in Ziegler Canyon is exclusively irrigated agriculture, with nearly all available acreage planted in wine grapes. In 2014, approximately 1,430 acres (DWR, 2017)in or adjacent to Ziegler Canyon are used for agriculture of which, approximately 470 acres and 960 acres are in San Luis Obispo and Santa Barbara Counties, respectively. Approximately 1 mile upstream from the downstream end of the valley there is a wetland area that is apparently too saturated to plant.

6.1.3 Water Use

All supply comes from alluvial wells within the valley. Based on the factors presented in Table 1, estimated crop demand is approximately 1,669 AFY.

6.1.4 Hydrology

Hydrology in the valley is dominated by releases from Twitchell Dam. Twitchell Reservoir has a capacity of 197,756 acre-feet, and is used for flood control and water conservation (releases intended for recharge of SMRVGB sediments). Long term average annual precipitation in the valley is about 14 inches (DWR, 2002).

6.2 Geologic Setting

Figure 30 displays a geologic map (Dibblee, 1994) in the vicinity of the Ziegler Canyon. The Bulletin 118 basin boundary appears to have been drawn to approximate the mapped outcrops of the Quaternary Alluvium associated with the Cuyama River. The Recent Alluvium consists of unconsolidated sands, silts, clays, and gravels that have been deposited by fluvial processes. Some areas of alluvium associated with feeder creeks on the east side of the valley are also included in the Bulletin 118 area. The Obispo Formation crops out along almost the entire west side of the valley. The Monterey Formation crops out along most of the east side of the valley, with some Obispo Formation cropping out at lower elevations of the eastern slopes.

Figure 31 displays cross section I-I' oriented down the long axis of Ziegler Canyon. There is no other water–bearing formation beneath the Recent Alluvium. All wells in the valley draw from the Recent Alluvium.

Figure 32 displays cross section J-J' oriented perpendicularly across the valley. This section displays a total thickness of alluvium of about 70 feet. Again, no wells draw from the bedrock formations in this area.

6.3 Hydrogeologic Setting

This section presents the hydrogeologic setting of Ziegler Canyon, including discussion of hydraulic parameters, hydrographs, recharge, and geophysical field work performed by Ramboll/Environ as part of this project.

6.3.1 Hydraulic Parameters

No reports were identified that documented specific aquifer tests using wells in Ziegler Canyon. Cleath (1997) posits a typical hydraulic conductivity of 200 ft/day for alluvial gravels in the valley, corresponding to a transmissivity of about 133,000 gpd/ft for the deeper wells in the area.

Well records from the landowners in Ziegler Canyon were reviewed and included several wells with specific capacity information. Specific capacity is a field-measured parameter frequently measured by pump service companies during routine well maintenance. In this test, the well is pumped for a brief time, while flow rate and drawdown are measured. Specific capacity is the flow rate in gpm divided by the drawdown. This test is not as robust as a constant rate aquifer test, but it gives an estimate of aquifer productivity. A hydrogeologic rule of thumb correlates specific capacity (gpm/ft) to transmissivity (gpd/ft) by multiplying the specific capacity value by a factor of 1,500 for unconfined aquifers. This calculation was performed for all wells that had specific capacity data. Hydraulic conductivity was then calculated by dividing transmissivity by saturated thickness. The results are presented in Table 4. (Well identification numbers are arbitrarily assigned to maintain the confidentiality of private well owners' data.)

Table 4 – Ziegler Canyon Specific Capacity Data Summary

Well No.	Specific Capacity (gpm/ft)	T (gpd/ft)	K ft/d
1	20.6	30,900	58
2	16.1	24,150	41
3	24.9	37,350	47
4	42.3	63,450	123
5	19.2	28,800	43
6	34.8	52,200	66
7	36.7	55,050	66
8	27.3	40,950	61
9	21.7	32,550	80
10	81.4	122,100	146
11	19.1	28,650	64
12	7.6	11,400	117
Average	--	43,963	76

Note: Well numbers presented in this table are arbitrary identifiers assigned to maintain the confidentiality of the data locations for private well owners.

Three pumping tests were performed in Ziegler Canyon for the purposes of this Study. The locations of these wells are presented on Figure 28. Transmissivity estimates based on these tests ranged from 18,000 gpd/ft to 33,000 gpd/ft, and averaged 25,000 gpd/ft (Table 3)), and associated hydraulic conductivity estimates range from 31 to 82 ft/day.

6.3.2 Hydrographs and Recharge

Figure 33 displays long-term water level hydrographs for wells in the Ziegler Canyon Fringe Area. This graph also displays the annual downstream releases from Twitchell dam since its construction. Three of these wells had data collection discontinued around the year 2000, while a fourth well was monitored after this period.

The three wells that were being monitored in the late 1980s show a decline of approximately 7-8 feet during the drought period of the late 1980s. However, as soon as releases from Twitchell Dam resume in 1990, the groundwater elevations quickly recover to their previous levels. The well that has been monitored since 2000 shows a decline of about 18 feet associated with the 2011-2016 drought. Releases from Twitchell Reservoir resumed in the second half of 2017 (the 2017 release data are not presented on this graph because the data was not available at the time of this report). However, the water level measured in 2017 clearly displays recovery associated with the resumption of surface water releases from the dam.

Figure 33 demonstrates the fact that the groundwater hydrology in Ziegler Canyon is dominated by the surface water releases from the dam. During drought cycles, when there are no releases, groundwater elevations decline. When the releases resume, the local alluvial aquifer is recharged, and groundwater elevations recover. In a very real sense, the groundwater in the valley is essentially managed by virtue of the downstream releases from Twitchell dam. There is no long term trend of declining water levels that would indicate that groundwater in the Ziegler Canyon alluvium is stressed or in need of active management.

6.3.3 Outflow to SMRVGB

The quantity of groundwater underflow leaving the alluvial aquifer of Ziegler Canyon is calculated as previously described. This estimate is limited to flow in the Recent Alluvium.

For hydraulic conductivity, an average of the values from the aquifer tests performed on the alluvial wells is applied. The average of these values is 56 ft/day.

Hydraulic gradient was estimated by measuring the gradient of the land surface elevation contours of the river channel thalweg displayed in Figure 27. This value is 0.003.

The cross-sectional area of flow was estimated as a rectangle across the bottom of the alluvial valley. The map distance across the neck at the bottom of the valley is approximately 1,100 feet. Saturated thickness in the alluvium is estimated at 95 feet based on information in well completion reports. Thus, the cross-sectional area of flow is estimated at 104,500 square feet. Therefore,

Q = (56 ft/day)*(0.003)*(104,500 square feet)

Q = 147 AFY

DWR estimated the average total inflow to the SMRVGB as 29,200 AFY (DWR, 2002). The Ziegler Canyon underflow estimates presented herein accounts for 0.5% of total inflow to the Basin.

6.4.4 Geophysical Study

As part of this project, staff from Ramboll/Environ performed a surface geophysical field study of suitable areas in lower Ziegler Canyon. A three-day investigation was undertaken on September 25-27, 2017. The Ramboll/Environ report documenting this work is included as Appendix D.

The Ramboll/Environ field crew utilized the equipment and methods of Time Domain Electromagnetics (TDEM) geophysical investigations. In brief, this method measures differences in resistivity/conductivity of subsurface geologic materials by imparting a direct electric current through a 40-meter square wire loop at the surface, then abruptly switching off the current, and measuring variation in decay speed of the subsurface magnetic field when the current is switched off. A series of stations are strung together, and the raw data for adjacent stations can be collectively interpreted to gain an understanding of variations in subsurface lithologic materials.

Because the geophysical technique depends on clear electrical signals, this method cannot be employed if there are any significant metal features or structures near the station. This may include pipelines, power lines, irrigation piping, or even thin metal wire used to support wine grape vines. Because almost the entire valley is planted out in vines, the area suitable for TDEM investigation was limited. Figure 34 displays the locations of 36 sounding stations that were used in the investigation.

Figure 34 displays interpreted conductivity data and associated inferred low permeability strata in the subsurface beneath the sounding stations. Along the primary north-south section line investigation, it appears that low permeability beds beneath the alluvium are dipping northward in the upper part of the section, and southward in the lower part of the section, essentially defining an anticlinal structure of low permeability in the bedrock beneath the alluvium. Inspection of the geologic map on both sides of Ziegler Canyon (Figure 30) indicates that the axis of this interpreted anticlinal structure approximately corresponds to anticlines mapped in the Monterey Formation east of the valley and the Obispo Formation west of the valley.

This interpretation of bedrock structure is significant in the characterization of Ziegler Canyon hydrogeology. As was mentioned previously, and is displayed on Figure 34, an area of wetlands is present in the valley just over a mile upstream from the bottom of the valley where it joins the SMRVGB. The presence of these wetlands may be associated with the low permeability anticline inferred from the geophysical study. This structure may be forcing groundwater flow to daylight in the wetland area due to the impermeable bedrock strata rising to near the ground surface. This geologic interpretation explains the presence of a perennial wetland at this location. There are no other wetland areas in Ziegler Canyon, or in any of the other Fringe Areas.

While the presence of the wetland area may be explained by the bedrock structure, the dimensions of the wetland area at land surface are significant to the hydrogeology of the Ziegler Canyon Fringe Area. As

indicated on Figure 34, the wetland area spans nearly the entire width of alluvium. In other words, groundwater daylights at the surface across nearly the entire width of the valley at this location, creating a hydrologic boundary between approximately the lower fifth and the upper four fifths of the valley. The presence of this hydrologic boundary remained unchanged through the recent drought, and is visible in historical air photos available on Google Earth. The significance of this is that the boundary separates the valley into two groundwater sub-areas that are essentially hydraulically disconnected. Where the wetland area is present, conditions upgradient of the boundary have no apparent effect on conditions downgradient of the boundary, and vice versa. So while the lower mile of the valley may have a nominal connection to the SMRVB, the upper four to five miles of the valley have no connection.

7 Summary

This Study has presented a summary of the most pertinent available data characterizing the hydrogeology of the five Fringe Areas (within San Luis Obispo County) adjacent to the adjudicated area boundary of the SMRVGB. The results of this Study are intended to produce foundational information for the GSAs and stakeholders potential future use in BBMRs and/or development of a Groundwater Sustainability Plan (GSP) and related efforts for the Fringe Areas within San Luis Obispo County.

All available data including Well Completion Reports and past technical reports, were reviewed. The Study presents pertinent physical data describing geographic setting, land use, water use, and hydrology for each of the five Fringe Areas, as well as geologic maps and cross sections. The Study also presents available hydrogeologic data, including information on hydraulic parameters, recharge, groundwater elevation hydrographs, and subsurface outflow to the SMRVGB.

In addition to reviewing available published data, this Study included collection of new data for the purposes of this study from several field investigation tasks. Current water levels were collected from alluvial wells in the upper Pismo Creek Valley Fringe Area. Five constant rate aquifer tests were performed on privately-owned wells in the Arroyo Grande Valley Fringe Area and Ziegler Canyon Fringe Area. Ramboll/Environ, Inc. performed a TDEM geophysical study in the Ziegler Canyon Fringe Area. The data collected for this Study was used in discussion of the hydrogeologic setting of each area.

The Pismo Creek Valley Fringe Area is a small alluvial valley adjacent to the northern extent of the SMRVGB. The southern extent of this area is within the City of Pismo Beach. The northern extent of this area is adjacent to Sentinel Peak Resources' Arroyo Grande Oil Field, which is currently in operation. Sentinel Peak Resources has performed studies which found that the extent of the Pismo Creek Alluvium is not as extensive as previously mapped. There are very few wells that screen the alluvium, and very little use of water from the Pismo Creek Alluvium for supply. Instead, many wells in the area east and west of the valley draw from the Pismo Formation, which is not considered to be part of the adjudicated basin materials. Outflow to SMRVGB is less than 0.5% of the estimated total inflow to SMRVGB. The throw across the Wilmar Avenue Fault at the bottom of Pismo Creek Valley juxtaposes the bedrock of the Monterey and Obispo formations against the aquifers of the SMRVGB.

The Arroyo Grande Creek Valley Fringe Area is an alluvial valley that extends from the Wilmar Avenue Fault in the South to Lake Lopez reservoir in the north. The southern extent of this area is within the City of Arroyo Grande. Most of the area is used for irrigated agriculture. Alluvial groundwater in this area is regularly recharged via percolation of stream flow from Arroyo Grande Creek that occurs as a result of downstream releases from Lake Lopez. As a result, water levels in the alluvial wells are stable, and do not display fluctuations associated with multi-year drought cycles. The throw across the Wilmar Avenue Fault at the southern end of the Arroyo Grande Valley juxtaposes the bedrock of the Monterey and Obispo Formations against the aquifers of the SMRVGB.

The Nipomo Valley and the Southern Bluffs Fringe Areas lie adjacent to and to the northeast of the adjudicated Basin boundary. Both areas have a relatively thin veneer of uplifted alluvial sediments (Older Alluvium and Orcutt Formation) on top of the bedrock formation of the Obispo and Monterey Formations and the Franciscan Assemblage. The uplifted alluvial materials are not saturated. They are not aquifers. Almost all wells in these areas draw from the deeper bedrock formations. The throw across the Santa Maria River Fault at the southwest extent of these areas juxtaposes the bedrock of the Monterey and Obispo Formations and the Franciscan Assemblage against the aquifers of the SMRVGB.

The Ziegler Canyon Fringe Area is an alluvial valley that extends from Twitchell Dam in the north to the junction with the SMRVGB in the south. This area is almost entirely planted out in wine grapes. Wells in this area draw exclusively from the alluvium; no wells draw from the underlying Monterey or Obispo Formations. Similar the Arroyo Grande Creek Valley Fringe Area, the alluvial groundwater is recharge via stream seepage resulting from downstream releases from Twitchell Dam. Water level hydrographs indicate that while water levels may decline during times of drought when dam releases are halted, the water levels recover to pre-drought conditions after dam releases resume. The TDEM geophysical study indicates an anticlinal structure of low permeability materials in the area of a perennial wetland located in the valley. This wetland represents a hydrogeologic barrier that isolates the upper part of the Ziegler Canyon Fringe Area basin from the lower part, and from the SMRVGB.

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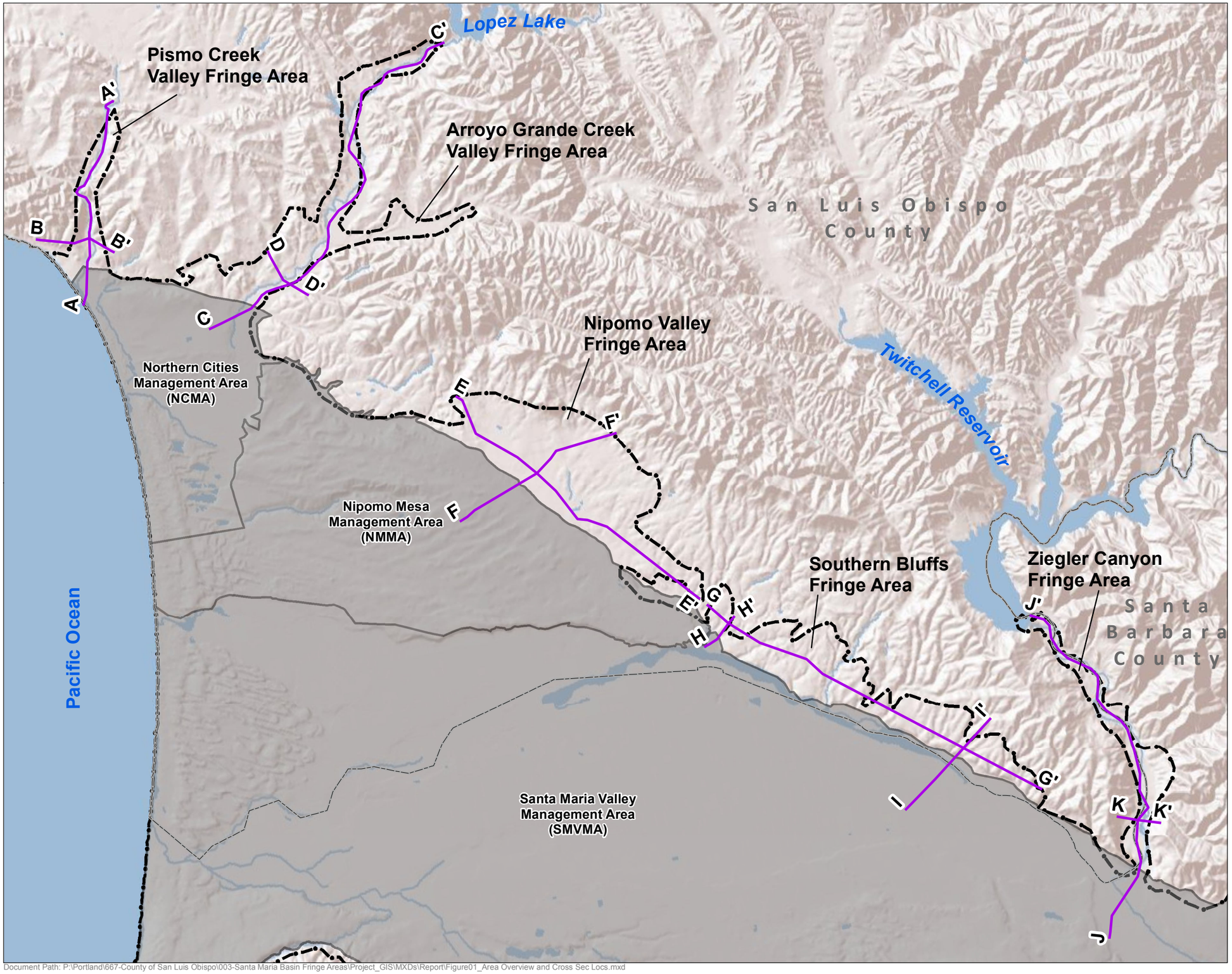
Figures

FIGURE 1

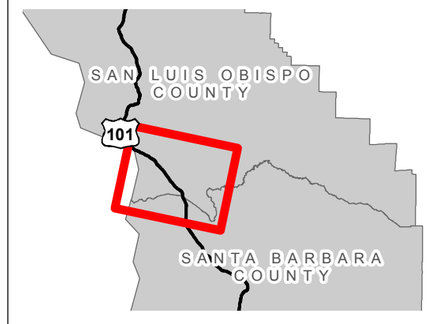
Fringe Area Overview Map and Cross Section Locations

Santa Maria River Valley Groundwater Basin Fringe Areas



LEGEND

- Santa Maria River Valley Groundwater Basin (Adjudicated)
- Santa Maria River Valley Groundwater Basin (DWR 2016)
- County Line
- Cross Section Lines



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Date: February 6, 2018
Data Sources:

GSI Water Solutions, Inc.

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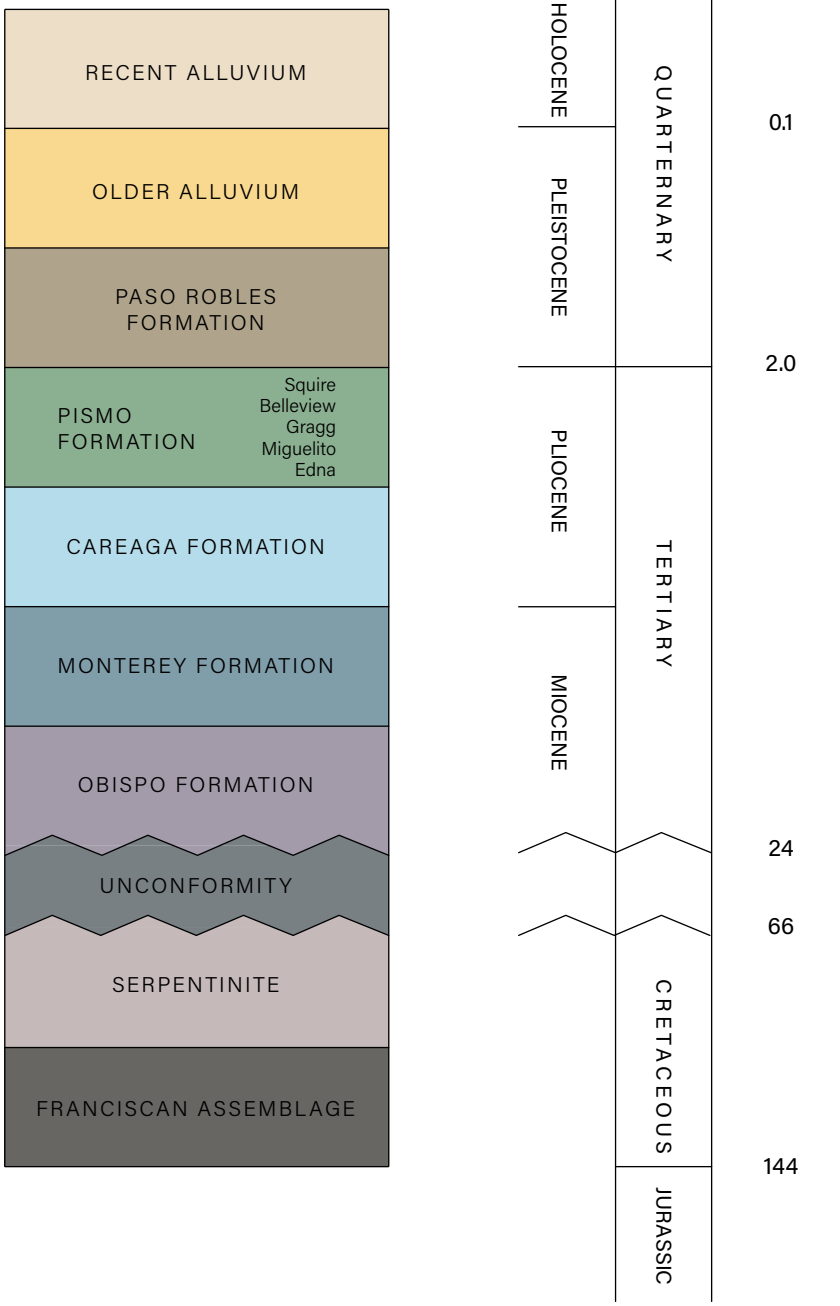


NOTE:
Adapted from Chipping, 1987.

FIGURE 2

Local Stratigraphic Column

Santa Maria River Valley Basin Characterization

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures\X Sections

Parameter	Pismo Creek Valley
DWR Bulletin 118 Area (acres)	1,120
Extent of Alluvium Area (acres)	530
Irrigated Area (acres)	95
Crop Demand (ac-ft/yr)	102
Hydraulic Conductivity (ft/day)	50
Saturated Thickness (ft)	50
Underflow Out (ac-ft/yr)	63
Percent of Total Inflow to SMRVGB	< 0.22%

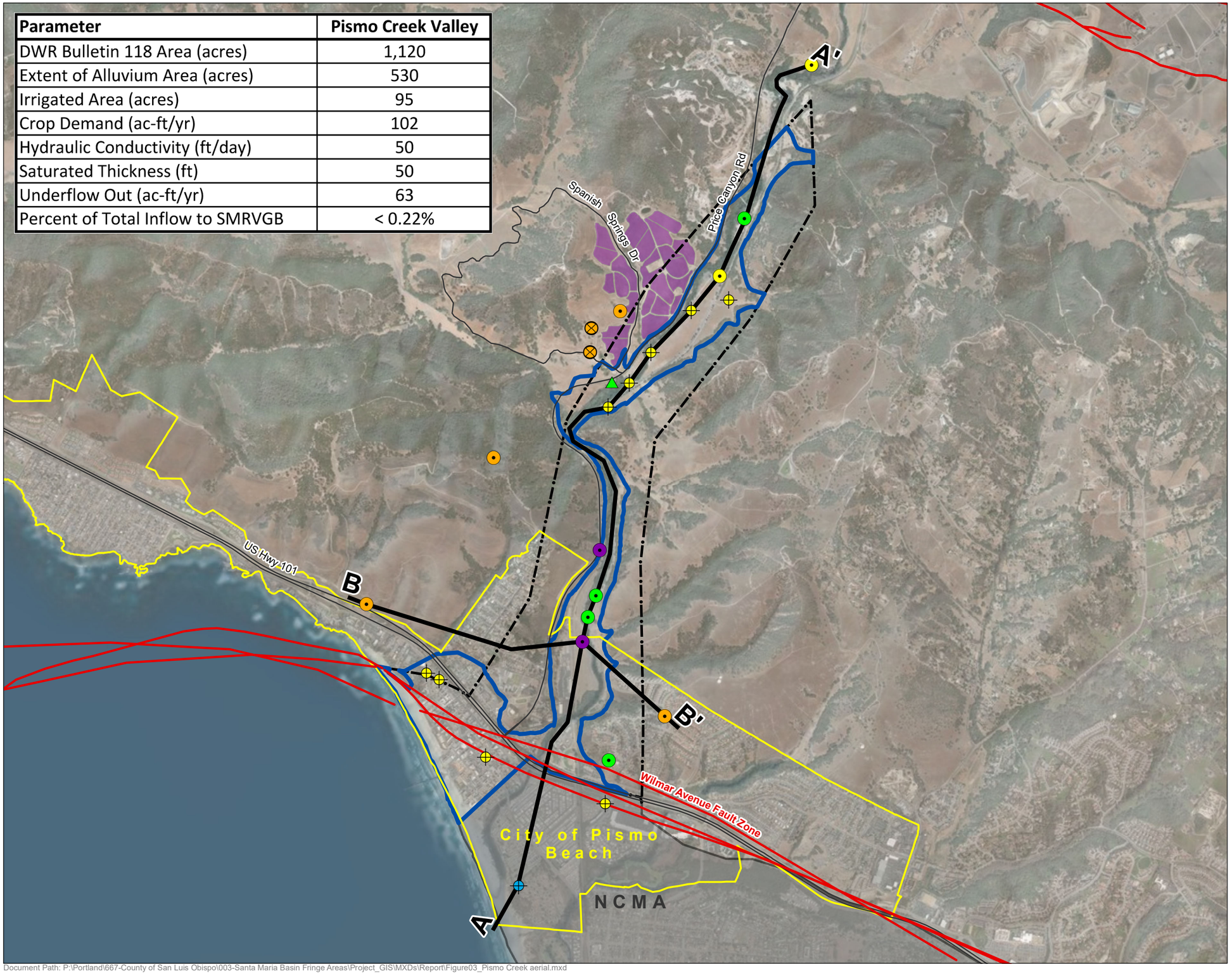


FIGURE 3

Pismo Creek Valley
Aerial Photo Map

Santa Maria River Valley
Groundwater Basin Fringe Areas

LEGEND

Wells

Screened Zone

- Alluvium
- Alluvium/Paso Robles/ Pismo
- Pismo
- Pismo/Bedrock
- Bedrock

Well Type

- Monitoring
- Supply
- Test
- Cathodic Protection

- Fault
- Cross Section Lines
- Extent of Alluvium
- Existing Basin Boundary
- City of Pismo Beach
- Santa Maria River Valley Groundwater Basin (Adjudicated)

Irrigated Area (Land IQ, 2017)

- Grapes

N

0 1,000 2,000 3,000
Feet

Date: March 23, 2018
Data Sources: Aerial photo taken 10/3/2016 (DigitalGlobe)
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

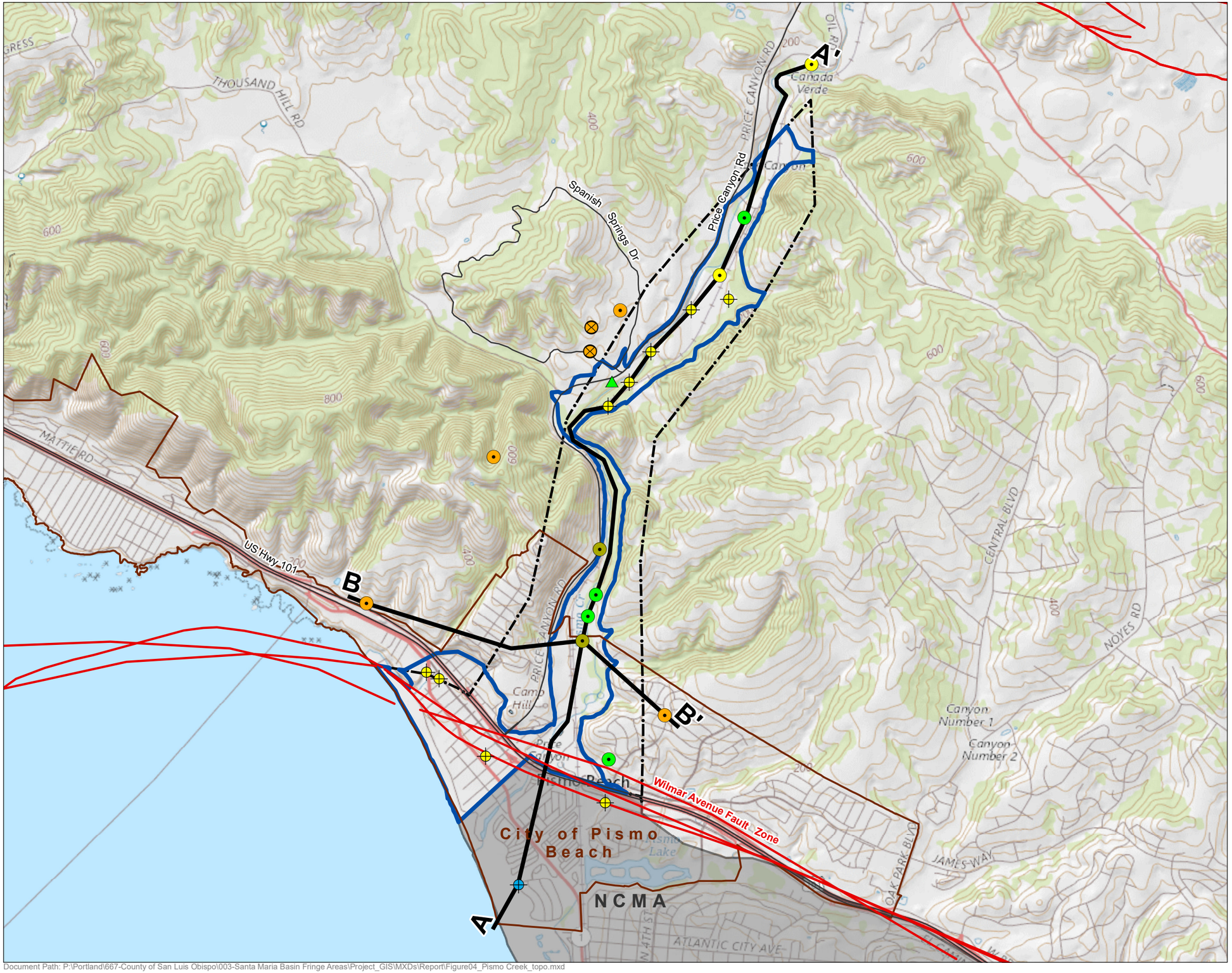
GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure03_Pismo Creek aerial.mxd

FIGURE 4

Pismo Creek Valley Topographic Map

Santa Maria River Valley Groundwater Basin Fringe Areas



LEGEND

Wells

Screened Zone	*Well Type*
Alluvium	Monitoring
Alluvium/Paso Robles/ Pismo	Supply
Pismo	Test
Pismo/Bedrock	Cathodic Protection
Bedrock	

- Fault
- Cross Section Lines
- Extent of Alluvium
- Existing Basin Boundary
- City of Pismo Beach
- Santa Maria River Valley Adjudicated Groundwater Basin

N

0 1,000 2,000 3,000

Feet

Date: March 23, 2018

Data Sources:
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure04_Pismo Creek_topo.mxd

FIGURE 5

Pismo Creek Valley Geologic Map

Santa Maria River Valley Groundwater Basin Fringe Areas

LEGEND

Wells

Screened Zone
- Alluvium
- Alluvium/Paso Robles/Pismo
- Pismo
- Pismo/Bedrock
- Bedrock

Well Type
- Monitoring
- Supply
- Test
- Cathodic Protection

Geology
- Pismo (Gregg)
- Pismo (Miguelito)
- Pismo (Edna)
- Pismo (Squire)
- Monterey
- Obispo
- Paso Robles
- Alluvial Terrace
- Fault

All Other Features
- Cross Section Lines
- Extent of Alluvium
- Existing Basin Boundary
- City of Pismo Beach
- Santa Maria River Valley Adjudicated Groundwater Basin

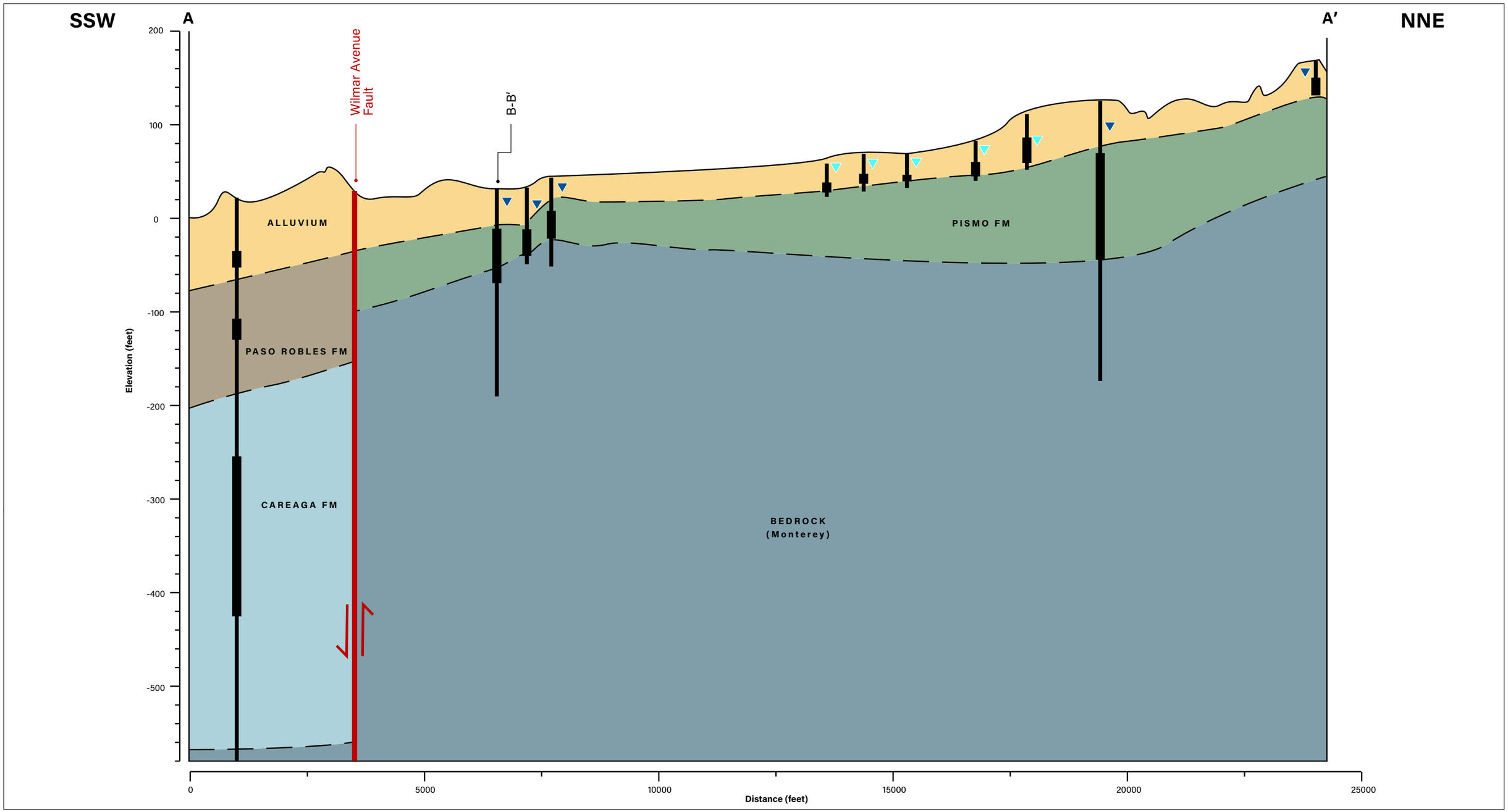
N

0 1,000 2,000 3,000
Feet

Date: March 26, 2018
Data Sources:
Surface Geology from Hall (1973)
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure05_Pismo Creek_geo.mxd



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Measured January 4, 2018
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
20X

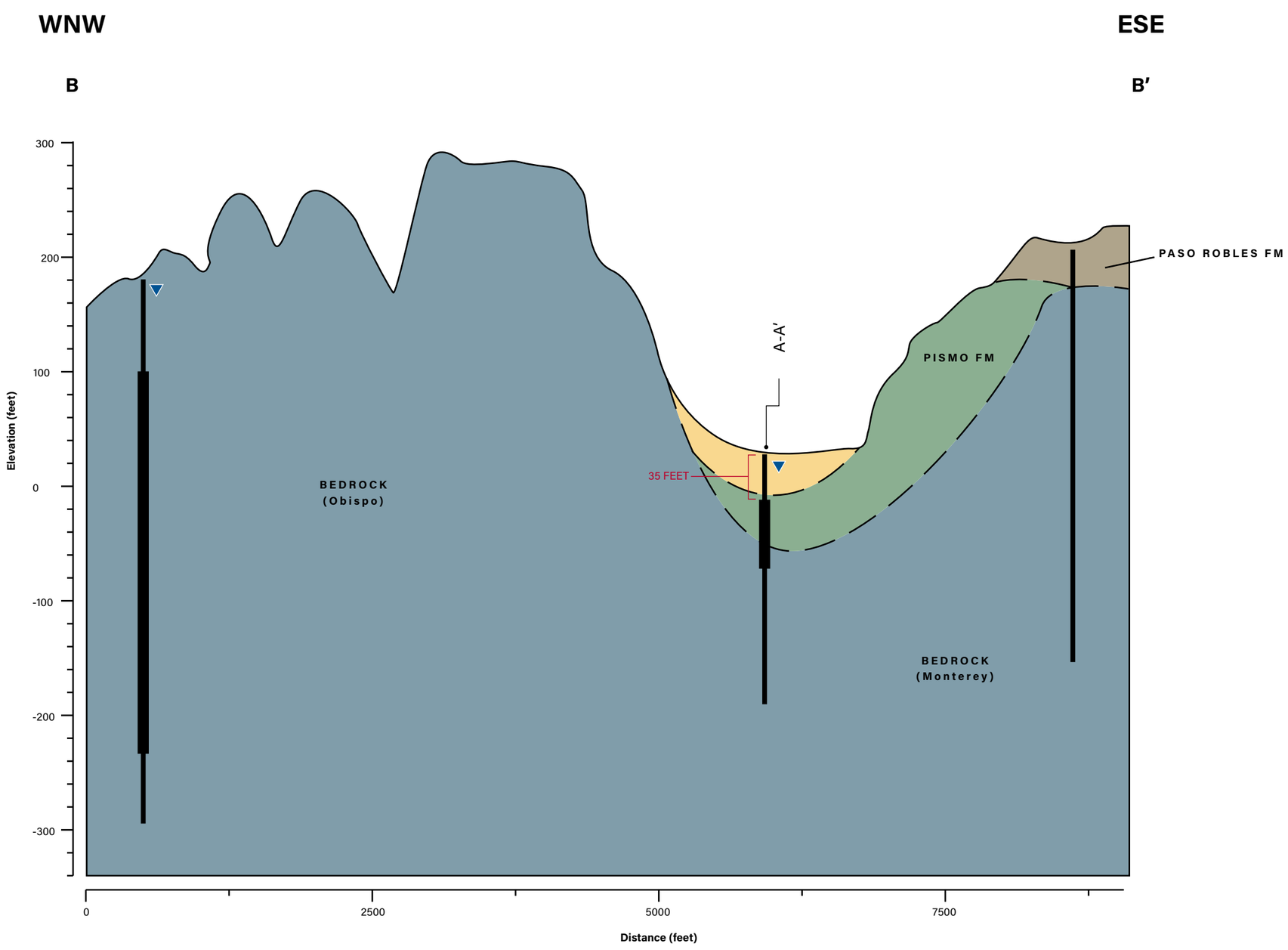
FIGURE 6

Pismo Creek Valley Longitudinal Section A-A′

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
10X

FIGURE 7

Pismo Creek Valley Cross Section B-B'

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

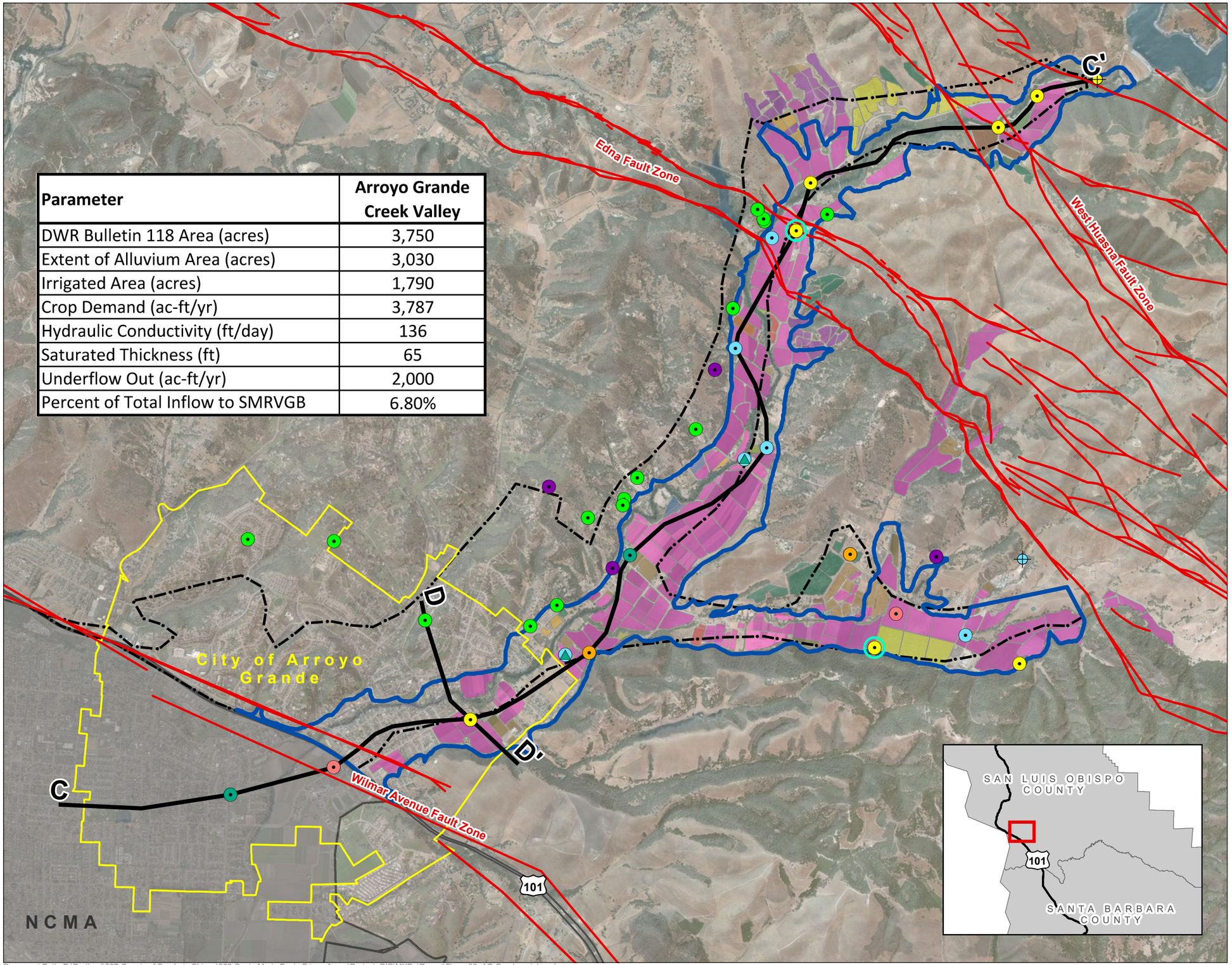
P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures

FIGURE 8

Arroyo Grande Creek Valley Aerial Photo Map

Santa Maria River Valley Groundwater Basin Fringe Areas

Parameter	Arroyo Grande Creek Valley
DWR Bulletin 118 Area (acres)	3,750
Extent of Alluvium Area (acres)	3,030
Irrigated Area (acres)	1,790
Crop Demand (ac-ft/yr)	3,787
Hydraulic Conductivity (ft/day)	136
Saturated Thickness (ft)	65
Underflow Out (ac-ft/yr)	2,000
Percent of Total Inflow to SMRVGB	6.80%



LEGEND

Wells

Screened Zone	*Well Type*
Alluvium	Monitoring
Alluvium/Pismo	Supply
Alluvium/Bedrock	Pumping Test
Paso Robles/Pismo	Hydrograph
Pismo	
Pismo/Bedrock	
Bedrock	

Cross Section Lines

Fault

Extent of Alluvium

Existing Basin Boundary

City of Arroyo Grande

Santa Maria River Valley Adjudicated Groundwater Basin

Irrigated Area (Land IQ, 2017)

- Avocados
- Bush Berries
- Citrus
- Cole Crops
- Grapes
- Idle
- Miscellaneous Deciduous
- Miscellaneous Grain and Hay
- Miscellaneous Grasses
- Miscellaneous Subtropical Fruits
- Miscellaneous Truck Crops
- Mixed Pasture
- Walnuts
- Young Perennials

N

0 0.5 1

Miles

Date: March 26, 2018

Data Sources: Aerial photo taken 7/14/2016 (DigitalGlobe)

Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure08_AG Creek aerial.mxd

FIGURE 9

Arroyo Grande Creek Valley Topographic Map

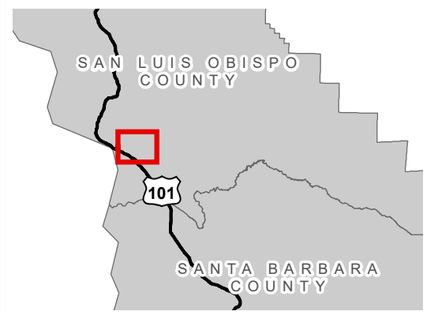
Santa Maria River Valley
Groundwater Basin Fringe Areas

LEGEND

Wells

Screened Zone	*Well Type*
Alluvium	Monitoring
Alluvium/Pismo	Supply
Alluvium/Bedrock	Pumping Test
Paso Robles/Pismo	Hydrograph
Pismo	
Pismo/Bedrock	
Bedrock	

- Cross Section Lines
- Fault
- Extent of Alluvium
- Existing Basin Boundary
- City of Arroyo Grande
- Santa Maria River Valley Adjudicated Groundwater Basin



N

0 0.5 1
Miles

Date: March 26, 2018
Data Sources:
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

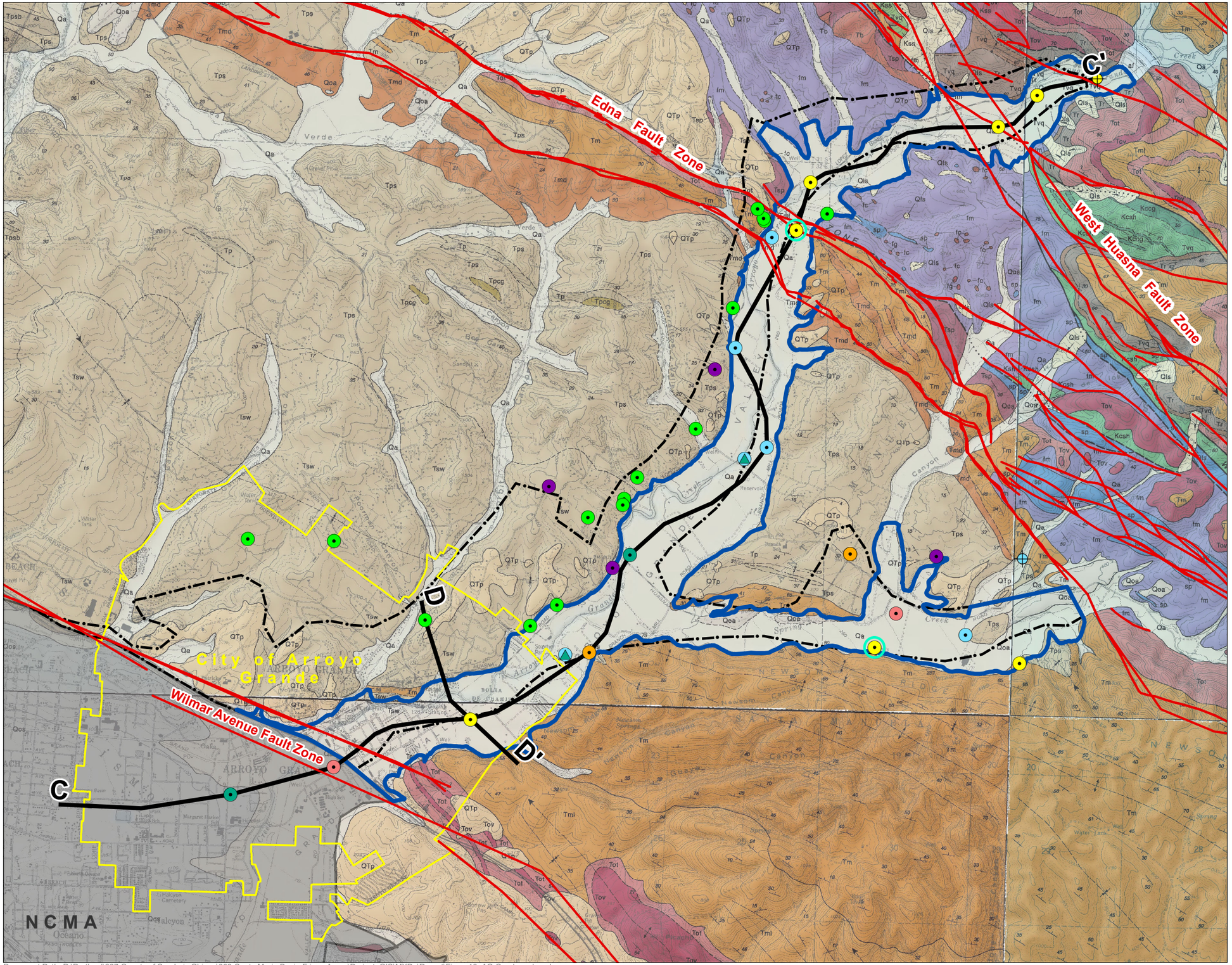
GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure09_AG Creek topo.mxd

FIGURE 10

Arroyo Grande Creek Valley Geologic Map

Santa Maria River Valley Groundwater Basin Fringe Areas



LEGEND

Wells

Screened Zone

- Alluvium
- Alluvium/Pismo
- Alluvium/Bedrock
- Paso Robles/Pismo
- Pismo
- Pismo/Bedrock
- Bedrock

Well Type

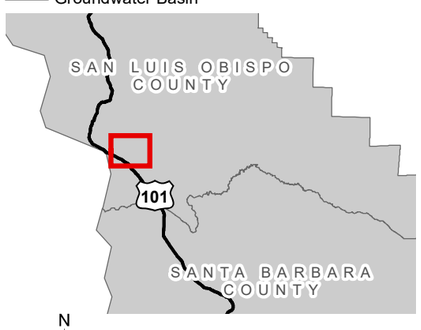
- Monitoring
- Supply
- Pumping Test
- Hydrograph

Geology

- Volcanic Intrusive Rocks
- Obispo Formation
- Franciscan Assemblage
- Serpentine
- Paso Robles
- Recent Alluvium
- Pismo Formation
- Monterey Formation
- Atascadero Formation
- Toro Formation

All Other Features

- Cross Section Lines
- Fault
- Extent of Alluvium
- Existing Basin Boundary
- City of Arroyo Grande
- Santa Maria River Valley Adjudicated Groundwater Basin



N

0 0.5 1

Miles

Date: March 26, 2018

Data Sources: Surface Geology from Dibblee (2006b, 2006c, 2006d, and 2006e) Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure10_AG Creek geol.mxd

SW

C

NE

C′

Wilmar Avenue Fault

Highway 101

D-D′

Tar Spring Creek

Syncline

Edna Fault

Huasna Fault

ALLUVIUM

PISMO FM

ALLUVIUM

PASO ROBLES FM

BEDROCK (Monterey)

BEDROCK (Franciscan)

CAREAGA FM

BEDROCK (Obispo)

Elevation (feet)

400

250

100

-50

-200

-350

-500

-650

0

10000

200000

30000

40000

50000

Distance (feet)

LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
20X

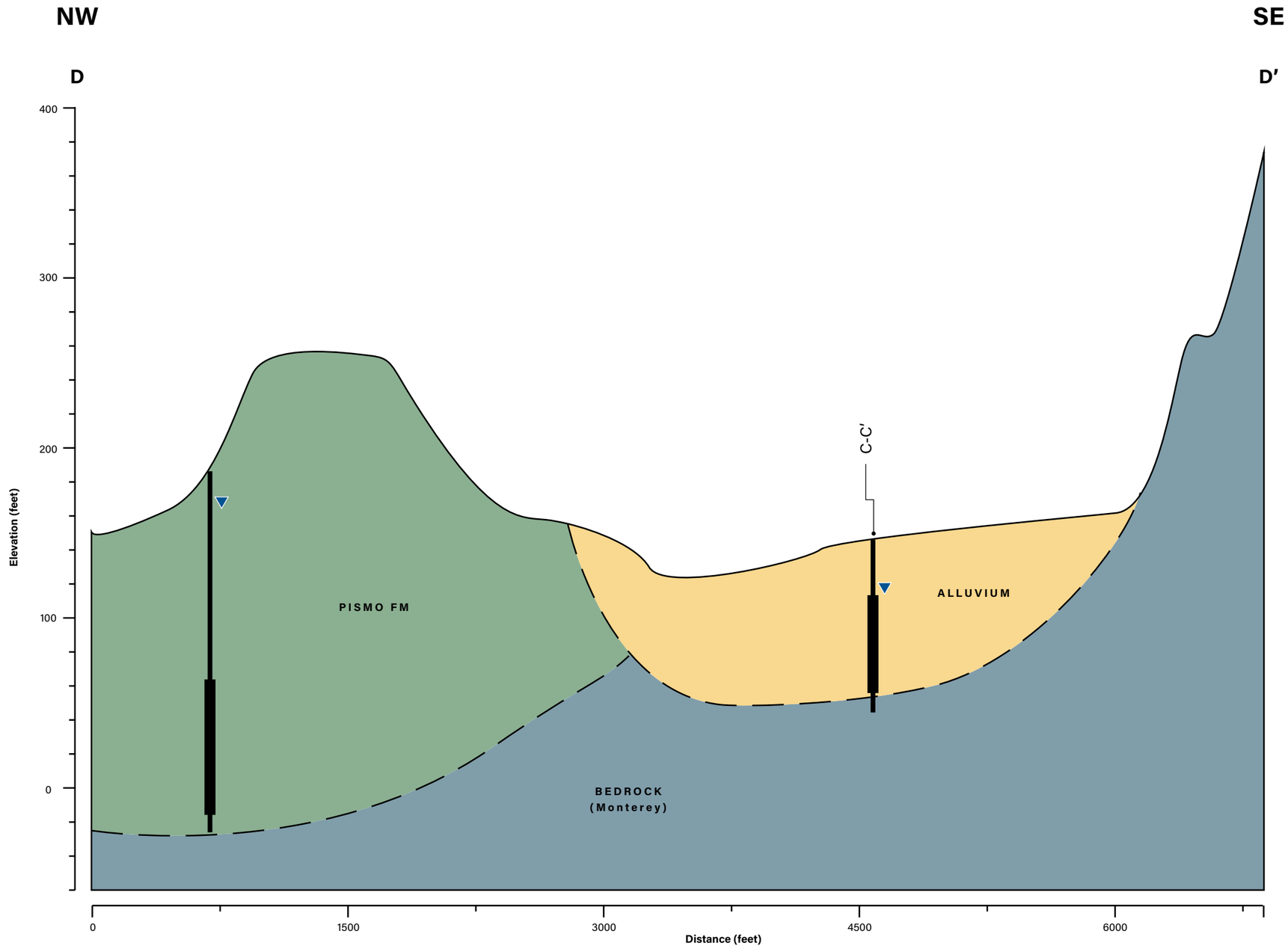
FIGURE 11

Arroyo Grande Creek Valley Longitudinal Section C-C′

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
10X

FIGURE 12

Arroyo Grande Creek Valley Cross Section D-D'

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

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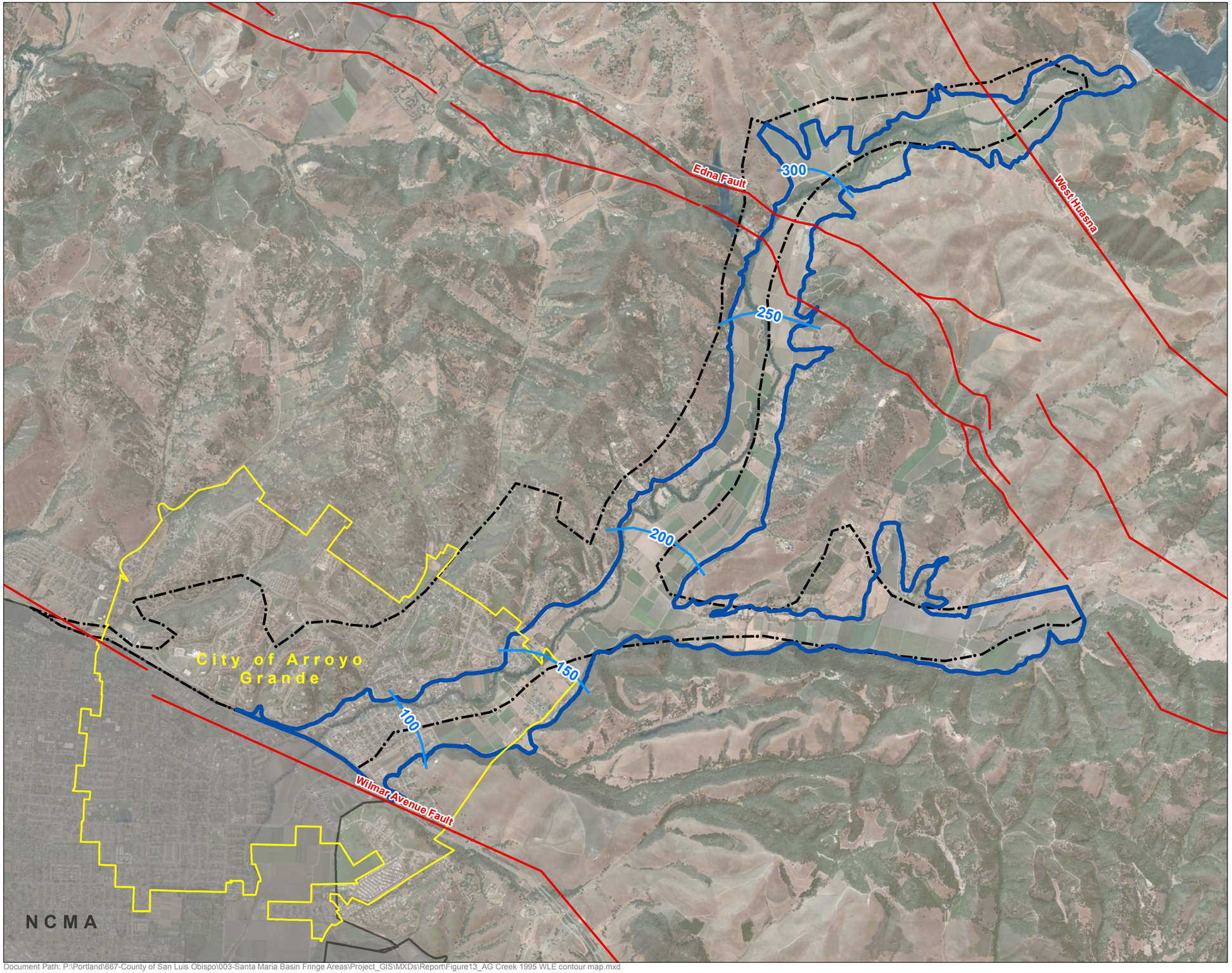


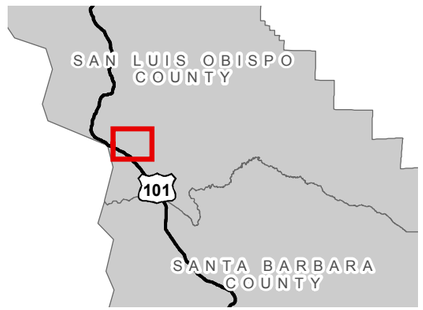
FIGURE 13
Spring 1995 Groundwater Elevations in Arroyo Grande Creek Valley

Santa Maria River Valley Groundwater Basin Fringe Areas

LEGEND

- Spring 1995 GW Elevations (DWR, 2002)
- Fault
- Extent of Alluvium
- Existing Basin Boundary
- City of Arroyo Grande
- Santa Maria River Valley Groundwater Basin (Adjudicated)

Contour Interval = 50 feet



N

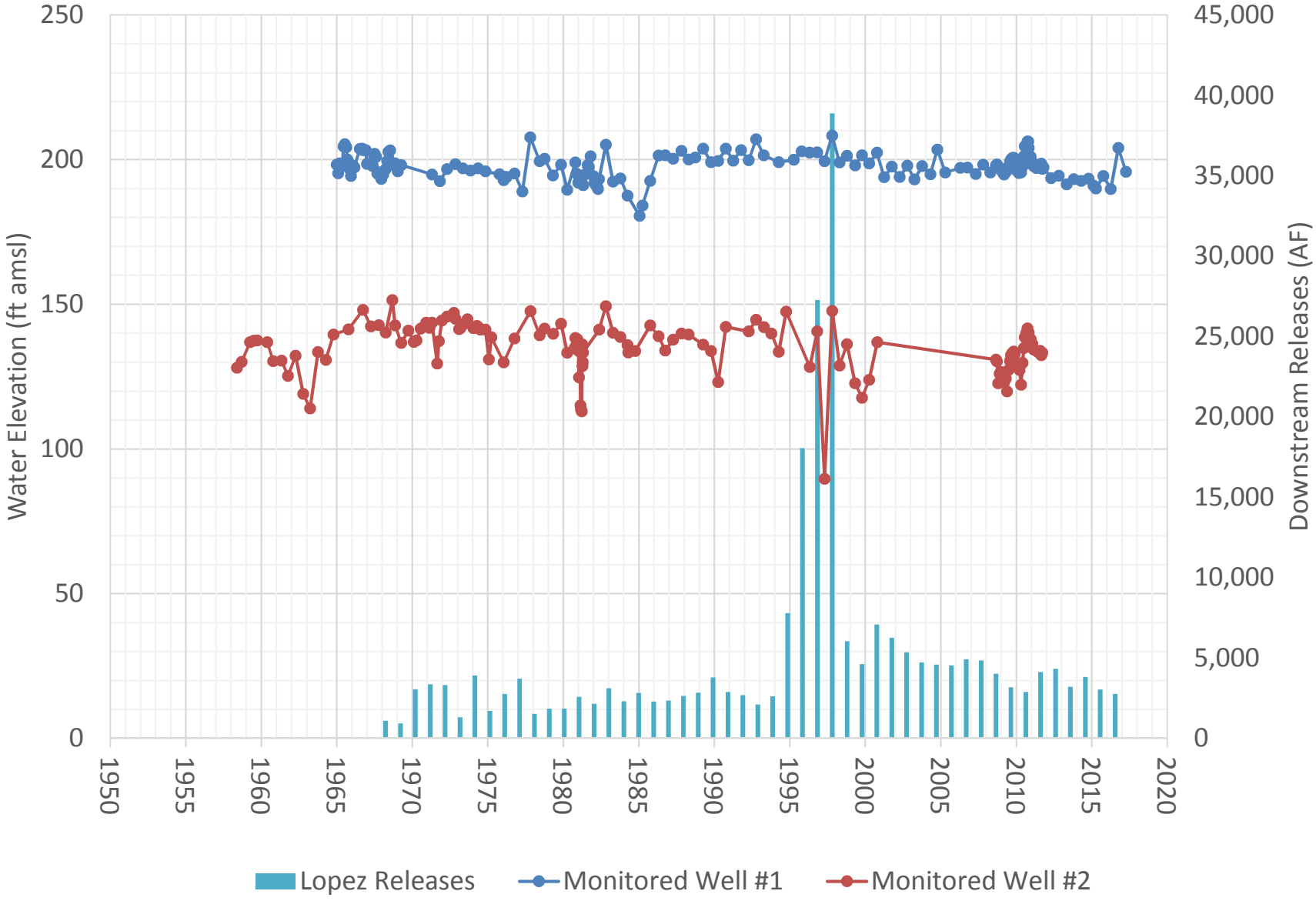
0 0.5 1
Miles

Date: February 6, 2018
Data Sources: Aerial photo taken 7/14/2016 (DigitalGlobe)

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure13_AG Creek 1995 WLE contour map.mxd

Figure 14 - Groundwater Level Elevations in County Monitored Wells Compared to Lopez Reservoir Releases (AF)



Parameter	Nipomo Valley
Bulletin 118 Area (acres)	5,450
Irrigated Area (acres)	2,370
Crop Demand (ac-ft/yr)	4,076
Underflow Out (ac-ft/yr)	na
Percent of Total Inflow to SMRVGB	na

E

E'

F

F'

NMMA

SMVMA

Wilmar Avenue Fault Zone

West Huasna Fault Zone

Oceano Fault

Santa Maria River Fault Zone

SAN LUIS OBISPO COUNTY

SANTA BARBARA COUNTY

101

FIGURE 15

Nipomo Valley
Aerial Photograph
Santa Maria River Valley
Groundwater Basin Fringe Areas

LEGEND

Wells

Screened Zone
- Alluvium
- Alluvium/Bedrock
- Paso Robles/Pismo
- Bedrock

Well Type
- Supply

- Cross Section Lines
- Fault
- Existing Basin Boundary (DWR Bulletin 118, 2016)
- Santa Maria River Valley Adjudicated Area
- Nipomo Community Services District

Irrigated Area (DWR, 2017)
- Avocados
- Bush Berries
- Citrus
- Flowers, Nursery and Tree Farms
- Grapes
- Idle
- Miscellaneous Grain and Hay
- Miscellaneous Grasses
- Miscellaneous Subtropical Fruits
- Miscellaneous Truck Crops
- Mixed Pasture
- Young Perennials

N

0 0.5 1
Miles

Date: June 22, 2018
Data Sources: Aerial photo taken 10/3/2016 (DigitalGlobe)
Fault shapefiles acquired from California Geological Survey and USGS Earthquake Hazards Program

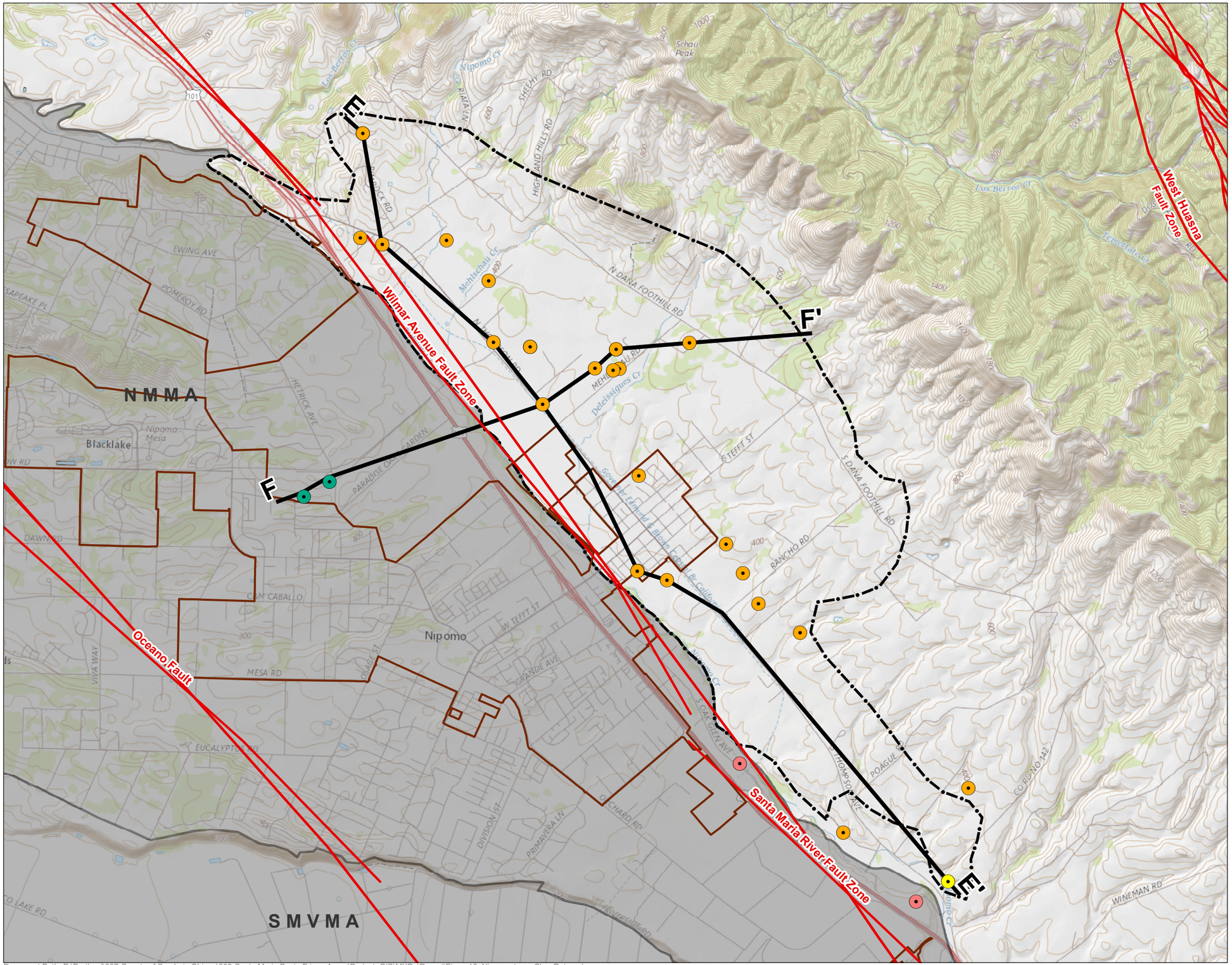
GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure15_Nipomo aerial_Char Rpt.mxd

FIGURE 16

Nipomo Valley Topographic Map

Santa Maria River Valley Groundwater Basin Fringe Areas

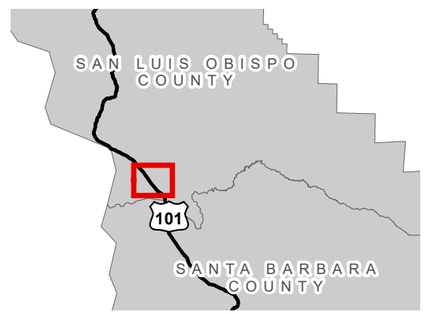


LEGEND

Wells

Screened Zone	*Well Type*
Alluvium	Supply
Alluvium/Bedrock	
Paso Robles/Pismo	
Bedrock	

- Fault
- Cross Section Lines
- Existing Basin Boundary (DWR Bulletin 118, 2016)
- Nipomo Community Services District
- Santa Maria River Valley Adjudicated Area



N

0 0.5 1

Miles

Date: June 22, 2018

Data Sources:
Fault shapefiles acquired from California Geological Survey and USGS Earthquake Hazards Program

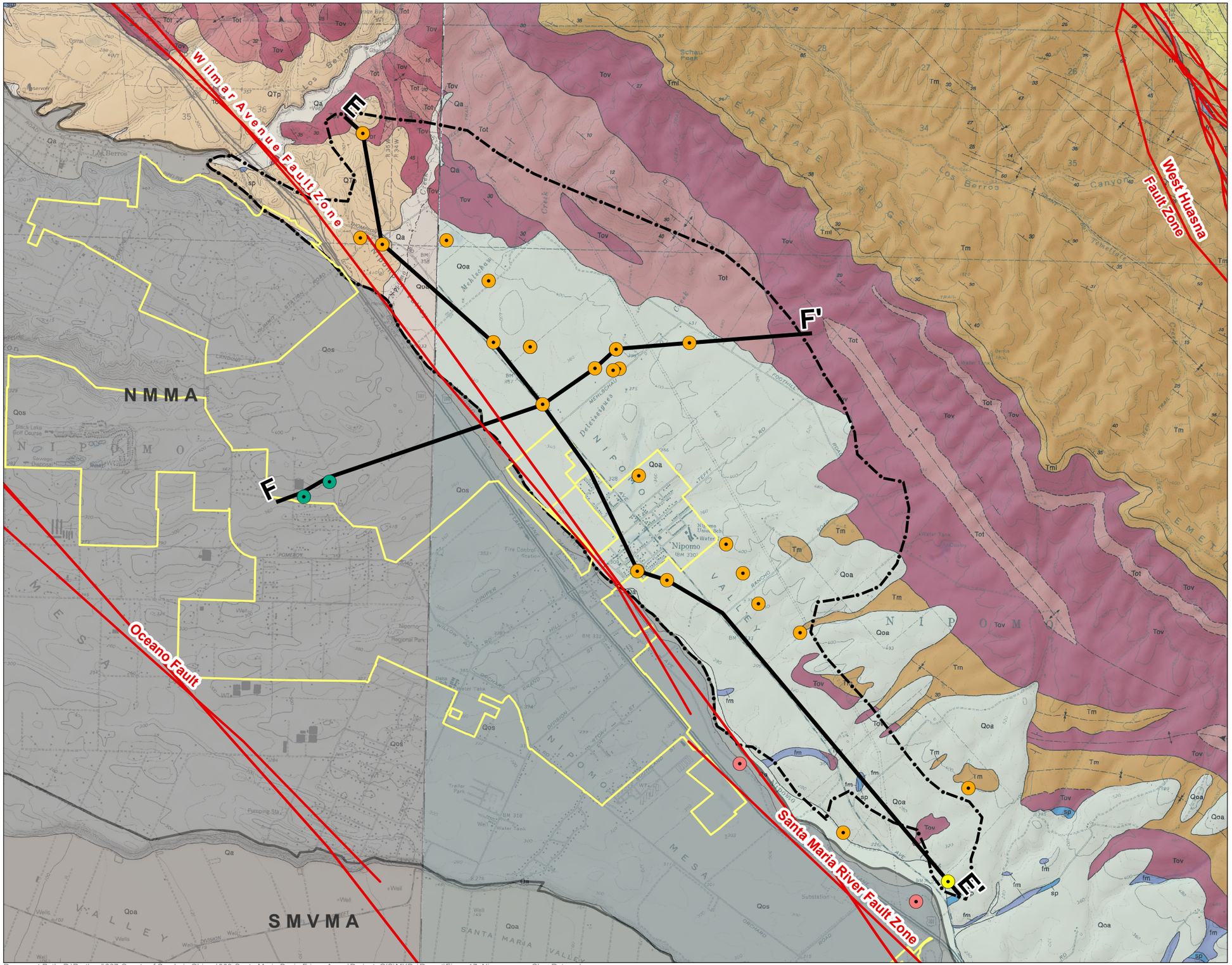
GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure16_Nipomo_topo_Char Rpt.mxd

FIGURE 17

Nipomo Valley Geologic Map

Santa Maria River Valley Groundwater Basin Fringe Areas



LEGEND

Wells

Screened Zone

- Alluvium
- Alluvium/Bedrock
- Paso Robles/Pismo
- Bedrock

Well Type

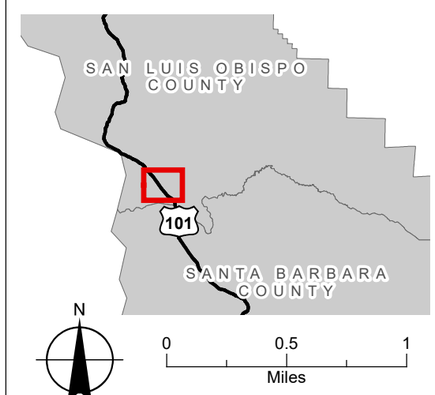
- Supply

Geology

- Volcanic Intrusive Rocks
- Obispo Formation
- Franciscan
- Serpentine
- Paso Robles
- Recent
- Pismo Formation
- Monterey Formation
- Atascadero Formation
- Toro Formation

All Other Features

- Cross Section Lines
- Fault
- Existing Basin Boundary (DWR Bulletin 118, 2016)
- Nipomo Community Services District
- Santa Maria River Valley Adjudicated Area



Date: June 22, 2018
Data Sources: Surface Geology from Dibblee (2006b and 2006c).
Fault shapefiles acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure17_Nipomo_geo_Char Rpt.mxd

NW

E

SE

E′

Nipomo Creek

F-F′

Tefft Street

PASO ROBLES FM

OLDER ALLUVIUM

BEDROCK
(Obispo)

BEDROCK
(Obispo/Monterey)

BEDROCK
(Franciscan)

Elevation (feet)

500
400
300
200
100
0
-100
-200

0
5000
10000
15000
20000
25000
30000
35000

Distance (feet)

LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
20X

FIGURE 18

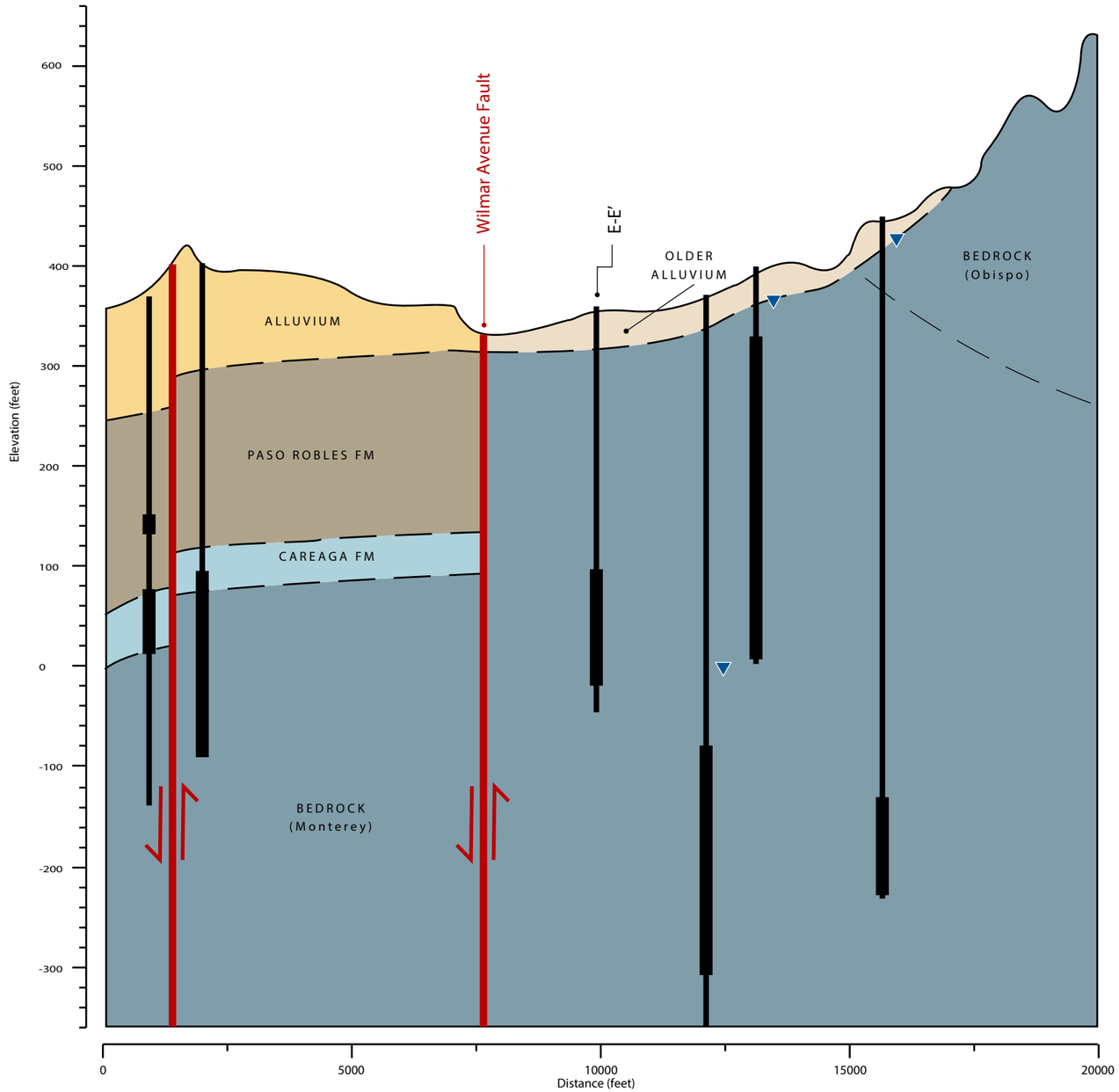
Nipomo Valley Longitudinal Section E-E′

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures

SW F F′ NE



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
20X

FIGURE 19

Nipomo Valley Cross Section F-F′

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures

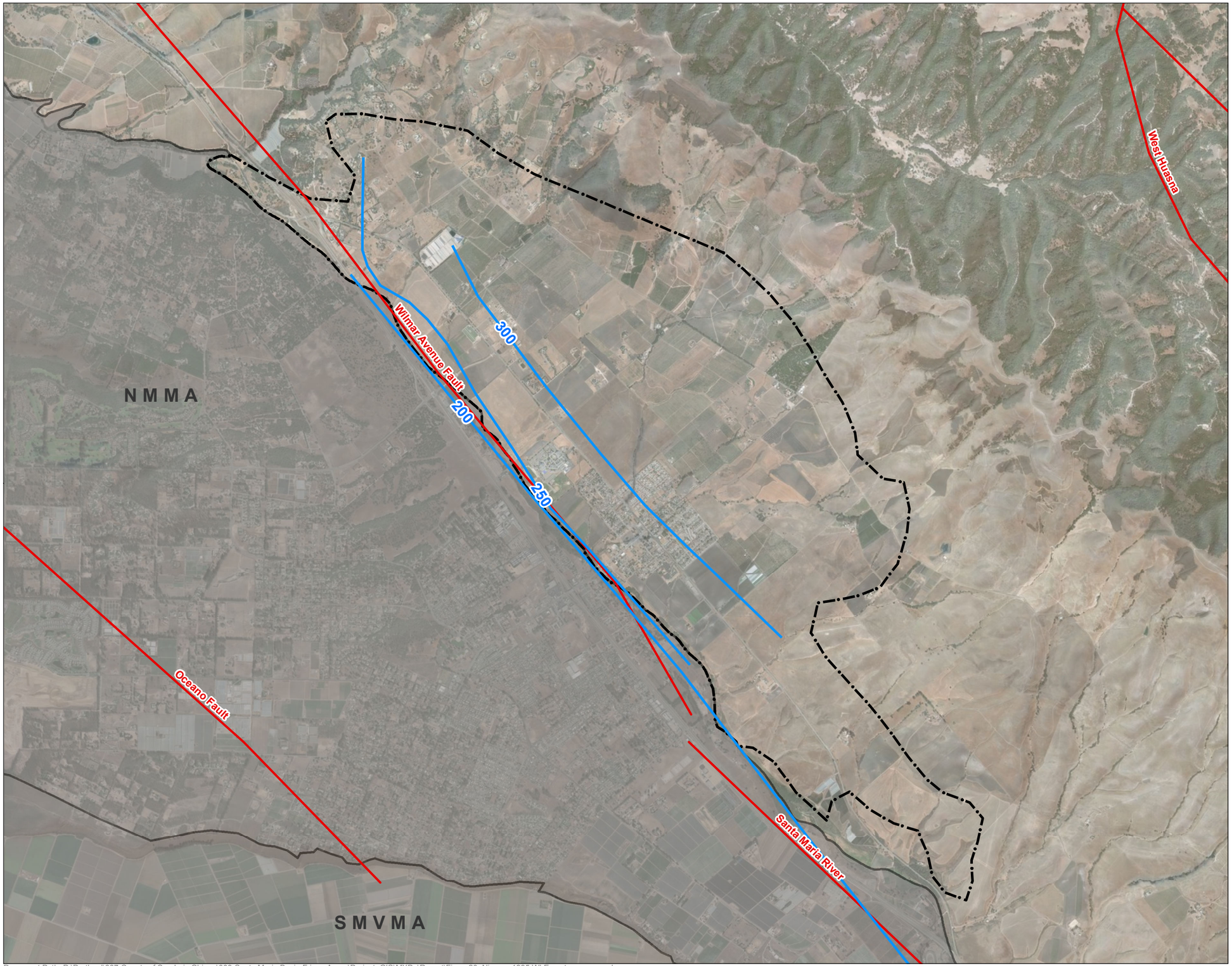


FIGURE 20

Spring 1995 Groundwater Elevations in Nipomo Valley

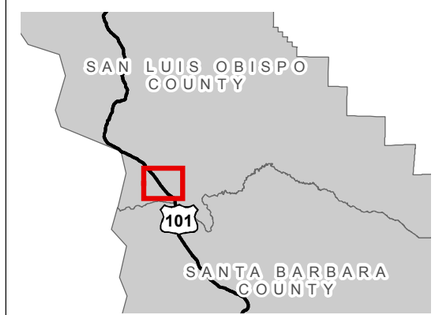
Santa Maria River Valley Groundwater Basin Fringe Areas

LEGEND

- Spring 1995 GW Elevations (DWR, 2002)
- Fault
- Existing Basin Boundary
- Santa Maria River Valley Groundwater Basin (Adjudicated)

Note: Contours reflect water levels in wells screening the Monterey Formation.

Contour Interval = 50 feet



N

0 0.5 1

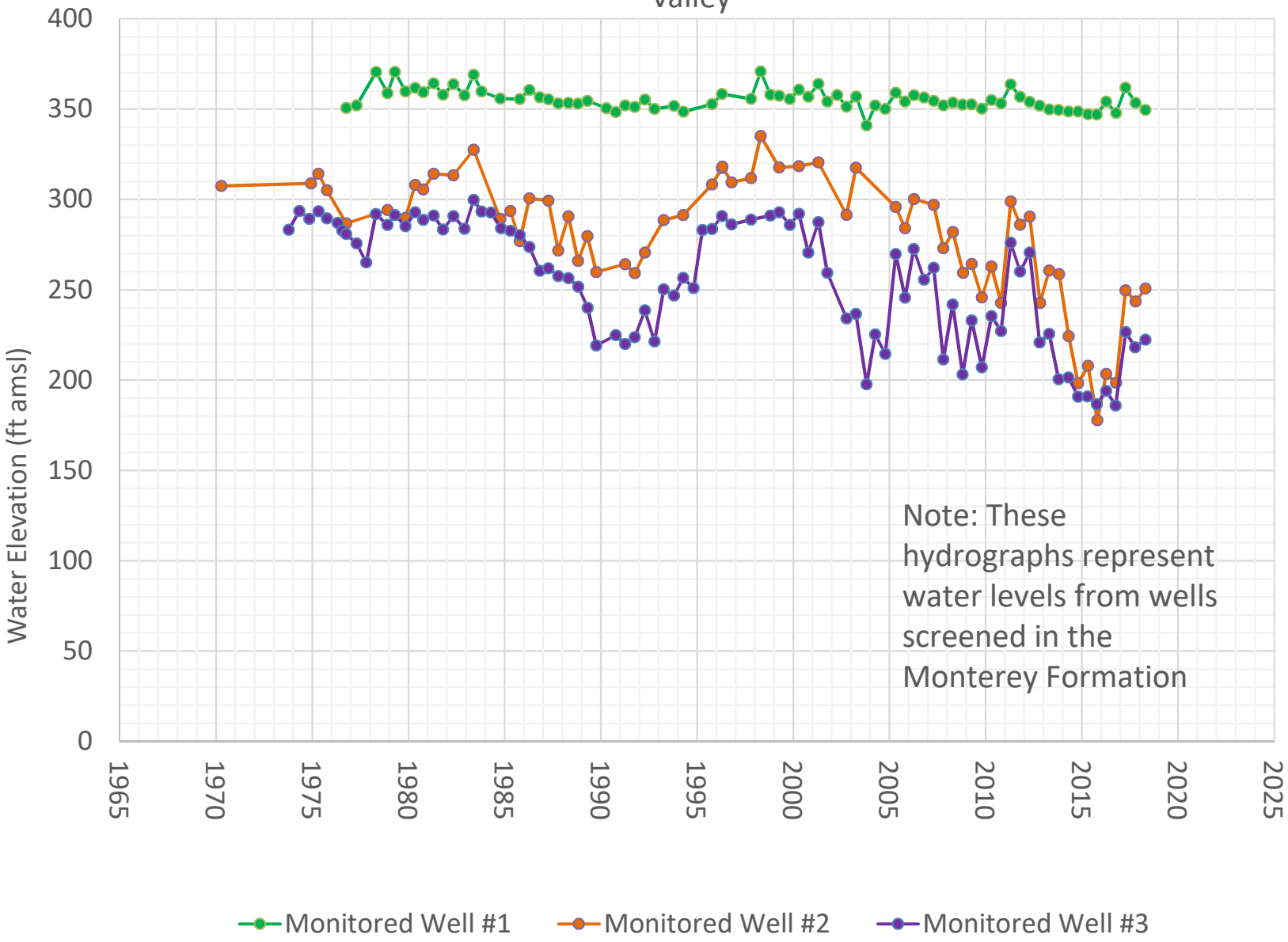
Miles

Date: February 6, 2018
Data Sources: Aerial photo taken 10/3/2016 (DigitalGlobe)

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure20_Nipomo 1995 WLE contour map.mxd

Figure 21 - Groundwater Level Elevations in County Monitored Wells - Nipomo Valley



Parameter	Southern Bluffs
DWR Bulletin 118 Area (acres)	4,060
Irrigated Area (acres)	2,100
Crop Demand (ac-ft/yr)	5,147
Hydraulic Conductivity (ft/day)	na
Saturated Thickness (ft)	na
Underflow Out (ac-ft/yr)	na
Percent of Total Inflow to SMRVGB	na

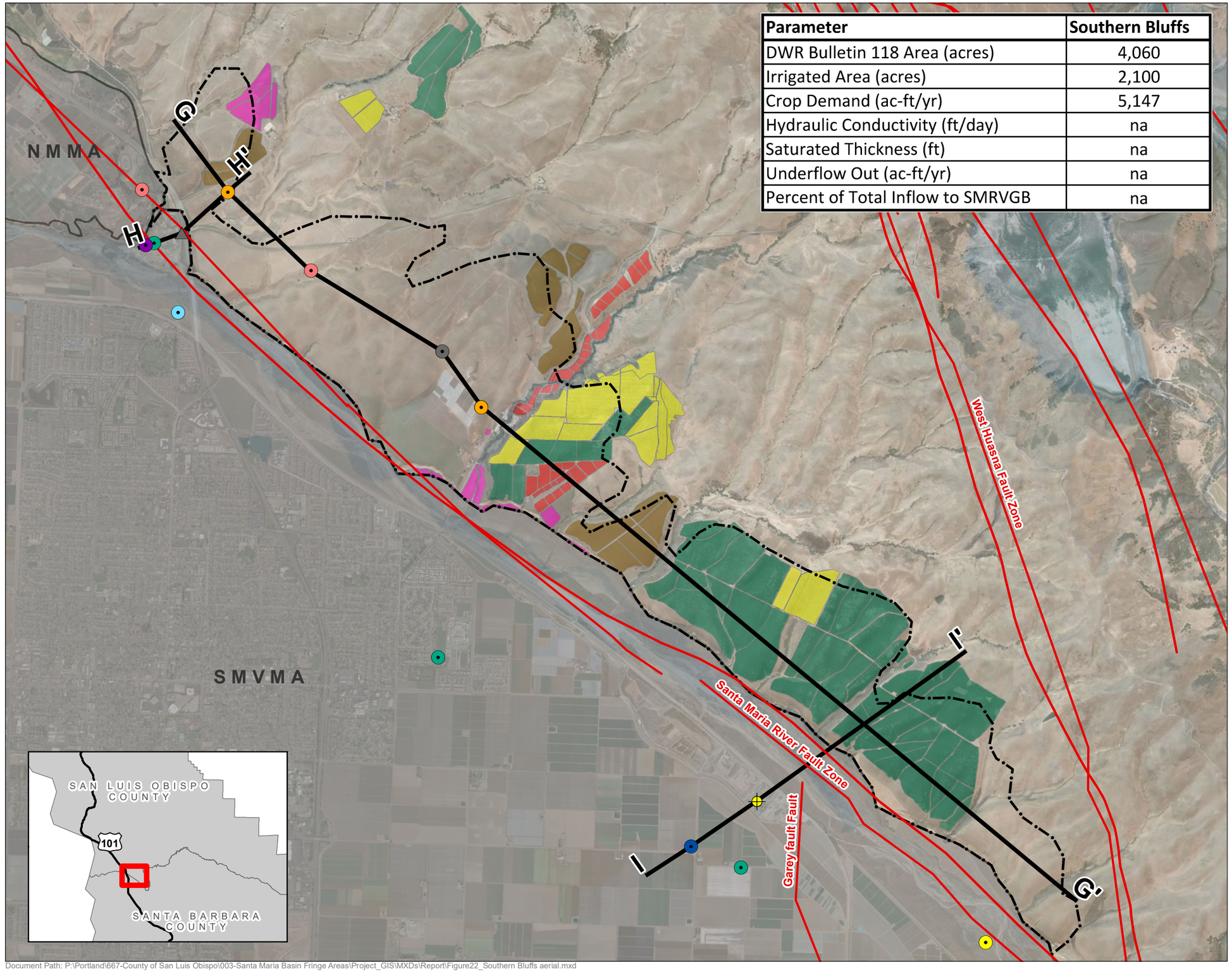


FIGURE 22

Southern Bluffs
Aerial Photo Map

Santa Maria River Valley
Groundwater Basin Fringe Areas

LEGEND

Wells

Screened Zone / *Well Type*

- Alluvium
- Alluvium/Paso Robles/ Careaga
- Alluvium/Careaga
- Alluvium/Bedrock
- Paso Robles/Careaga
- Paso Robles/Careaga/Bedrock
- Bedrock
- Unknown
- Monitoring
- Supply
- Cathodic Protection
- Cross Section Lines
- Fault
- Existing Basin Boundary
- Santa Maria River Valley Adjudicated Groundwater Basin

Irrigated Area (Land IQ, 2017)

- Avocados
- Bush Berries
- Citrus
- Idle
- Miscellaneous Truck Crops

N

0 0.5 1
Miles

Date: March 26, 2018
Data Sources: Aerial photo taken 10/3/2016 (DigitalGlobe)
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

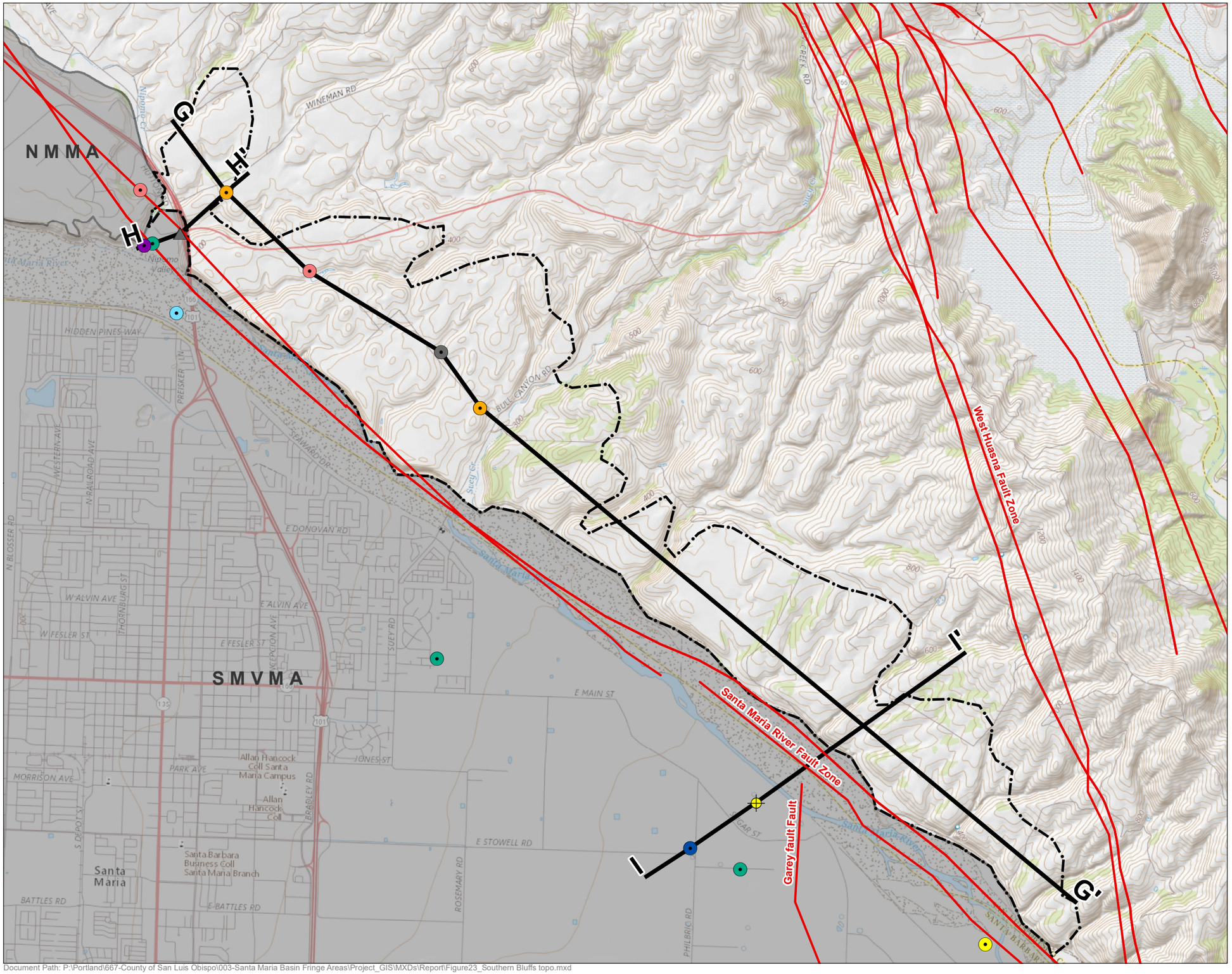
GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure22_Southern Bluffs aerial.mxd

FIGURE 23

Southern Bluffs Topographic Map

Santa Maria River Valley Groundwater Basin Fringe Areas



LEGEND

Wells

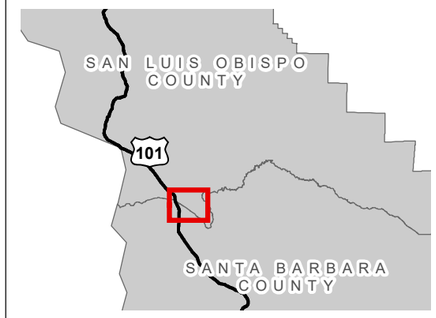
Screened Zone	*Well Type*
Alluvium	
Alluvium/Paso Robles/ Careaga	
Alluvium/Careaga	Monitoring
Alluvium/Bedrock	Supply
Paso Robles/Careaga	Cathodic Protection
Paso Robles/Careaga/Bedrock	
Bedrock	
Unknown	

Cross Section Lines

Fault

Existing Basin Boundary

Santa Maria River Valley Adjudicated Groundwater Basin



N

0 0.5 1

Miles

Date: March 26, 2018

Data Sources:
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

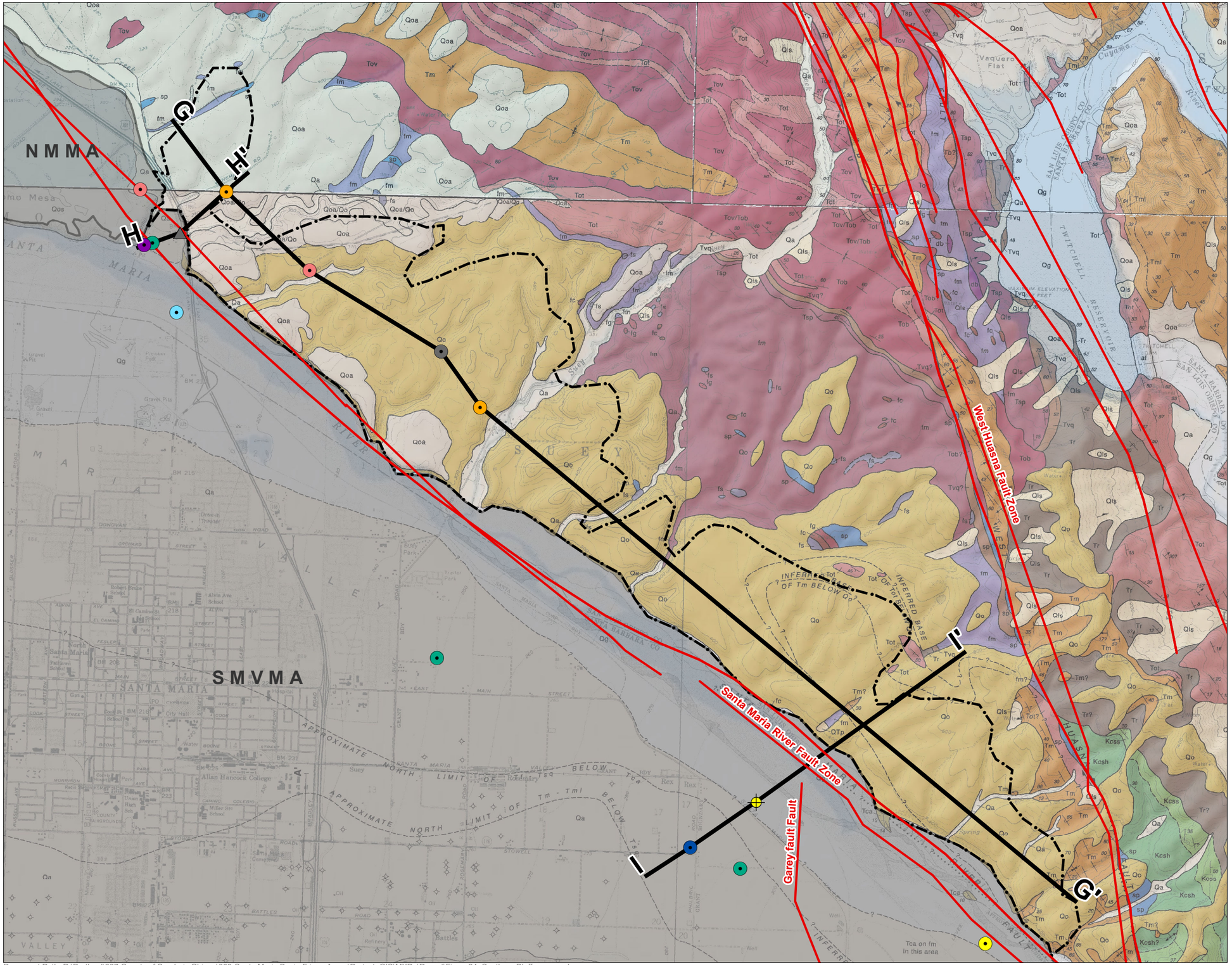
GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure23_Southern Bluffs topo.mxd

FIGURE 24

Southern Bluffs Geologic Map

Santa Maria River Valley Groundwater Basin Fringe Areas



LEGEND

Wells

Screened Zone

- Alluvium
- Alluvium/Paso Robles/Careaga
- Alluvium/Careaga
- Alluvium/Bedrock
- Paso Robles/Careaga
- Paso Robles/Careaga/Bedrock
- Bedrock
- Unknown

Well Type

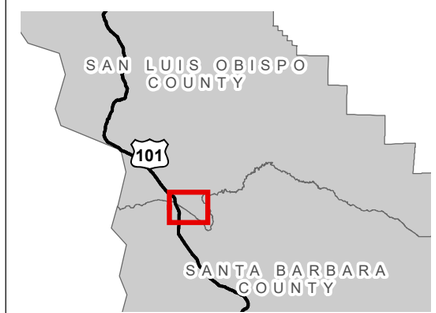
- Monitoring
- Supply
- Cathodic Protection

Geology

- Volcanic Intrusive Rocks
- Obispo Formation
- Franciscan Assemblage
- Serpentine
- Paso Robles
- Recent Alluvium
- Pismo Formation
- Monterey Formation
- Atascadero Formation
- Toro Formation

All Other Features

- Cross Section Lines
- Fault
- Existing Basin Boundary
- Santa Maria River Valley Adjudicated Groundwater Basin



N

0 0.5 1 Miles

Date: March 26, 2018
Data Sources: Surface Geology from Dibblee (1994, 2006a, and 2006b).
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

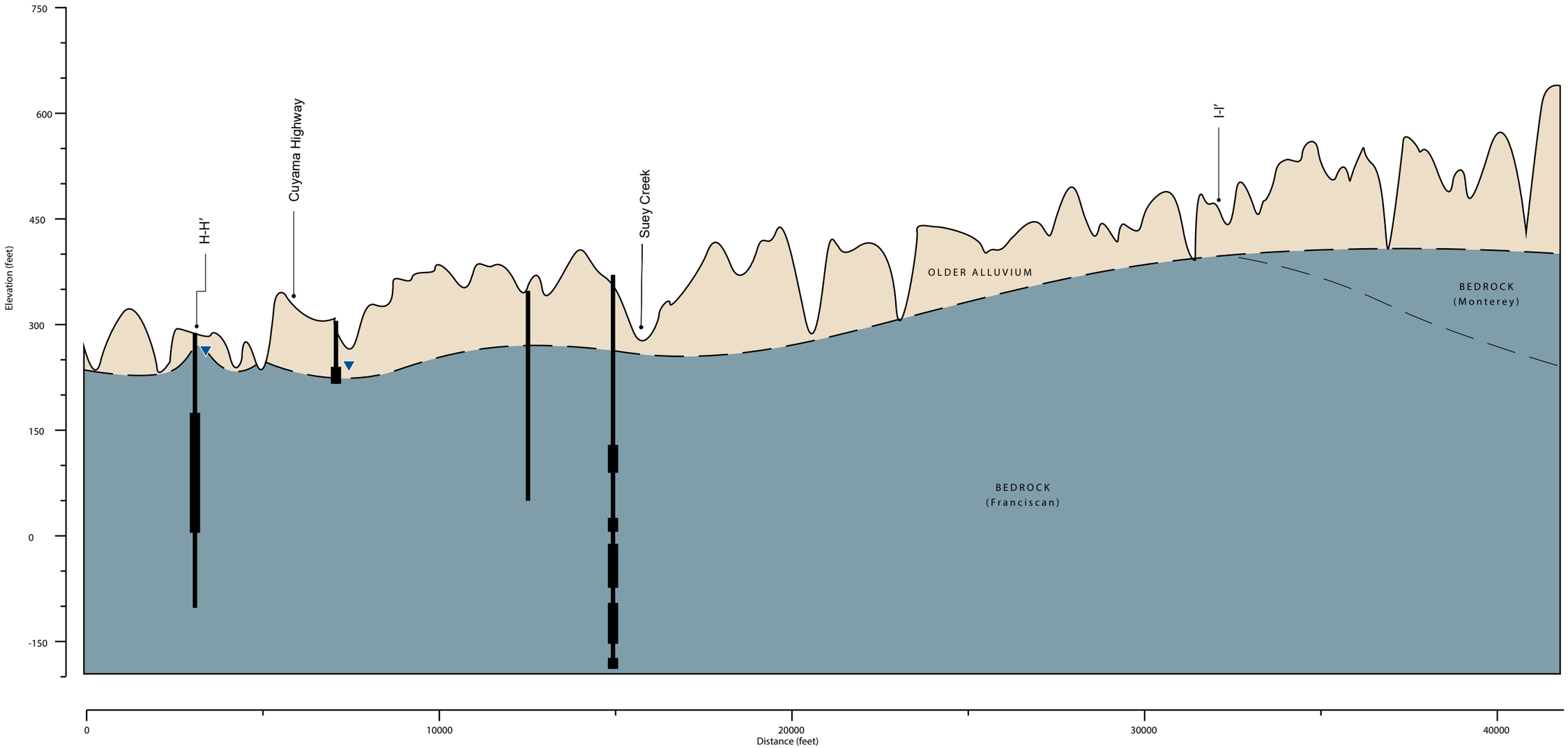
Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure24_Southern Bluffs geo.mxd

NW

SE

G

G'



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
20X

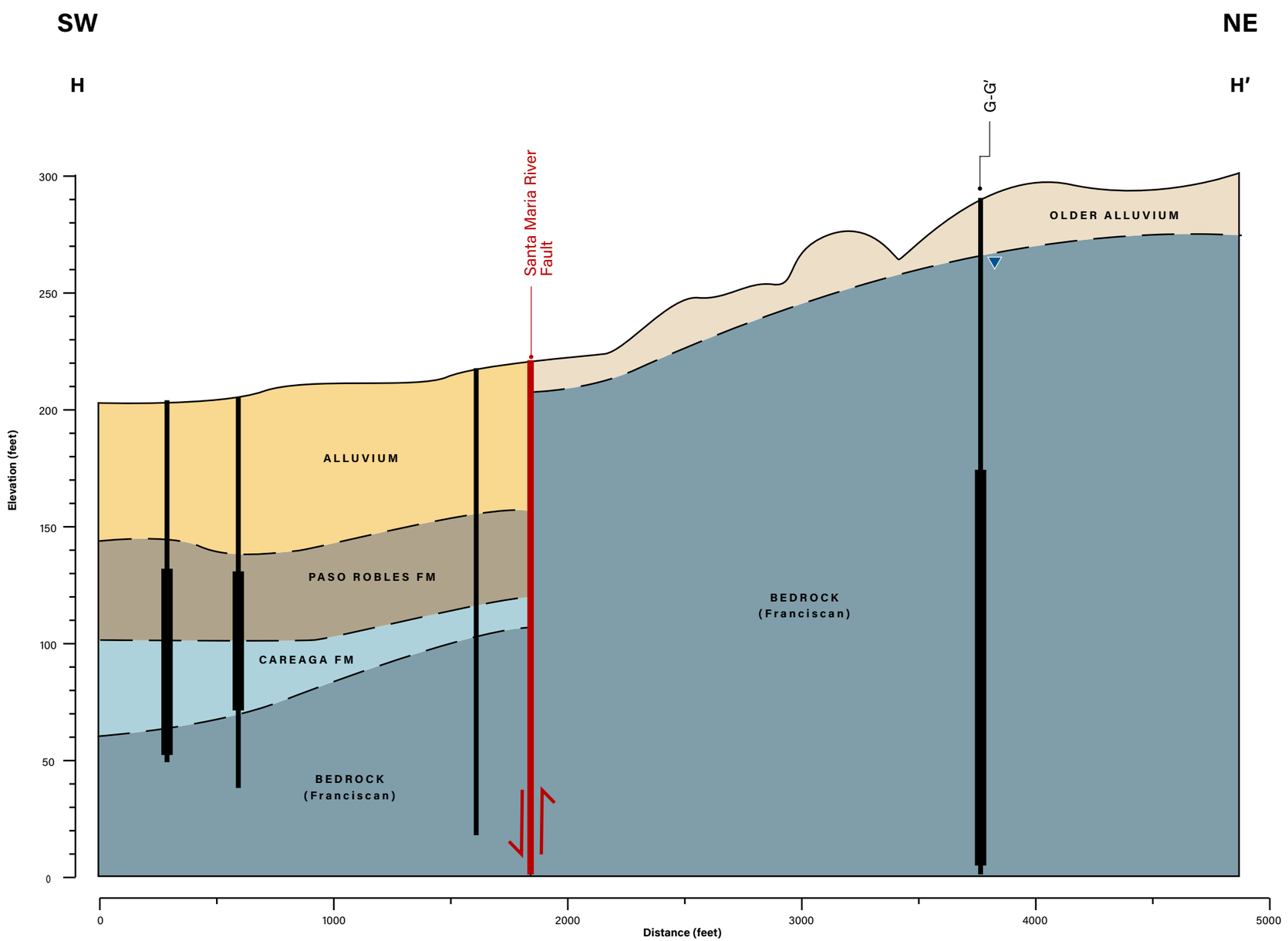
FIGURE 25

Southern Bluffs Longitudinal Section G-G'

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
10X

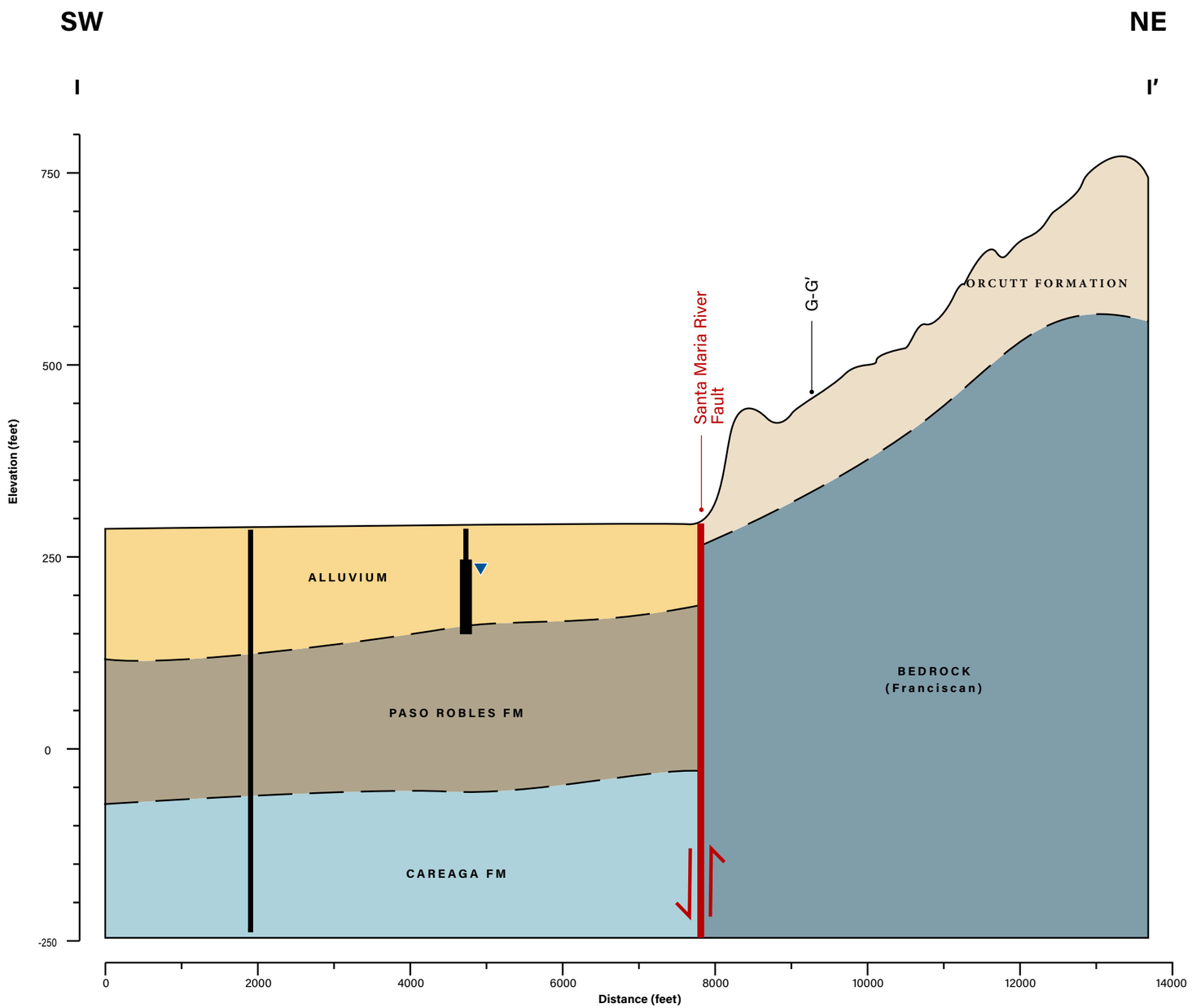
FIGURE 26

Southern Bluffs Cross Section H-H'

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
10X

FIGURE 27

Southern Bluffs Cross Section I-I'

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures

Parameter	SLO County	Santa Barbara County	Total
DWR Bulletin 118 Area (acres)	830	740	1,570
Extent of Alluvium Area (acres)	720	1,090	1,810
Irrigated Area (acres)	470	960	1,430
Crop Demand (ac-ft/yr)	610	1,059	1,669
Hydraulic Conductivity (ft/day)	56		
Saturated Thickness (ft)	95		
Underflow Out (ac-ft/yr)	147		
Percent of Total Inflow to SMRVGB	0.50%		

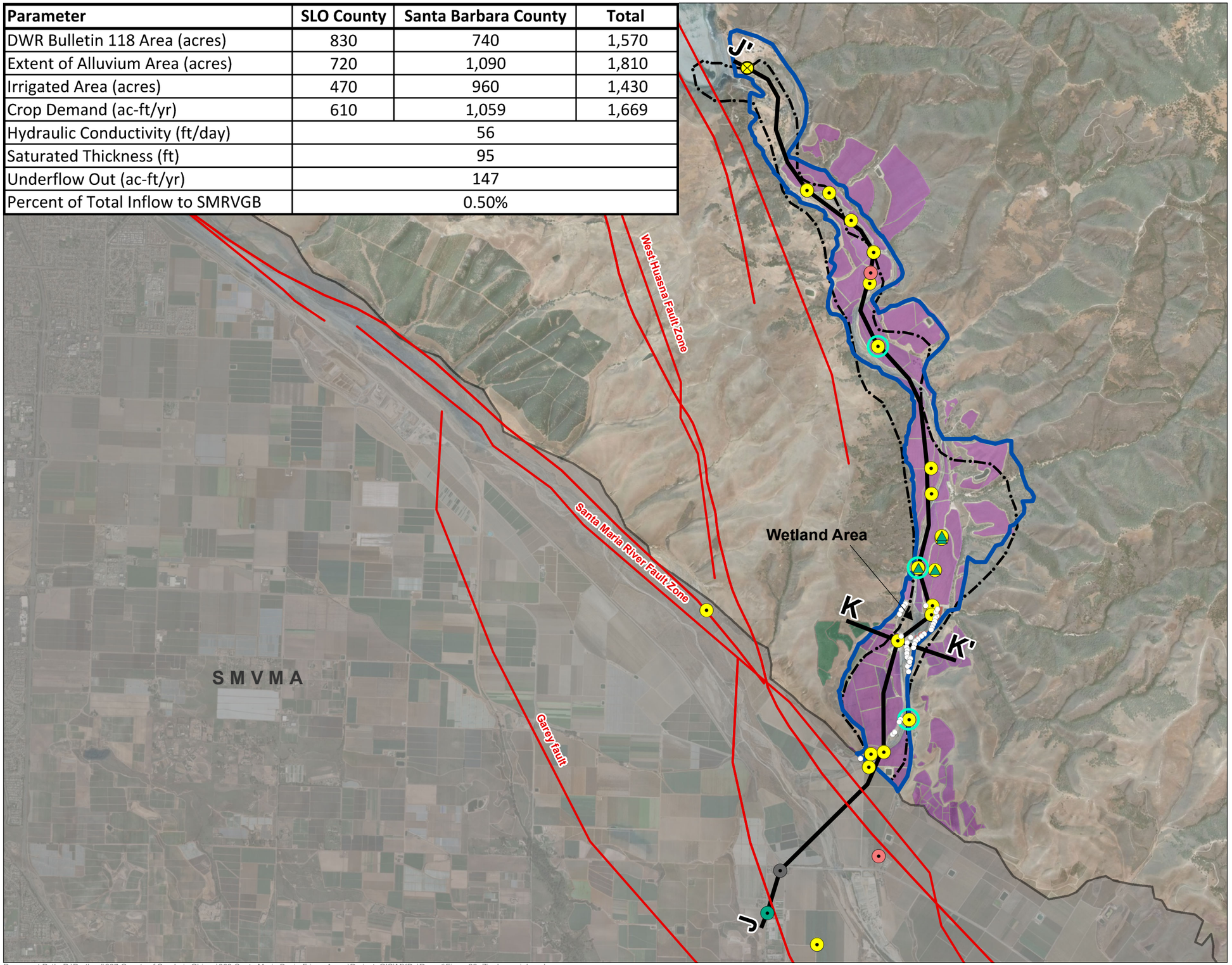


FIGURE 28

Ziegler Canyon Aerial Photo Map

Santa Maria River Valley Groundwater Basin Fringe Areas

LEGEND

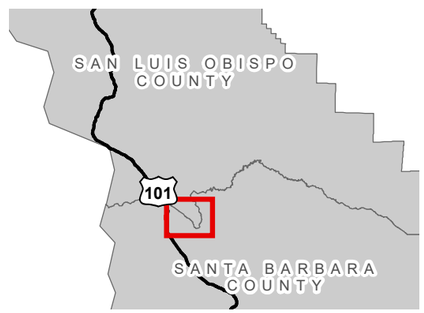
Wells

Screened Zone	*Well Type*
Alluvium	Supply
Alluvium/Bedrock	Test
Paso Robles/Careaga	Pumping Test
Unknown	Hydrograph
TDEM Survey Point	

- Cross Section Lines
- Fault
- Extent of Alluvium
- Existing Basin Boundary
- Santa Maria River Valley Groundwater Basin (Adjudicated)

Irrigated Area

- Avocados
- Bush Berries
- Grapes
- Idle
- Miscellaneous Truck Crops



N

0 0.5 1 Miles

Date: March 26, 2018
Data Sources: Aerial photo taken 10/3/2016 (DigitalGlobe)
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure28_Ziegler aerial.mxd

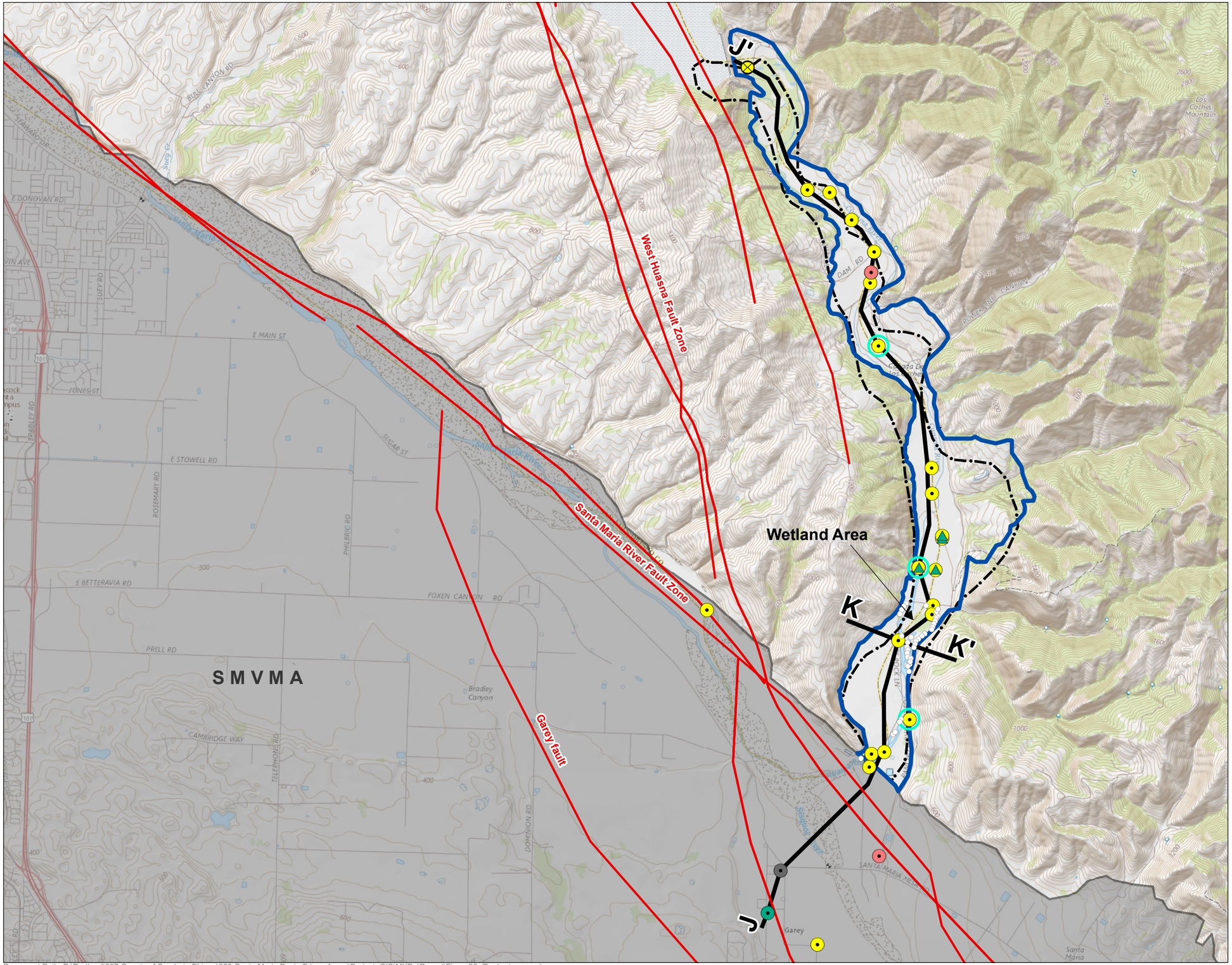


FIGURE 29

Ziegler Canyon Topographic Map

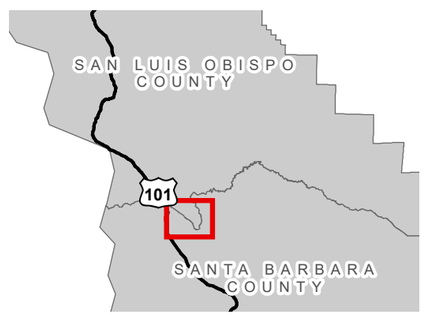
Santa Maria River Valley Groundwater Basin Fringe Areas

LEGEND

Wells

Screened Zone	*Well Type*
Alluvium	Supply
Alluvium/Bedrock	Test
Paso Robles/Careaga	Pumping Test
Unknown	Hydrograph
TDEM Survey Point	

- Fault
- Extent of Alluvium
- Existing Basin Boundary
- Santa Maria River Valley Adjudicated Groundwater Basin



N

0 0.5 1

Miles

Date: March 26, 2018

Data Sources:
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure29_Ziegler topo.mxd

FIGURE 30

Cuyama River Valley Geologic Map

Santa Maria River Valley Groundwater Basin Fringe Areas

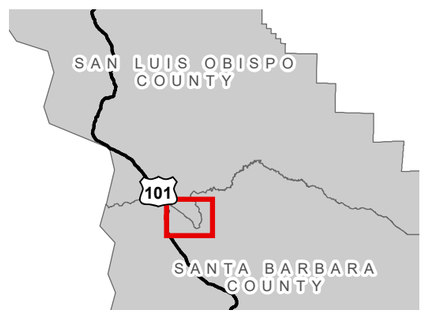
LEGEND

Wells

Screened Zone	*Well Type*
Alluvium	Supply
Alluvium/Bedrock	Test
Paso Robles/Careaga	Pumping Test
Unknown	Hydrograph
TDEM Survey Point	

Geology

- Volcanic Intrusive Rocks
- Obispo Formation
- Franciscan
- Serpentine
- Paso Robles
- Recent
- Pismo Formation
- Monterey Formation
- Atascadero Formation
- Toro Formation
- Fault
- Extent of Existing Basin Boundary
- Santa Maria River Valley Groundwater Basin (Adjudicated)



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0 0.5 1

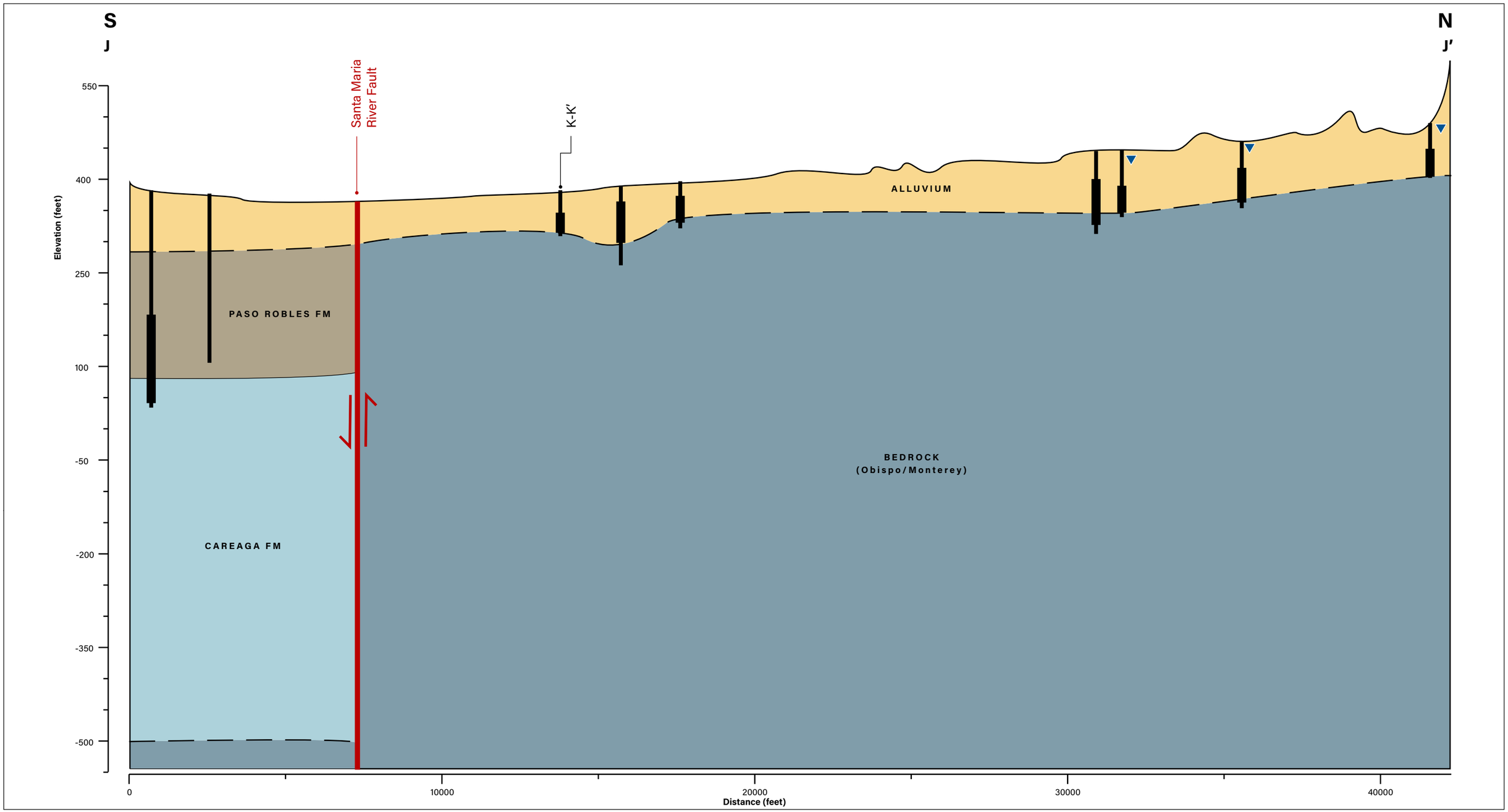
Miles

Date: March 26, 2018

Data Sources: Surface Geology from Dibblee (1994).
Fault shapefile acquired from California Geological Survey and USGS Earthquake Hazards Program

GSI Water Solutions, Inc.

Document Path: P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Project_GIS\MXDs\Report\Figure30_Ziegler geo.mxd



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
20X

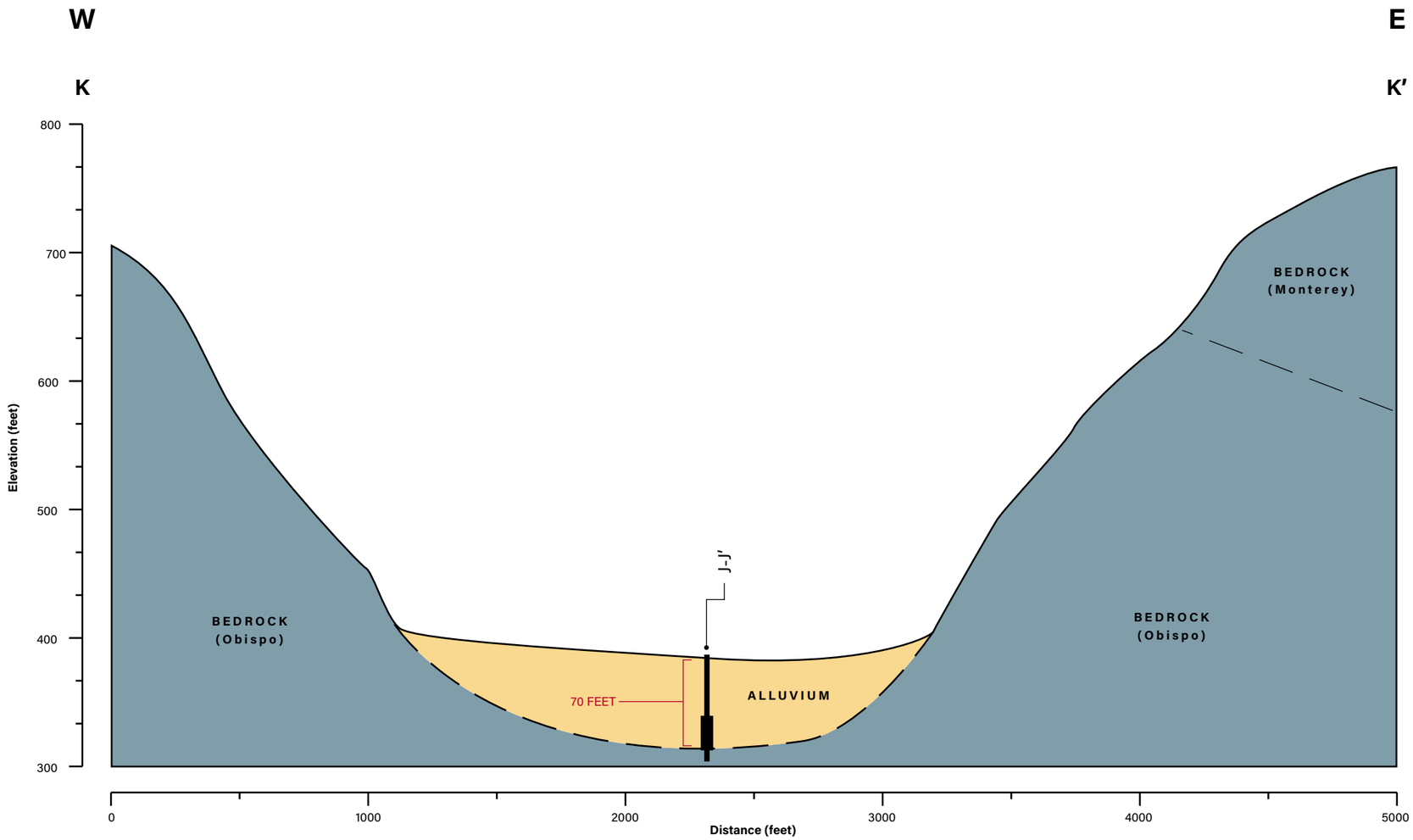
FIGURE 31

Ziegler Canyon Longitudinal Section J-J'

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures



LEGEND

- Alluvium
- Older Alluvium
- Paso Robles Fm
- Pismo Fm
- Careaga Fm
- Bedrock
- Static Water Level - Historic from WCR
- Borehole
- Perforated

VERTICAL EXAGGERATION:
5X

FIGURE 32

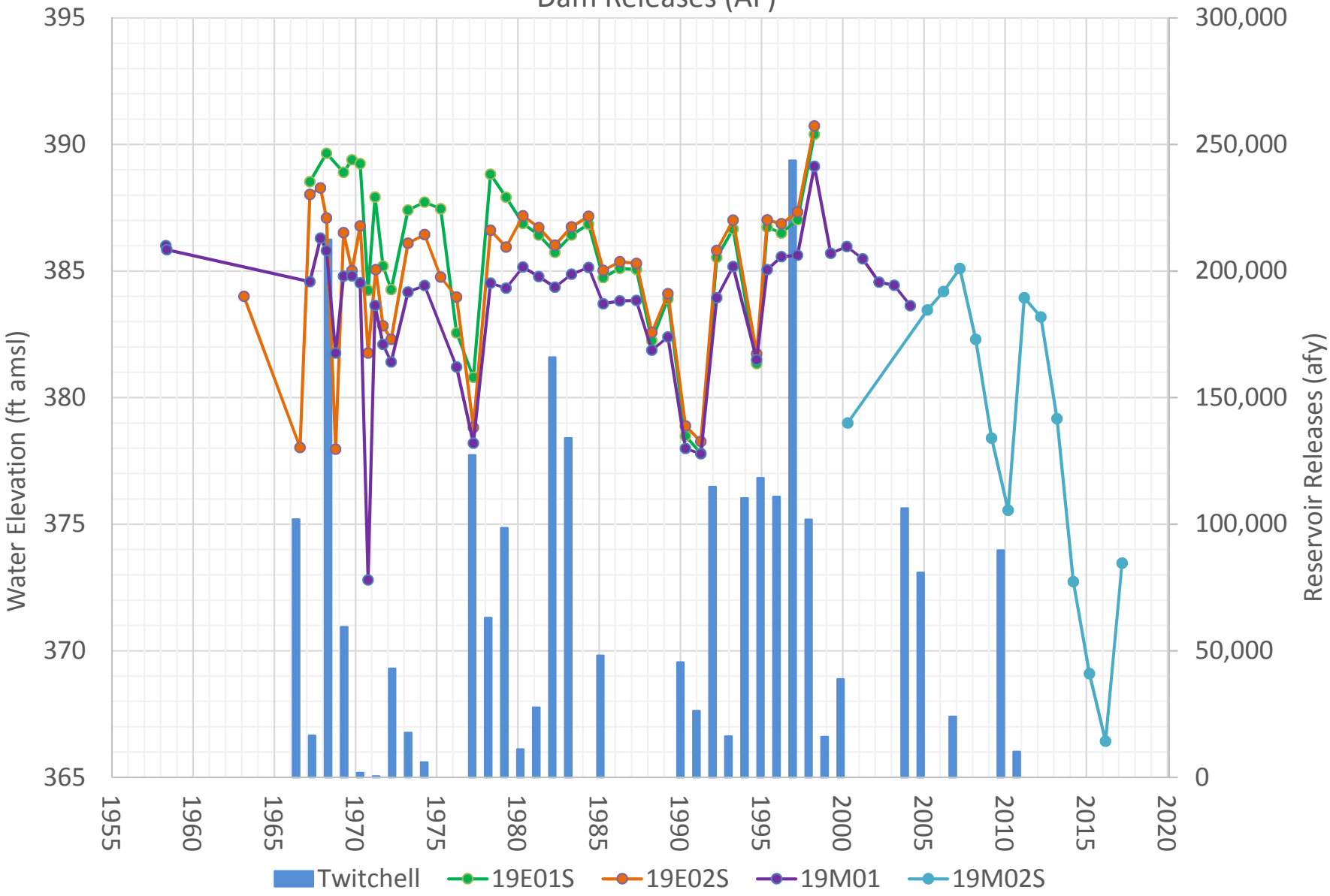
Ziegler Canyon Cross Section K-K'

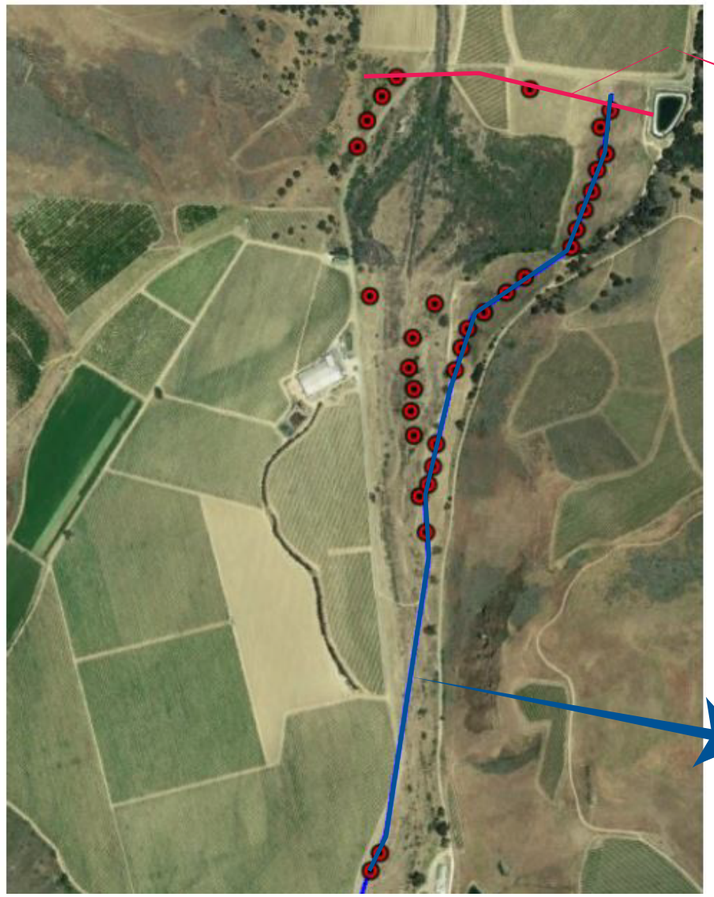
Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

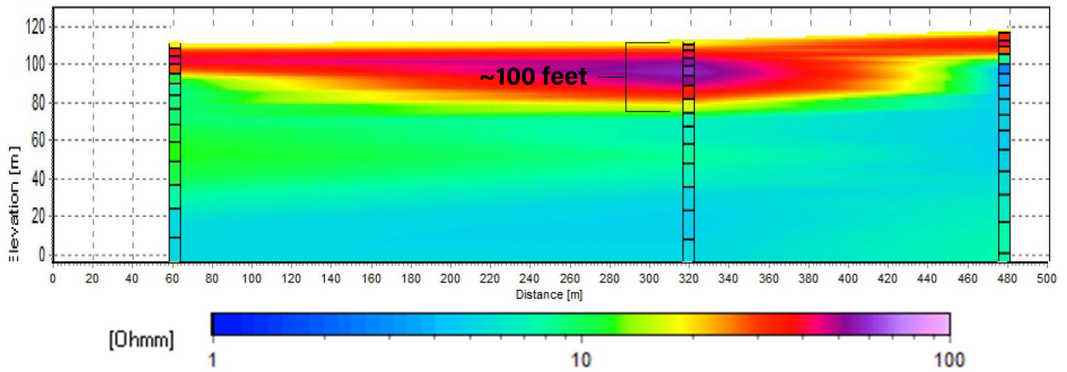
P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures

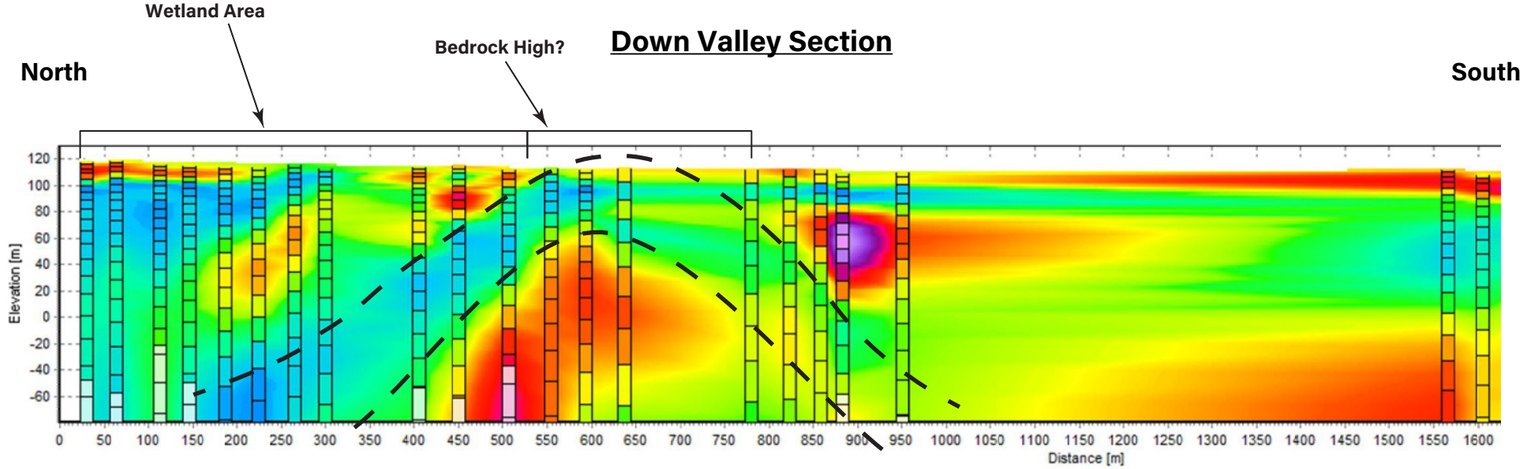
Figure 33 - Groundwater Level Elevations in USGS Wells Compared to Twitchell Dam Releases (AF)





Cross Valley Section





Anticlinal Feature

LEGEND

FIGURE 34

Ziegler Canyon TDEM Survey

Santa Maria River Valley Groundwater Basin Fringe Areas

GSI Water Solutions, Inc.

P:\Portland\667-County of San Luis Obispo\003-Santa Maria Basin Fringe Areas\Figures

Appendix A

Well Completion Reports and Lithologic Data (Confidential)

Appendix B

WIZ Pismo Alluvium Report

WZI INC.

Plains Exploration & Production Company

Pismo Creek Alluvial Evaluation
Arroyo Grande Oil Field
San Luis Obispo County, California

February 2007

Submitted to:
Plains Exploration & Production Company
1200 Discovery Drive, Suite 500
Bakersfield, California 93309

Prepared by:
WZI Inc.
1717 28th Street
Bakersfield, California 93301

TABLE OF CONTENTS

EXHIBITS

APPENDICES

Introduction

Plains Exploration & Production Company (PXP) recently received a conditional use permit (CUP) from San Luis Obispo County for their Phase IV drilling project at the Arroyo Grande (AG) Oil Field located along Price Canyon Road in San Luis Obispo County, California (Location Map, **Exhibit 1**). An additional CUP is currently being sought for a water treatment plant to support the Phase IV operations.

As a result of the Phase IV permitting process, several issues concerning the potential impact of the project on surface and groundwater resources in the area were identified. Previous geologic mapping of the area (Hall, 1973) indicated the presence of a fresh water alluvial aquifer that extends along Pismo Creek.

As a requirement of San Luis Obispo County for approval of the Phase IV drilling project, four sentry monitoring wells were installed along Pismo Creek in October 2005 to monitor shallow groundwater within the alluvium. Based on the results of the sentry well installations, it was determined that the actual extent of the alluvium in the area was not as depicted on the published geologic map of the area. Consequently, field mapping of the contact between the alluvium and underlying Pismo Formation were conducted to better define the actual extent of the alluvium in the area of the PXP's property. The following presents the methodology utilized to evaluate the extent of alluvium along Pismo Creek and the results of the field investigation.

Geologic Setting

A geologic map of the area was published by the California Division of Mines and Geology in 1973 on the Arroyo Grande 15' Quadrangle (Hall, 1973). According to the 1973 map, surface geology in the area of the Arroyo Grande Oil Field consists primarily of hard sandstones, pebbly sands, and conglomerates of the Edna Member of the Pismo Formation. The Edna member grades to the southwest of the Arroyo Grande Oil Field into brown clays and silts of the Meguelito Member of the Pismo Formation.

An area containing Quaternary age alluvium was mapped along the drainage of Pismo Creek and adjacent tributaries. It was interpreted that the veneer of alluvium provided a fresh water aquifer in the area which could potentially be impacted by the Phase IV oil and gas operations. The published extent of the alluvium was later utilized in a report on the geologic separation of the Price Canyon oil development from the fresh water aquifer (Pacific Geotechnical Associates, Inc., 2005). A cross section depicting the interpretation of the distribution of alluvium along Pismo Creek from the 2005 Pacific Geotechnical Associates, Inc. report presented as **Exhibit 2**.

Investigation Methodology

In order to evaluate the extent of alluvium along Pismo Creek a total of three days were spent conducting a field mapping program. The area along Pismo Creek was initially observed by vehicle and on foot. The field mapping program was then conducted which consisted of making a series of eight transects across the Pismo Creek drainage, recording lithologies at 54 outcrop locations, recording field observations, and photographing the Pismo Creek drainage. The

California State Plane coordinates for each outcrop location were recorded using a Magelan Meridian Series GPS unit. The coordinates were then plotted on a geo-referenced air photo. An air photo map depicting the transects and the individual outcrop locations observed is included as **Exhibit 3**.

Investigation Results and Conclusions

During the field investigation, the Pismo Creek drainage was observed to be incised directly into the Edna Member of the Pismo Formation bedrock. A soil profile of decomposed Pismo Formation is present in the vegetated areas adjacent to the creek but no extensive or continuous alluvial deposits are present along the Pismo Creek drainage through the PXP property.

The Edna Member of the Pismo Formation is characterized by gray sandstone containing natural crude oil stain and seepage at many of the outcrop locations observed along Pismo Creek. The observed outcrop lithologies and crude oil seepage appear to be consistent with formation conditions encountered in the 4 sentry wells located along Pismo Creek. **Appendix 1** contains a series of representative photographs that show the Pismo Creek drainage incised directly into the Edna Member of the Pismo Formation.

Based on the results of the field investigation, it was determined that the previously mapped distribution of alluvium within the Pismo Creek drainage and tributaries was incorrect. Consequently, no alluvial aquifer appears to be present within the Pismo Creek drainage in the area of PXP's property.

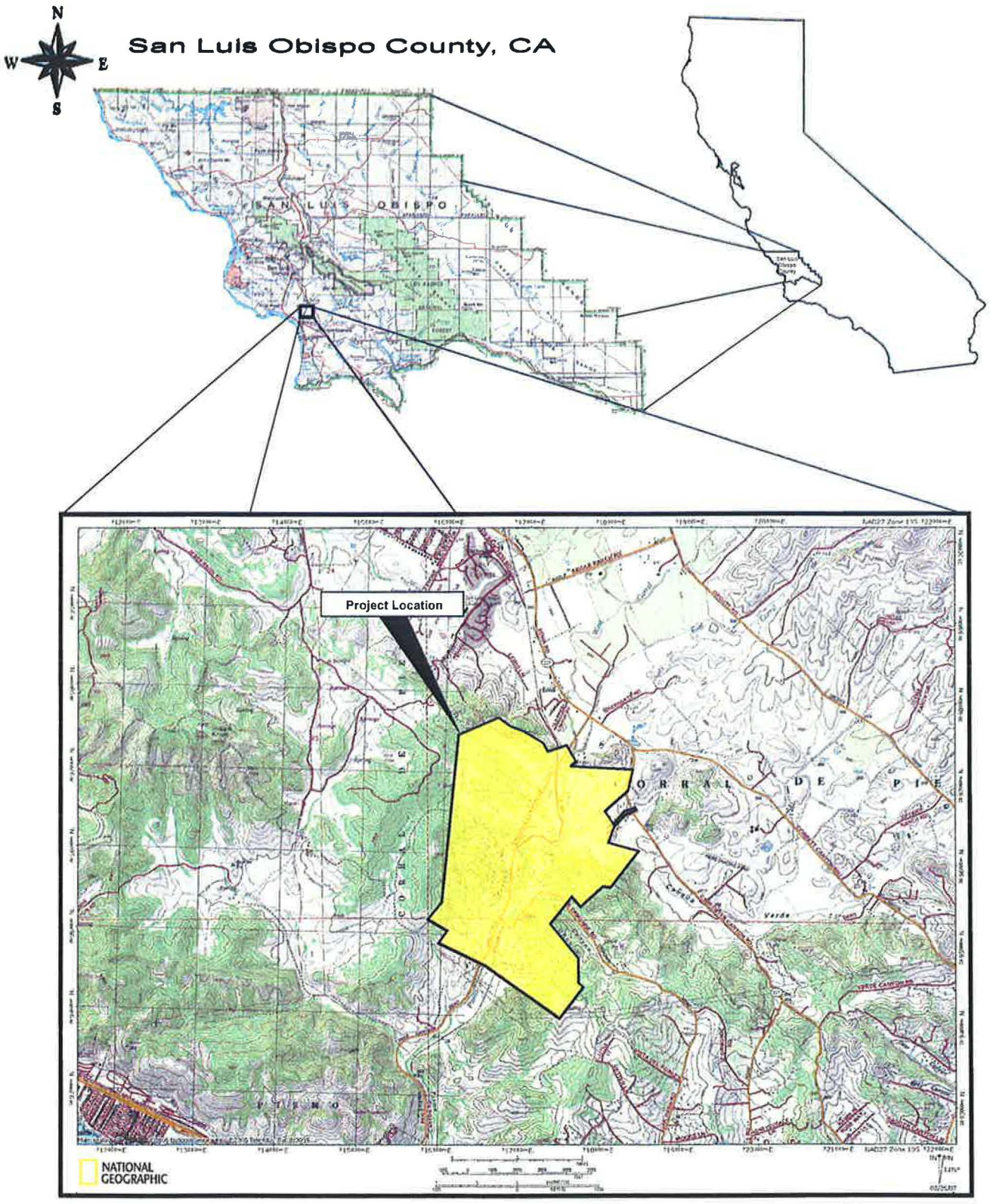
References

Entrix, Inc., 2006, *Sentry Well Groundwater Monitoring Installation and Initial Sampling, Arroyo Grande Oil Field 1821 Price Canyon Road, San Luis Obispo, California*, consulting report prepared by Entrix, Inc. for Plains Exploration & Production Company.

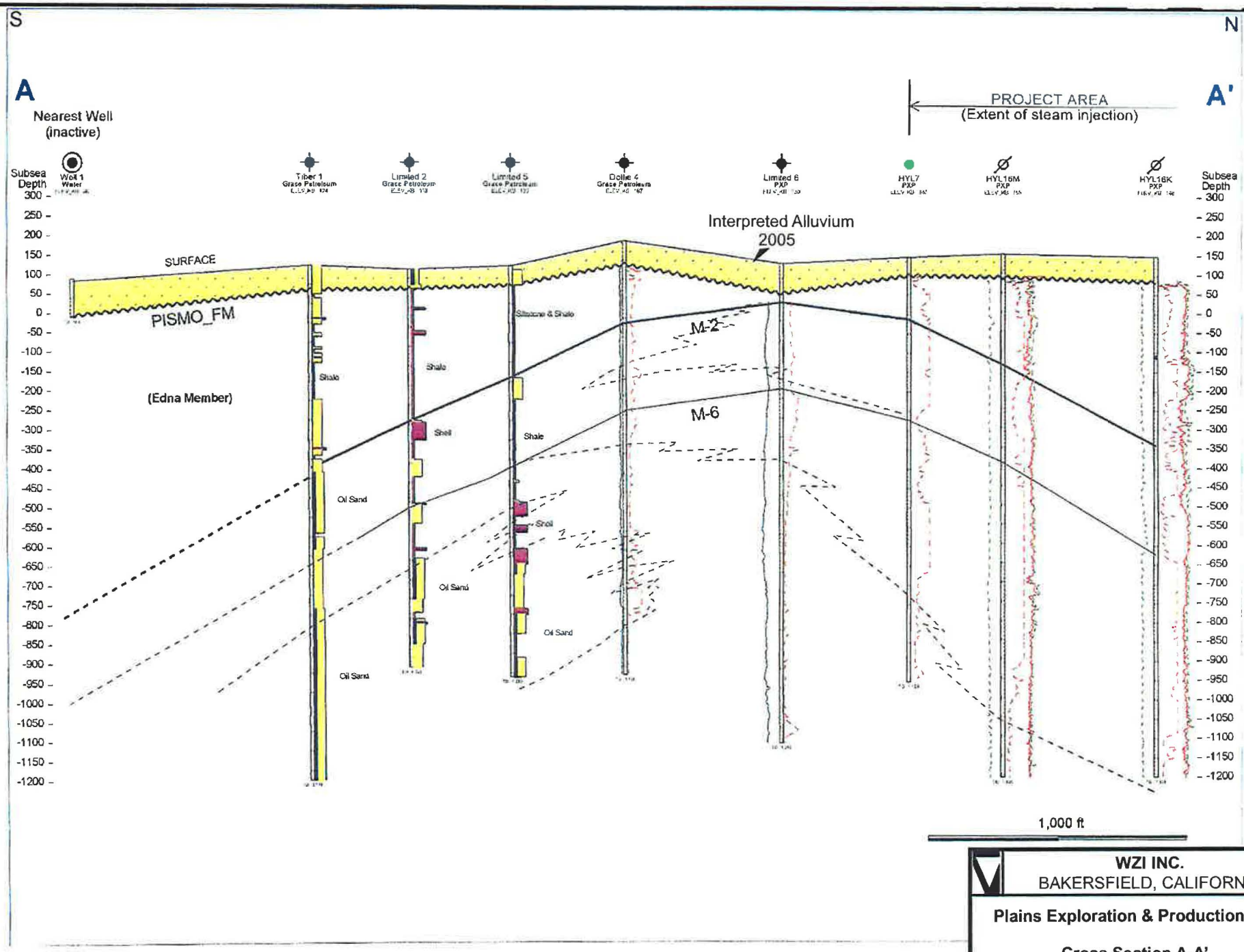
Hall, C.A., 1973, *Geology of the Arroyo Grande 15' Quadrangle, San Luis Obispo County, California*, California Division of Mines and Geology Arroyo Grande 15' Quadrangle map sheet 24.

Pacific Geotechnical Associates, Inc., 2005, *Analysis of Geological Separation of Price canyon Oil Development From the Fresh Water Aquifer, Price canyon, Arroyo Grande, San Luis Obispo County,* consulting report prepared for Plains Exploration & Production Company.

EXHIBITS



WZI INC. BAKERSFIELD, CALIFORNIA	
Plains Exploration & Production Co.	
Location Map	
DATE 2/07	1601000010 EXHIBIT 1



WZI INC.
BAKERSFIELD, CALIFORNIA

Plains Exploration & Production Co.

Cross Section A-A'
Pismo Creek Alluvium Interpretation
Pacific Geotechnical Associates 2005

DATE		EXHIBIT
2/07	1601000010	2

W-2
W-1
W-3
A
A'
Legend
- FIELD POINTS (10/25/06)
- FIELD POINTS 2 (11/10/06)
- PXP Water Wells
- Sentry Wells (Entrix, 2006)
- Photo Locations
- Pismo Creek
- X-Section A-A' (Pacific Geotecnical, 2005)
- Transect Lines
- Alluvium (Hall, 1973)

0 390 780 1,170 1,560 Feet

N

WZI INC.
BAKERSFIELD, CALIFORNIA

Plains Exploration & Production Co.

Site Plan Map with
Transects and Field Points

DATE		EXHIBIT
2/07	1601000010	3

APPENDIX

Pismo Creek Photo Location #5

Appendix 1

Pismo Creek Photo Location #9

Appendix 1

Pismo Creek Photo Location #15

Appendix 1

Poso Creek Photo Location #20

Appendix 1

Pismo Creek Photo Location #22

Appendix 1

Pismo Creek Photo Location #23

Appendix 1

Pismo Creek Photo Location #33

Appendix 1

Pismo Creek Photo Location #34

Appendix 1

Pismo Creek Photo Location #48

Appendix 1

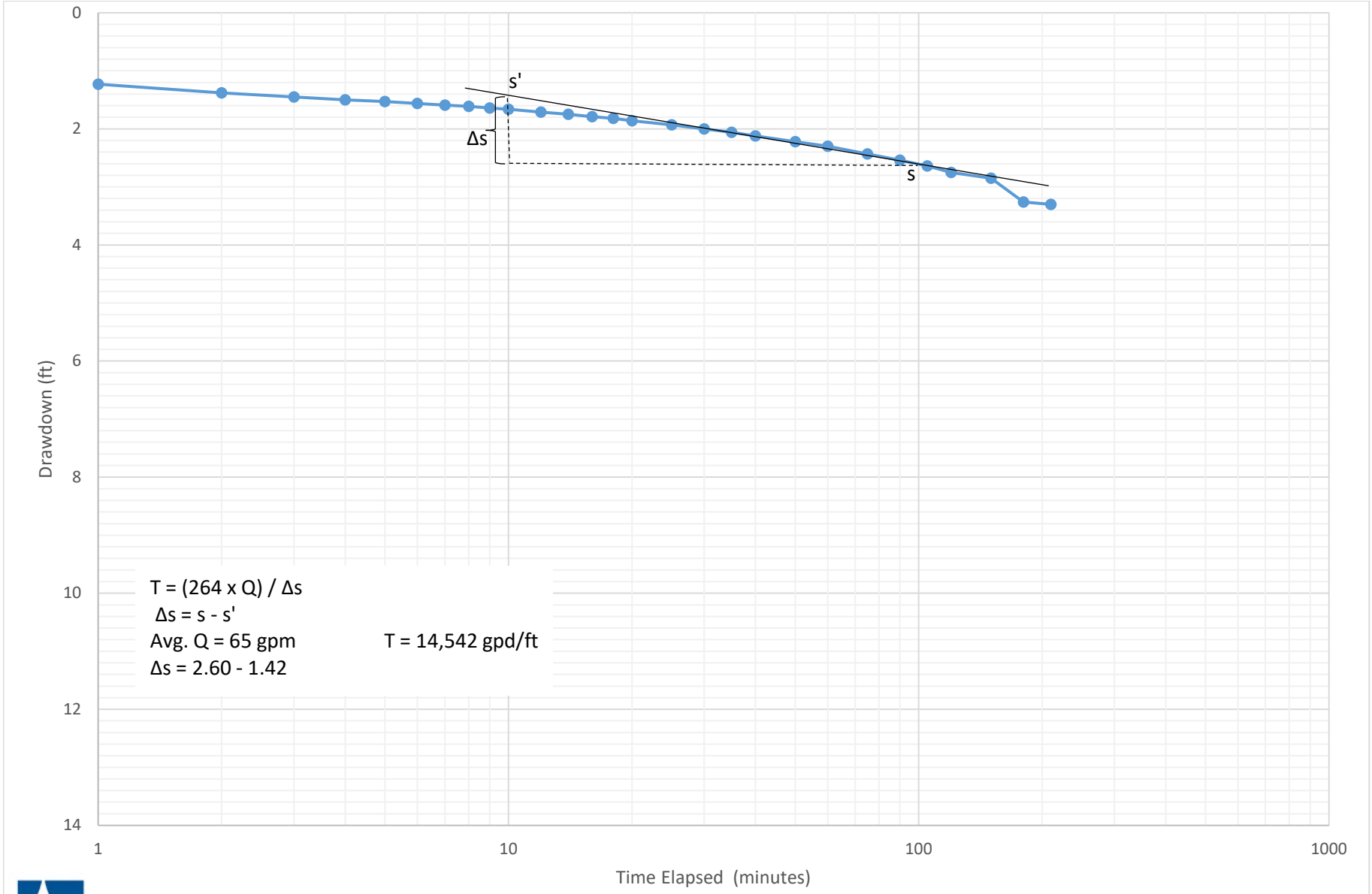
Pismo Creek Photo Location #6

Appendix 1

Poso Creek Photo Location #19

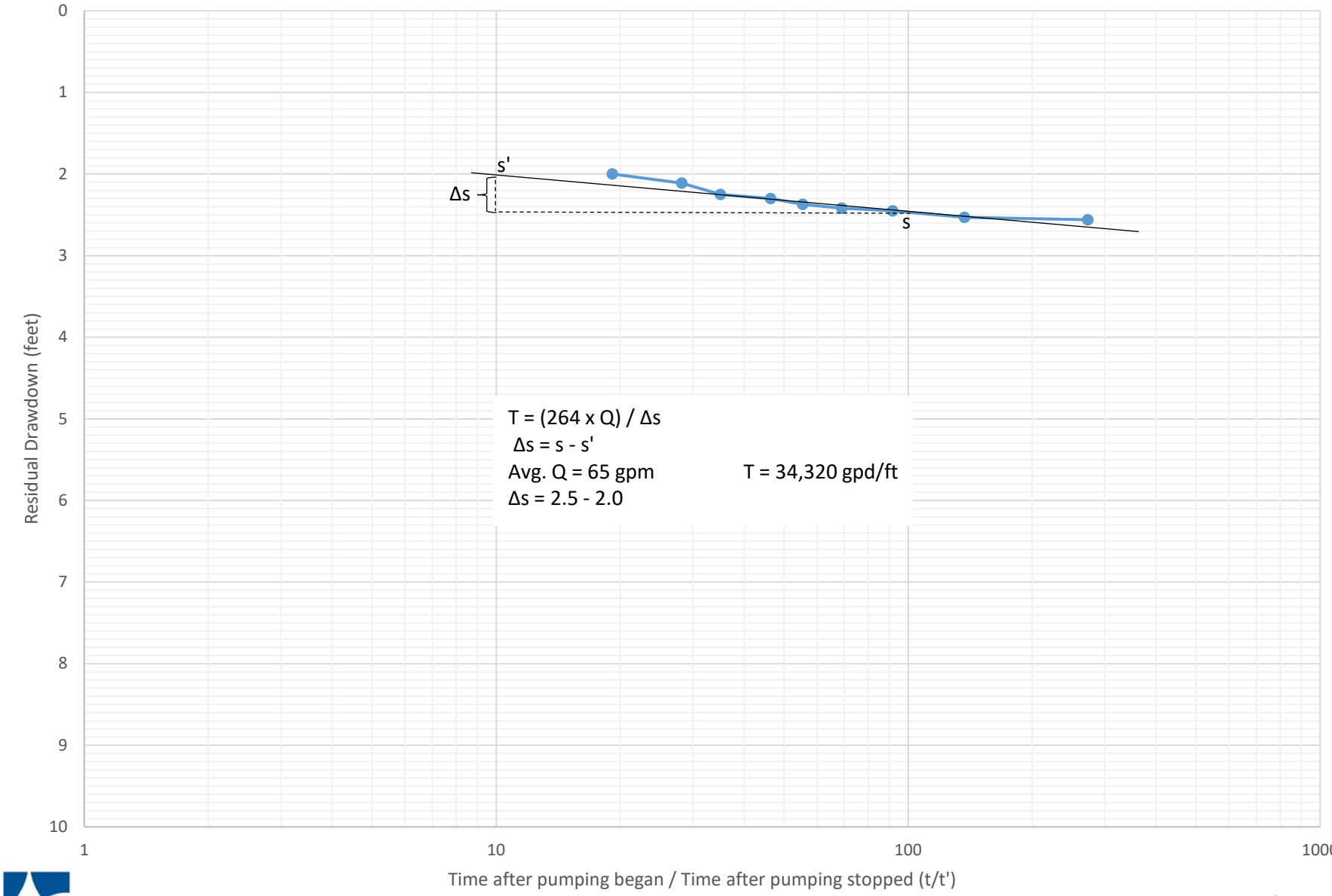
Appendix C

Aquifer Test Graphs



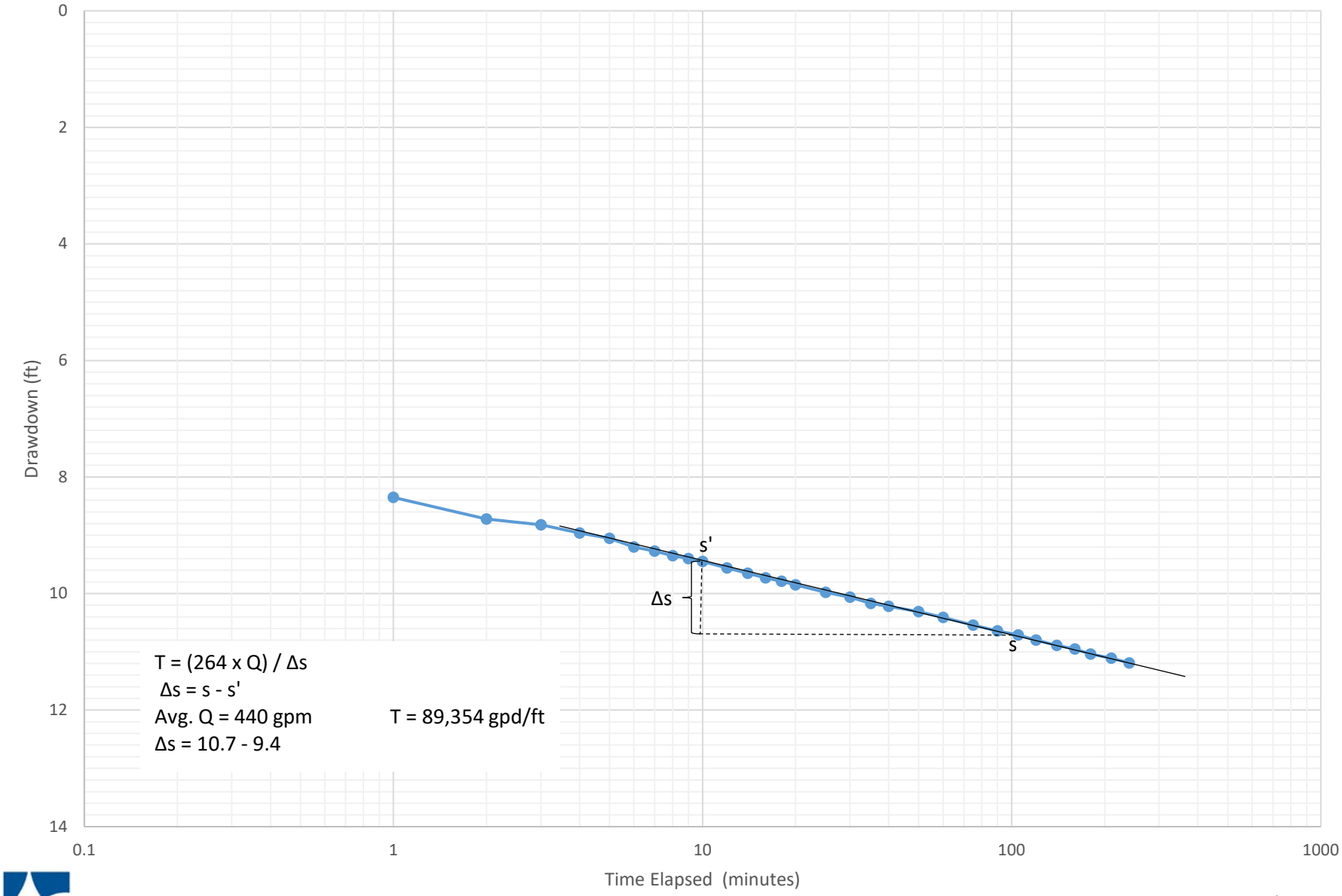
GSI Water Solutions, Inc.

Figure C1
Santa Maria Basin Fringe Areas
Arroyo Grande Biddle Domestic Well Constant Rate Test



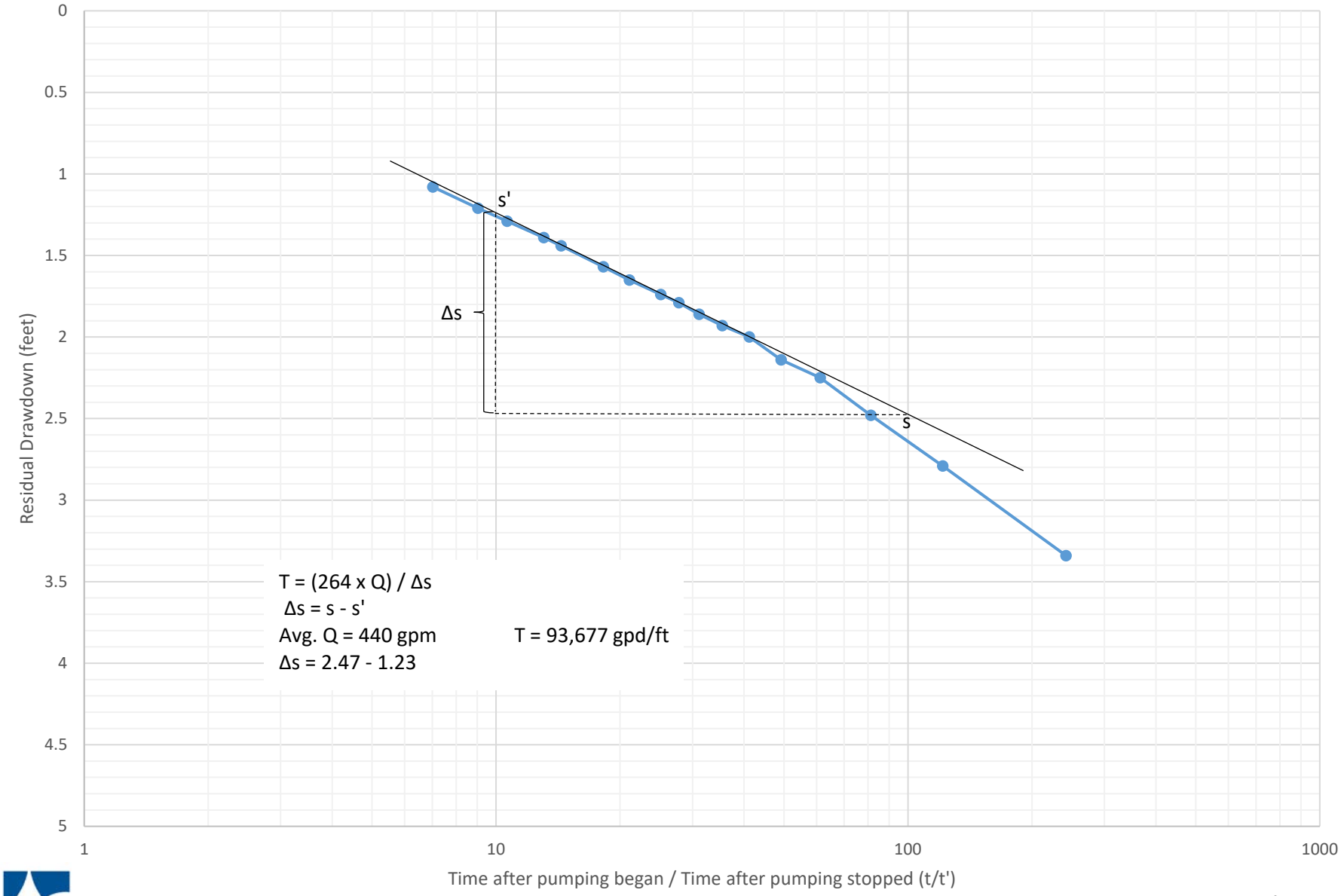
GSI Water Solutions, Inc.

Figure C2
Santa Maria Basin Fringe Areas
Arroyo Grande Biddle Domestic Well Recovery Test



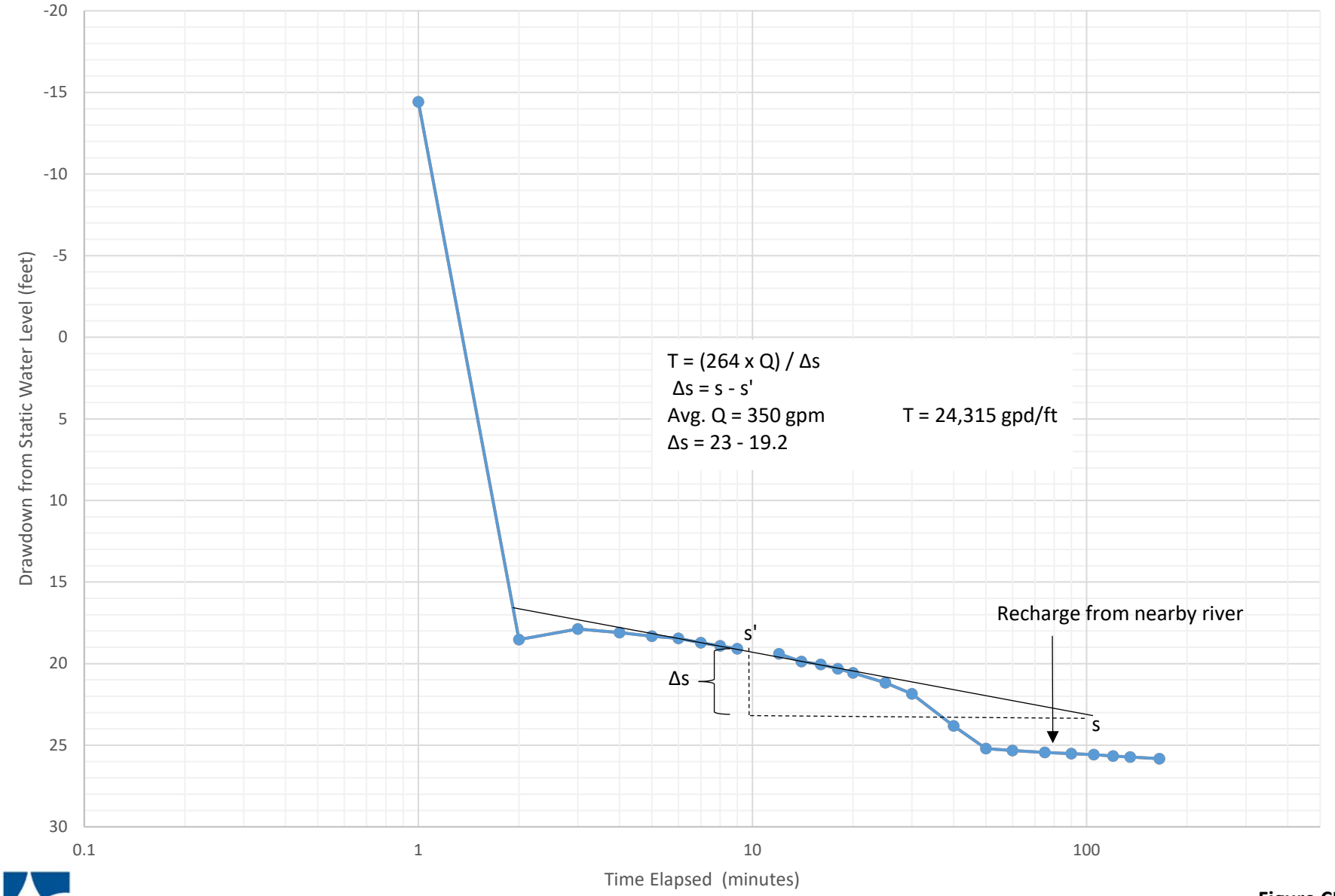
GSI Water Solutions, Inc.

Figure C3
Santa Maria Basin Fringe Areas
Arroyo Grande Huasna Road Well Constant Rate Test



GSI Water Solutions, Inc.

Figure C4
Santa Maria Basin Fringe Areas
Arroyo Grande Huasna Road Well Recovery Test



GSI Water Solutions, Inc.

Figure C5
Santa Maria Basin Fringe Areas
Ziegler Canyon Tantara Well Constant Rate Test

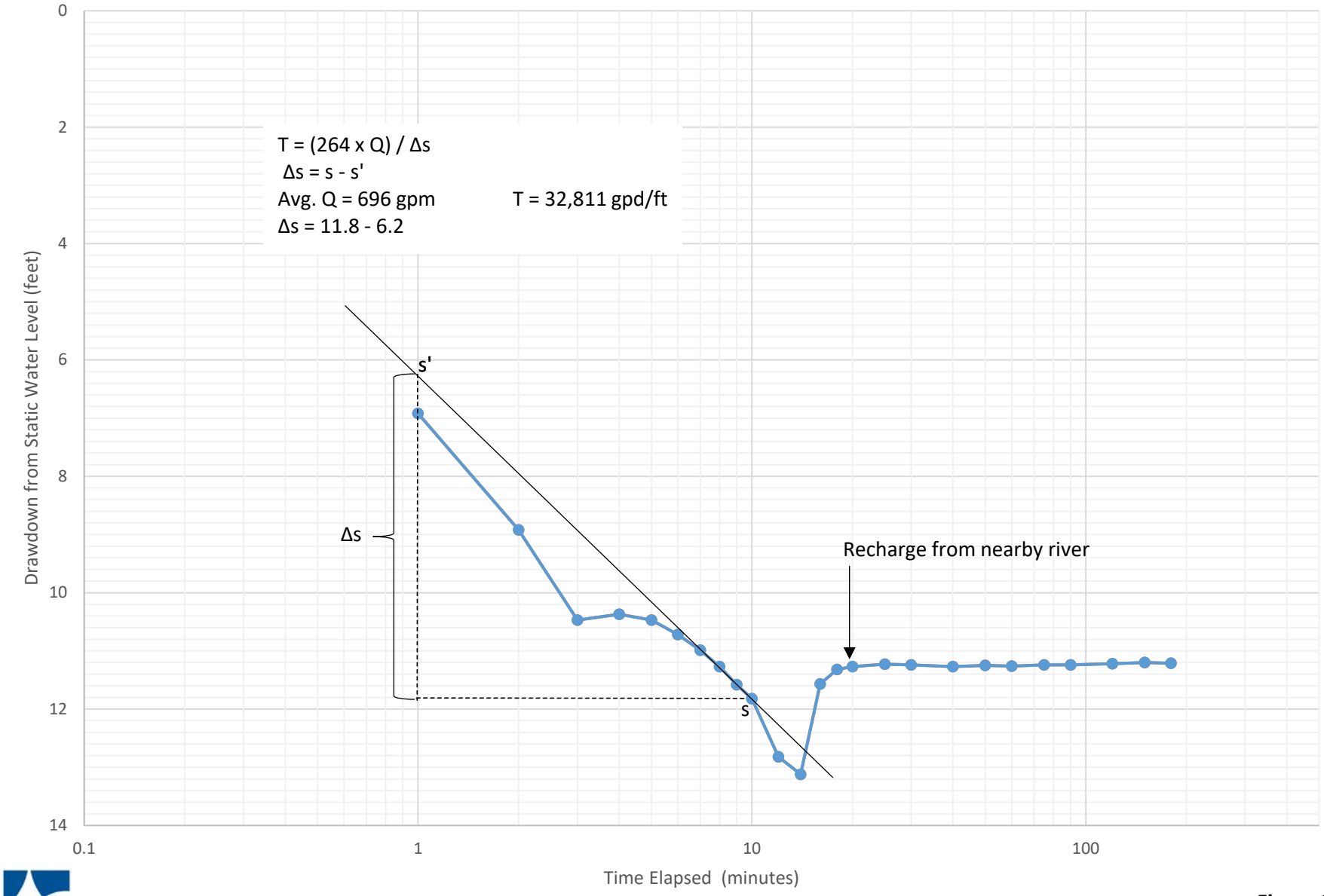
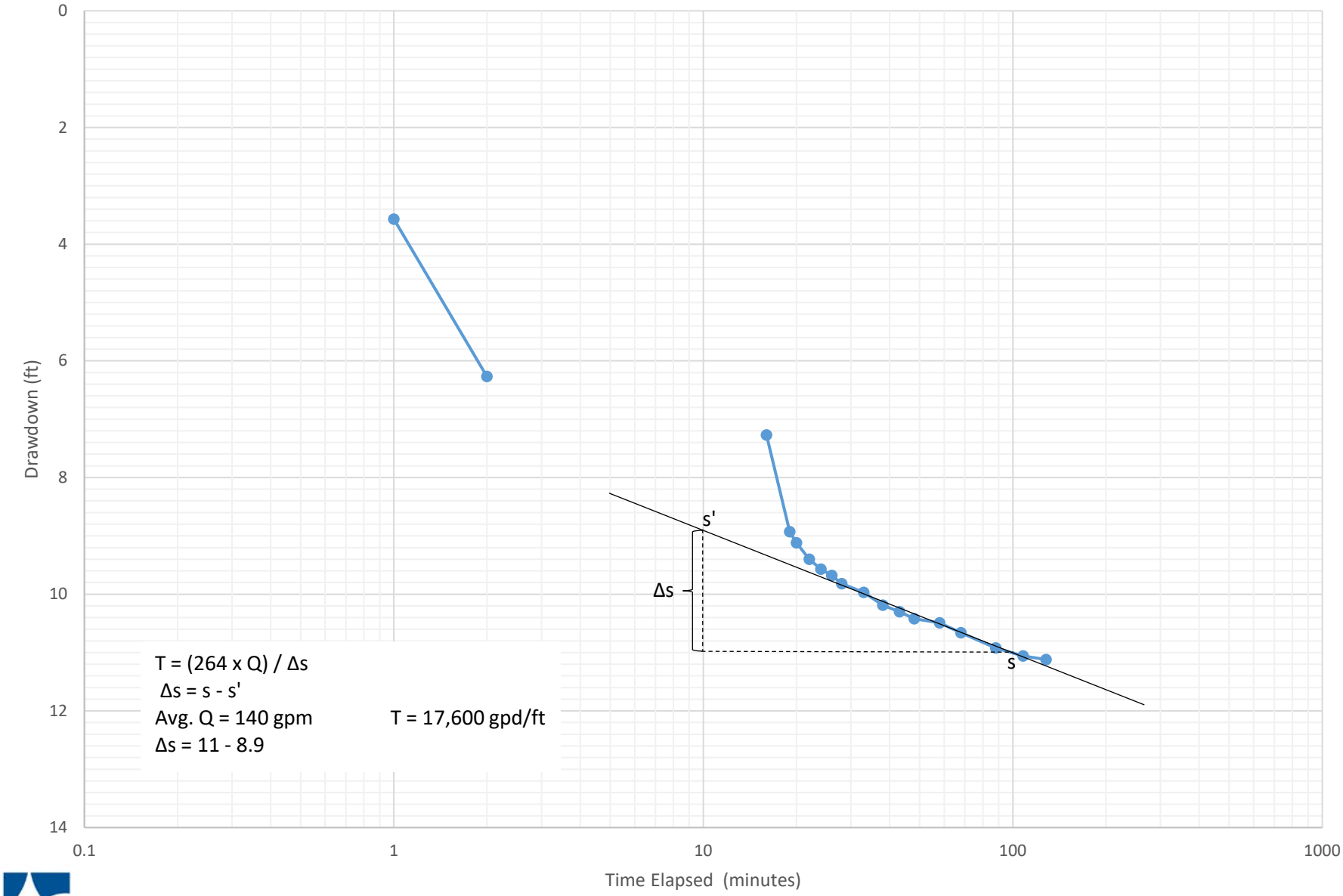
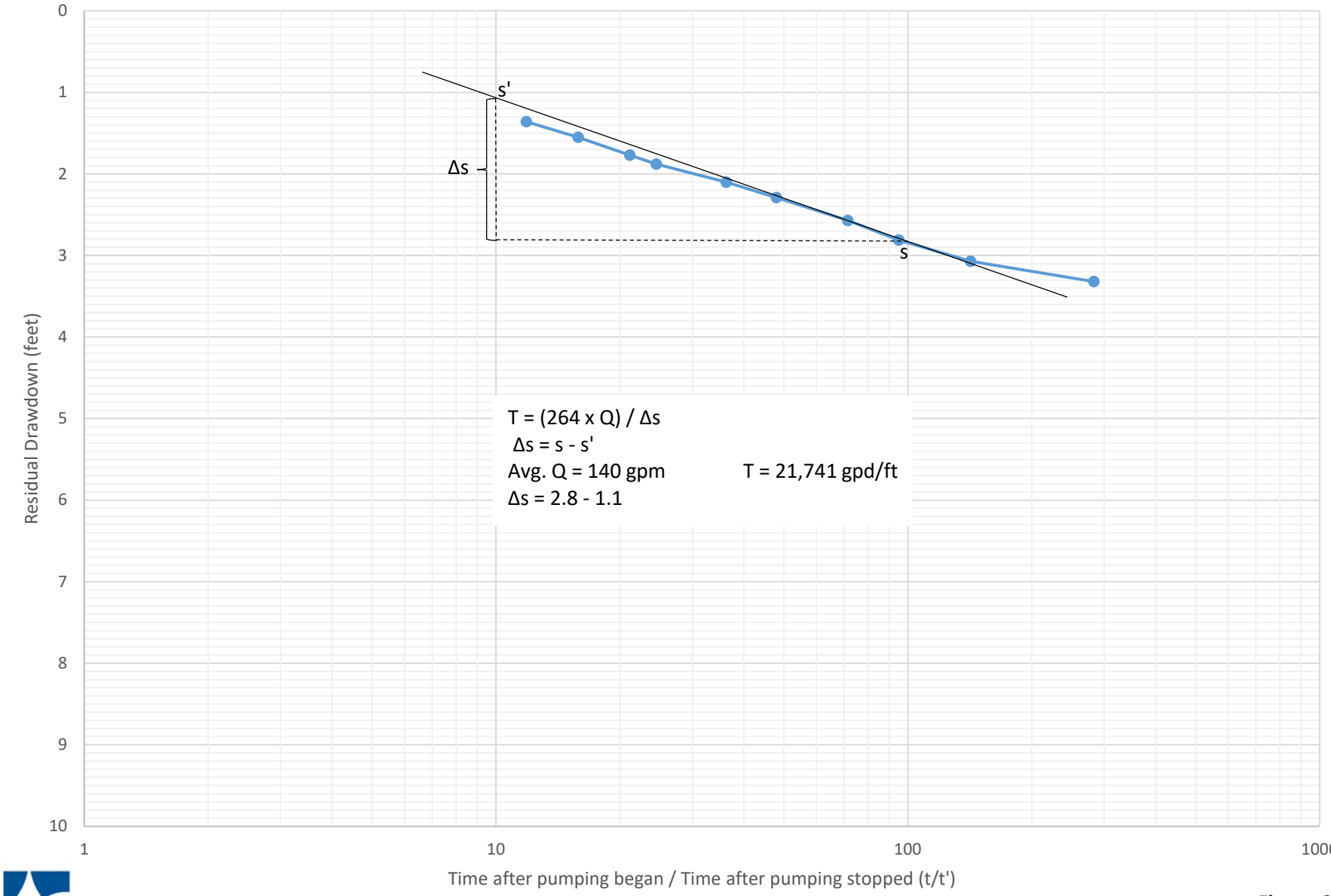


Figure C6
Santa Maria Basin Fringe Areas
Ziegler Canyon Well 1P Constant Rate Test



GSI Water Solutions, Inc.

Figure C7
Santa Maria Basin Fringe Areas
Ziegler Canyon Well 3P Constant Rate Test



GSI Water Solutions, Inc.

Figure C8
SLO Basin Characterization
Ziegler Canyon Well 3P Recovery Test

Appendix D

Cuyama River Valley (Ziegler Canyon) Fringe Area Geophysics-TDEM Technical Report

Intended for
San Luis Obispo County Flood Control and Water Conservation District

Document type
Technical Report

Date
December 2017

CUYAMA RIVER VALLEY FRINGE AREA
GEOPHYSICS - TDEM

RAMBOLL

CUYAMA RIVER VALLEY FRINGE AREA GEOPHYSICS - TDEM

Revision	**1**
Date	**12/12/2017**
Made by	**Max Halkjaer, Peter Thomsen**
Checked by	**Joakim Westergaard**
Approved by	**Max Halkjaer**
Description	**Technical Report**
[Optional 1]	**Cuyama River Valley Fringe Area Geophysics - TDEM**

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https://projects.rambollgrp.com/projects/1100030175/Project Documents/20170926_Report_CuyanaRiver_TDEM.docx

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FIGURES

ANNEX

1. INTRODUCTION

This is a technical report describing a geophysical survey in the lower part of Cuyama River valley where it reaches the Santa Maria Valley groundwater basin.

The scope of work has been to develop insight in the hydrogeological connection between the side valley and the main basin. The geophysical method Time Domain Electromagnetics (TDEM) has been applied. It is a none invasive method, where soundings will show the variations in the resistivity of the geological layers.

The geophysical results will enter into other hydrogeological investigations to create fundamental knowledges about the hydraulic conditions and layer connectivity in the area.

1.1 Survey area

The survey area is located 8 miles southeast of Santa Maria at the lower part of Cuyama River. The area is dominated by vineyards. The location of the survey area is shown at Figure 1.

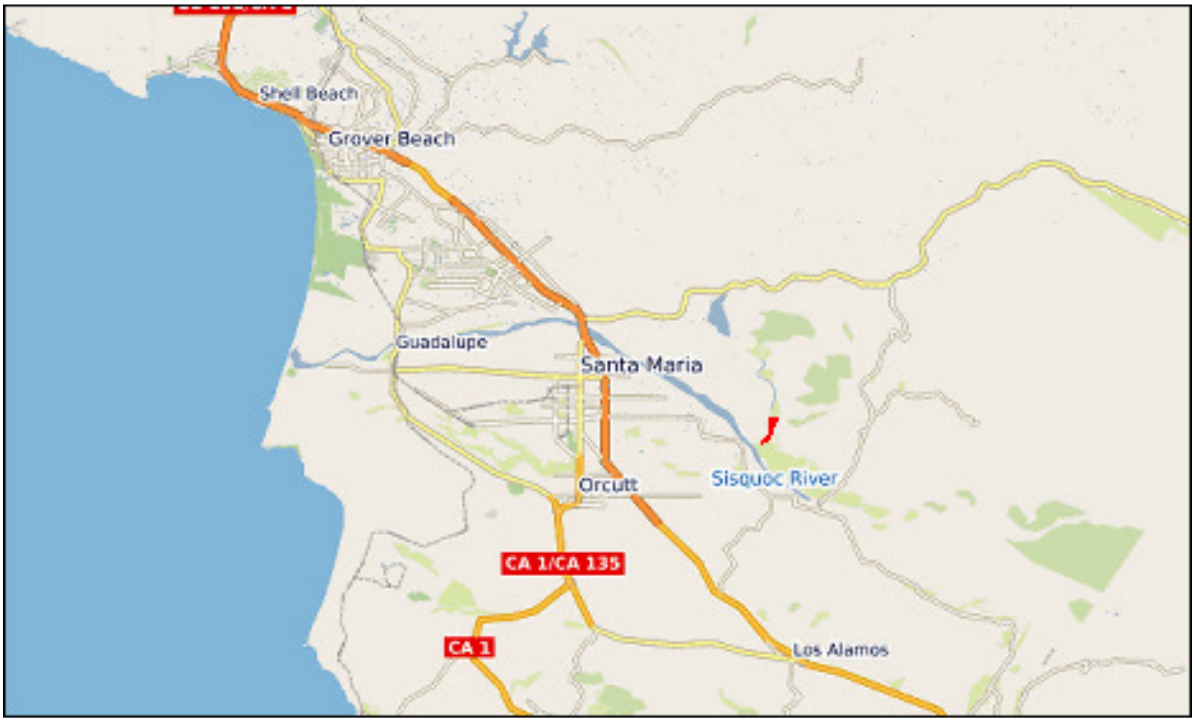


Figure 1 Survey area marked with red

2. METHOD AND INSTRUMENTATION

Time Domain Electromagnetics (TDEM) is a geophysical survey technique used frequently in groundwater exploration.

TDEM soundings yield insight in the resistivity (or the reciprocal, the conductivity) of the survey area. The resistivity can be related to the subsurface conditions, being lithology, saturation and ground water composition (i.e salinity). The measured values are presented in Ohm-m. In general dry and/or unsaturated lithology's (dry sand and gravel) will yield high resistivity values. As sediments becomes saturated the resistivity will decrease, these values will further decrease if the groundwater contains dissolved salts. Less permeable clays results in low resistivity values, silt will yield intermediate values.

When interpreting resistivity data it is important to include 'ground truth' data, because the measured values can reflect different combinations of lithology and groundwater quality. For example a sand layer saturated with brackish groundwater can show the same resistivity values as a clay layer saturated with fresh water.

The technique deployed at Cuyama River is a so-called 1D survey technique. Data is collected per station which can be seen as a single (1D) location; however the measured value will reflect a footprint and hence an average of a volume of soil.

2.1 Principles of TDEM

A direct current (DC) is build up in a transmitter loop. When the current is stable the current is abruptly turned off. The process of abruptly reducing the transmitter current to zero induces a short-duration voltage pulse in the ground, which creates current in the subsurface. The amplitude of the current flow as a function of time is measured by measuring its decaying magnetic field (the secondary magnetic field) using a receiver coil located at the centre of the transmitter loop.

2.2 Instrumentation

The survey at Cuyama River Valley Fringe was executed using a WalkTEM unit manufactured by Guideline Geo, Figure 2.

Figure 2 WalkTEM. The transmitter and the receiver is combined in one instrument that can be hand carried from site to site.

For the specific survey a single loop transmitter with a size of 40x40 m (ø2.5 mm^2) has been applied, Figure 3.

The receiver coil is a two turn wire in a 10x10m loop in the centre of the transmitter loop. The receiver coil has a low pass filter characteristic of 150 kHz.

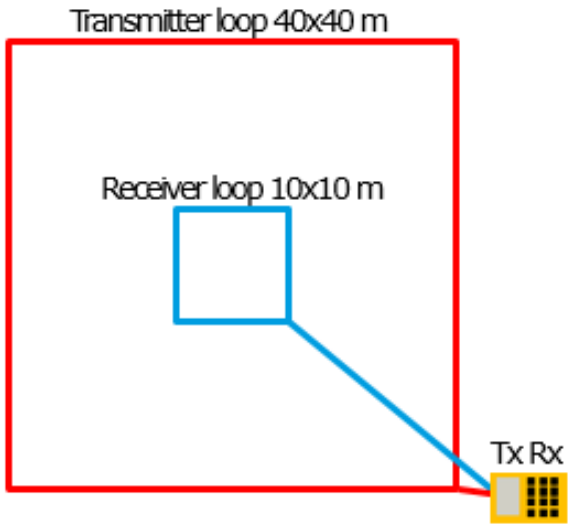


Figure 3 System setup for Cuyama River survey

Transmitter for low moment was approx. 1 Amp, and for high transmitter moment it was 7 Amp.

2.3 GPS positioning

Handheld GARMIN 62S. The G625 has accuracy in the range of +/-5m which is satisfactory when taking the footprint and the uncertainties for the TDEM system into account.

The GPS position is measured in the centre of the receiver/transmitter loop.

3. FIELD WORK

The field operation was carried out from the 25th to the 27th of September 2017. Field crew was Max Halkjær and Peter Thomsen from Ramboll. David O'Rourke from GSI Water Solutions was supervising and there was no problem with instrumentation or access during data acquisition.

Figure 4 Data acquisition

As the TDEM methods require a safe distance to powerlines, metal fence and other metal object it has been a challenge to locate site in the valley, especially due to the presents for vineyards in the area. The location of the 36 soundings are listed in Table 3.1 below (projection: NAD83 / California zone 5 (ftUS), EPSG: 2229). Note that there is no sounding no. 23.

Table 3.1 Position of the 36 TDEM from Cuyama River. NAD83 / California zone 5 (ftUS), EPSG: 2229

Sounding number	UTM - X	UTM - Y
01	5874601	2166039
02	5874570	2166205
03	5874635	2166306
04	5874544	2165940
05	5874508	2165807
06	5874459	2165694
07	5874407	2165572
08	5874373	2165462
09	5874078	2165283
10	5873961	2165191
11	5873818	2165073
12	5873714	2164973
13	5873512	2165134
14	5873672	2164854
15	5873370	2164925
16	5871425	2160087
17	5873629	2164718
18	5873341	2164739
19	5873371	2164606
20	5873348	2164469
21	5873363	2164318
22	5873502	2164261
24	5873478	2164121
25	5873446	2164011
26	5873387	2163936
27	5873425	2163714
28	5874136	2166453
29	5873307	2166547
30	5873212	2166430
31	5873116	2166280
32	5873052	2166119
33	5872749	2161098
34	5872852	2161191
35	5873093	2161727
36	5873031	2161619
37	5873108	2165190

At Figure 5 the location of the 36 TDEM are shown on an aerial photo. Many of the soundings are collected “side by side” with a distance between soundings at 40 meter.

Figure 5 Location of the 36 TDEM in Cuyama River. Note that No. 23 is missing.

4. PROCESSING AND INVERSION

4.1 Data flow

Data are uploaded from the WalkTEM unit to PC. Data are processed using the SPIA version 2.3.1 software packages from University of Aarhus. This software is specially designed for processing and inversion of TDEM-soundings.

Data are merged with GPS position. Data influenced by noise from man-made installations are cruelled. Finally the data are filtered and averaged. For the TDEM at Cuyama River the S/N level is relatively high and data are of general high quality.

Inversion is performed by applying a multilayer approach (smooth), using 30 layers model with fixed layer boundaries. In the inversion scheme, the thickness of each layer is constant and only resistivity can vary within each layer. The result is a smooth transition from layer to layer. This type of inversion is unbiased as the inversion scheme starts out with a homogenous half space. The initial resistivity is 50 ohmmeter for all layers as a starting model.

All data curves and inversion results are attached as Annex1.

5. RESULTS

The inverted models are presented as model sections and as mean resistivity in depth intervals.

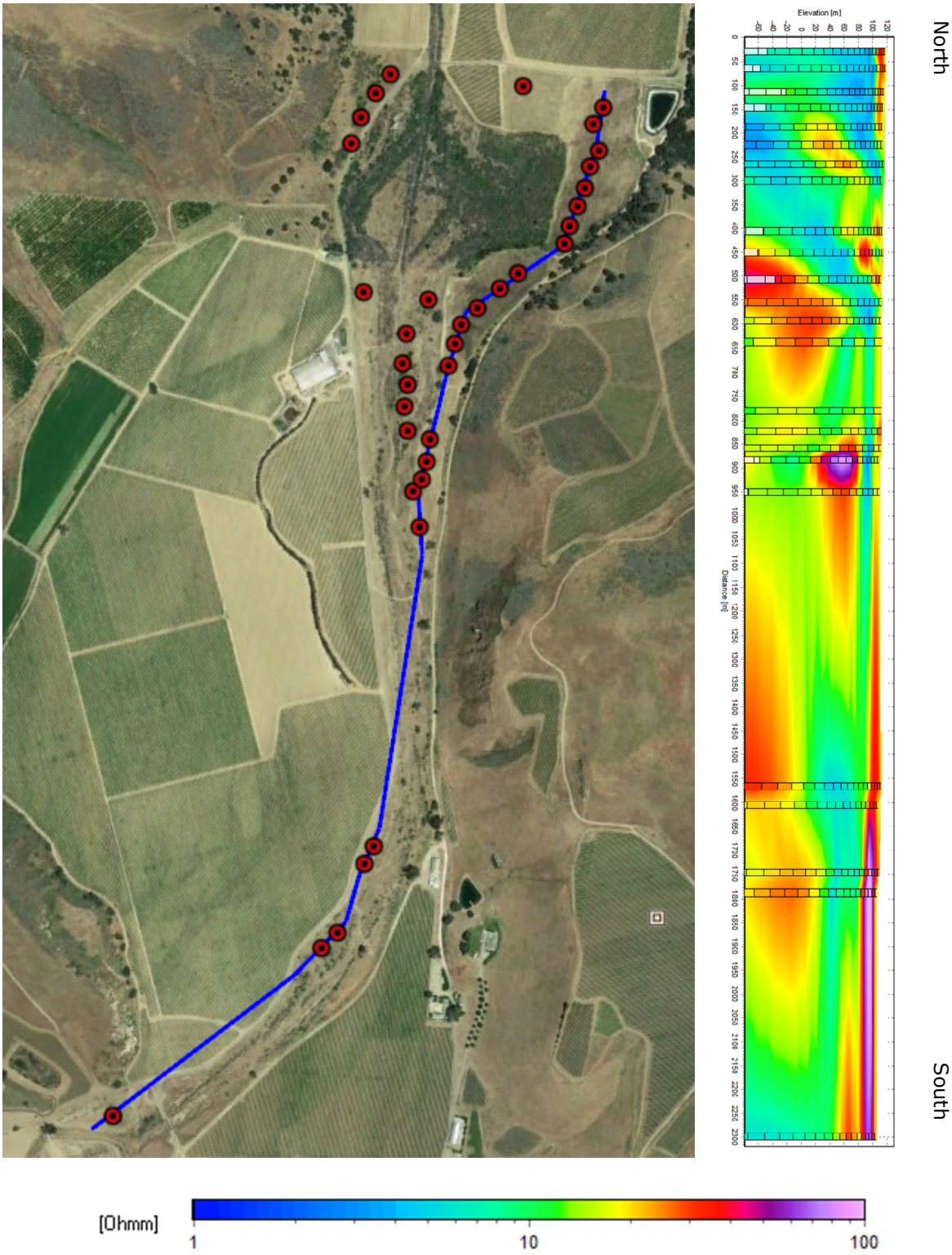


Figure 6 Model section 1

At Figure 6 a cross section from north to south is presented. From north and 600 m south dipping layers with varying resistivity can be identified. Layers are dipping towards north and have alternating low and high resistivity. From around 600 m the resistivity indicates more layered

geology and from the sounding at 1550 m a top high resistive layer with a thickness at around 10 m is determined.

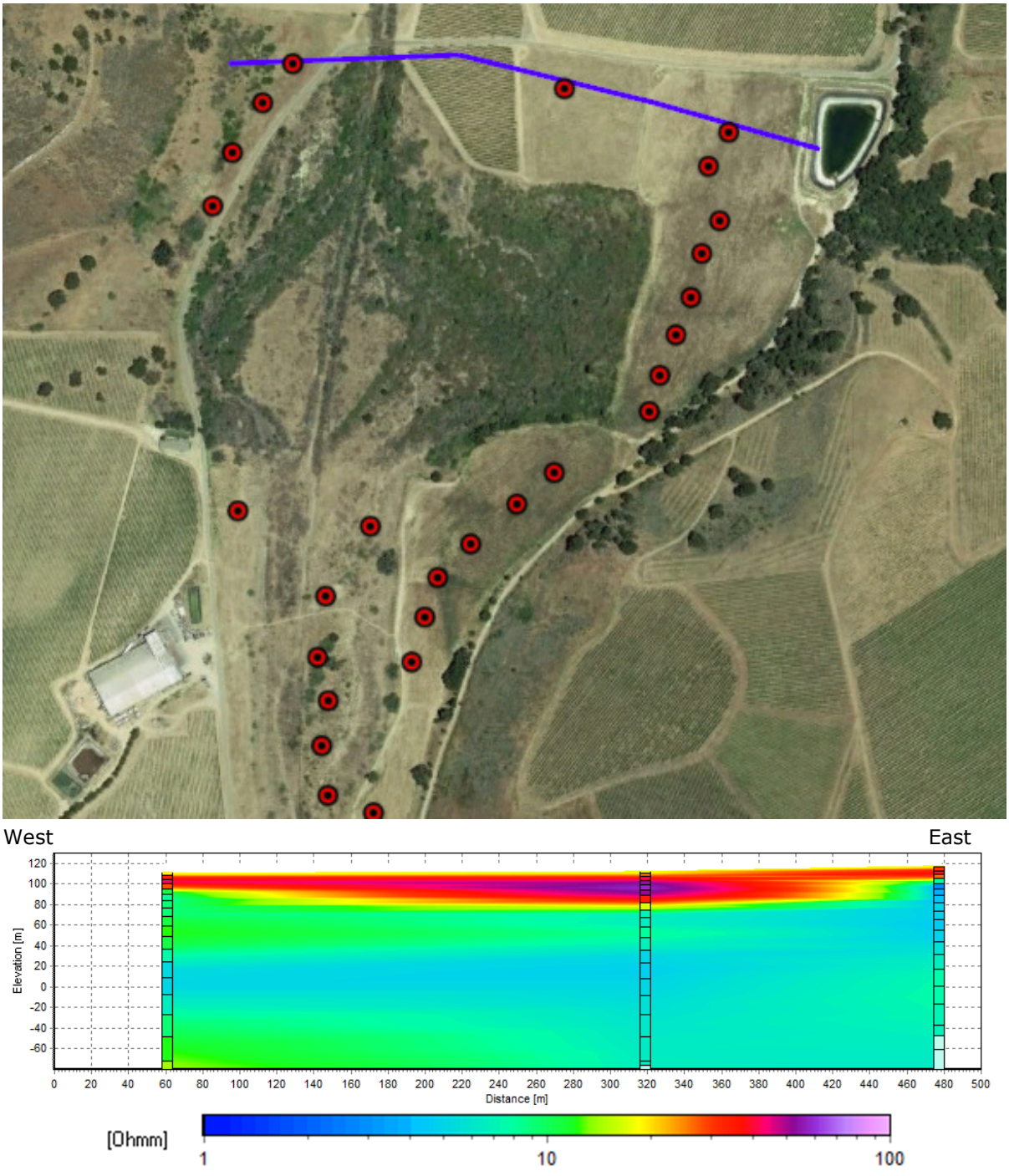


Figure 7 Model section 2

Model section 2, Figure 7 is located in the northern part of the area and is orientated from west to east. There are only three TDEM sounding shown on the section, indicating a top high resistive and high permeable layer, with a thickness at around 10 m to 20 m. Below this layer the resistivity drops to around, or below 10 ohm-m indicating less permeable sediments.

At Figure 8 model section 3 is shown from north to south. As for section 2 a high resistive layer can be seen in the upper 10 m to 20 m. In the lower part it seems like layers are dipping towards north, in accordance to what was mapped along model section 1.

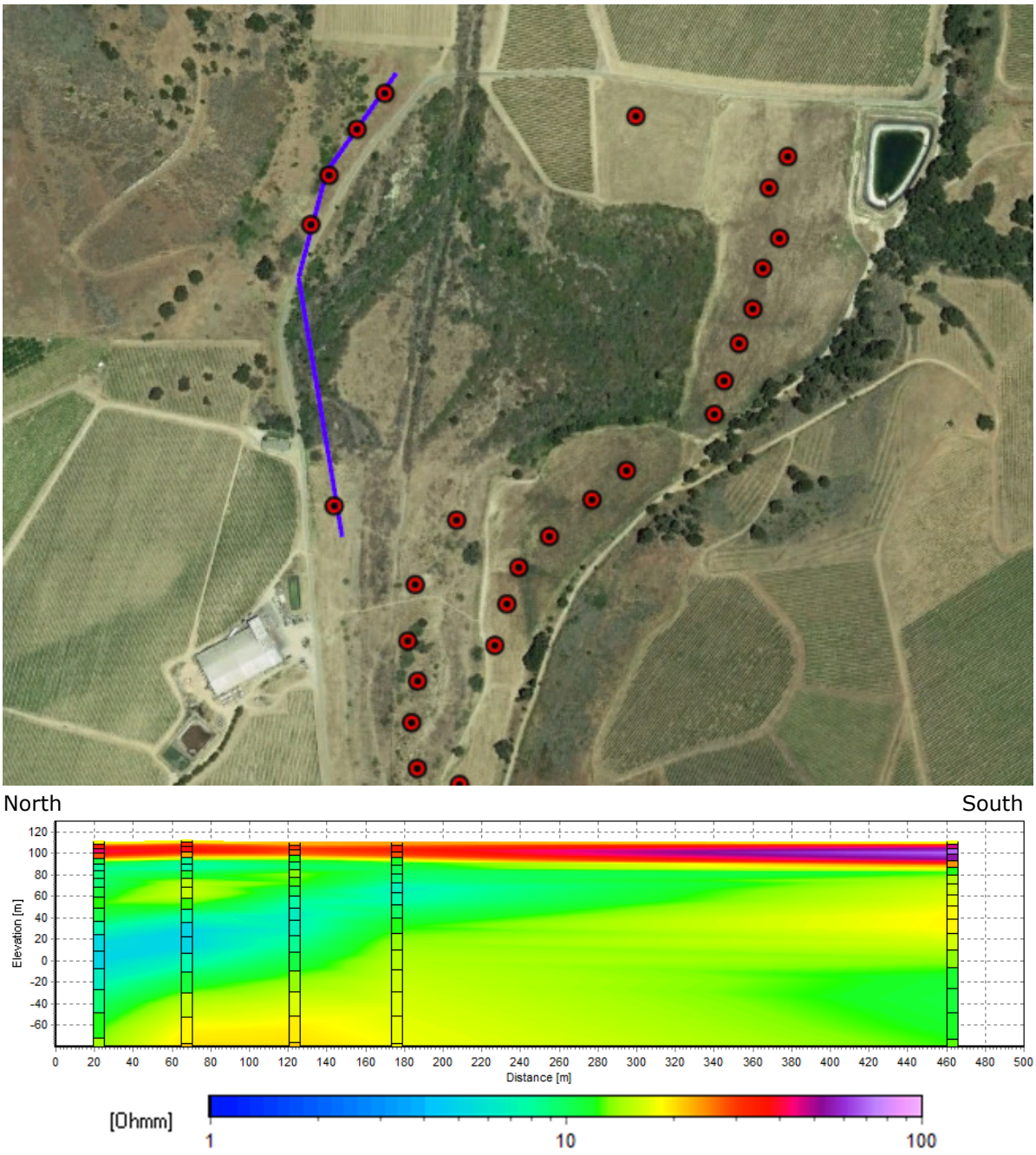


Figure 8 Model section 3

Model section 4, Figure 9, is also presented from north to south. At this section the top resistive layer is less than 10 m thick, decreasing in resistivity towards south. Towards north dipping layers can be seen in the northern half of the section, while the southern half is characterized with more horizontal layers.

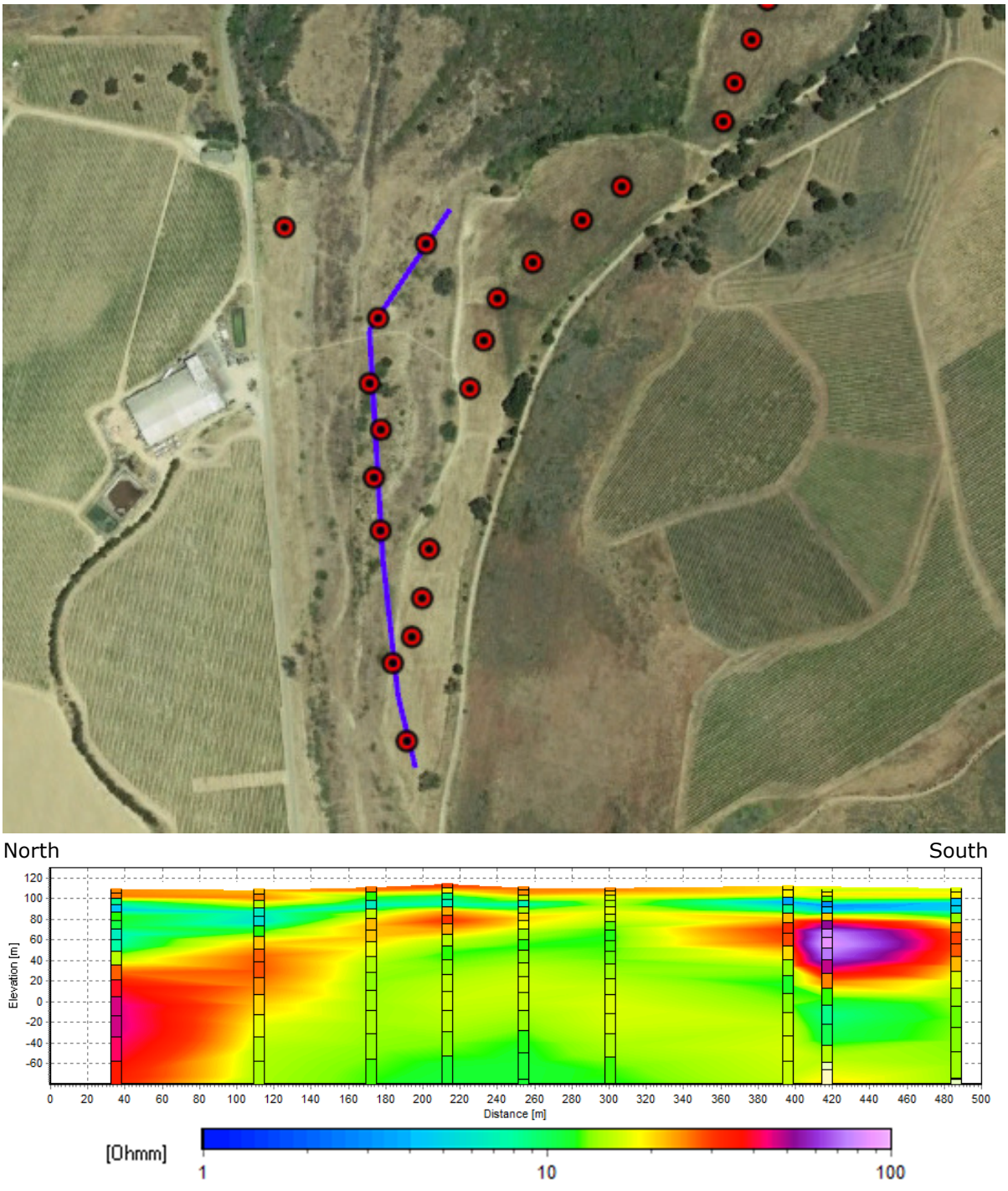


Figure 9 Model section 4

At Figure 10 a short cross section from west to east is shown. At this section the top high resistive layer is interpreted, especially in the western part of the section. In the central and for the most eastern sounding a high resistive layer is identified below a layer with resistivity at around 10 oh-m. This layer is assumed to have a high hydraulic conductivity.

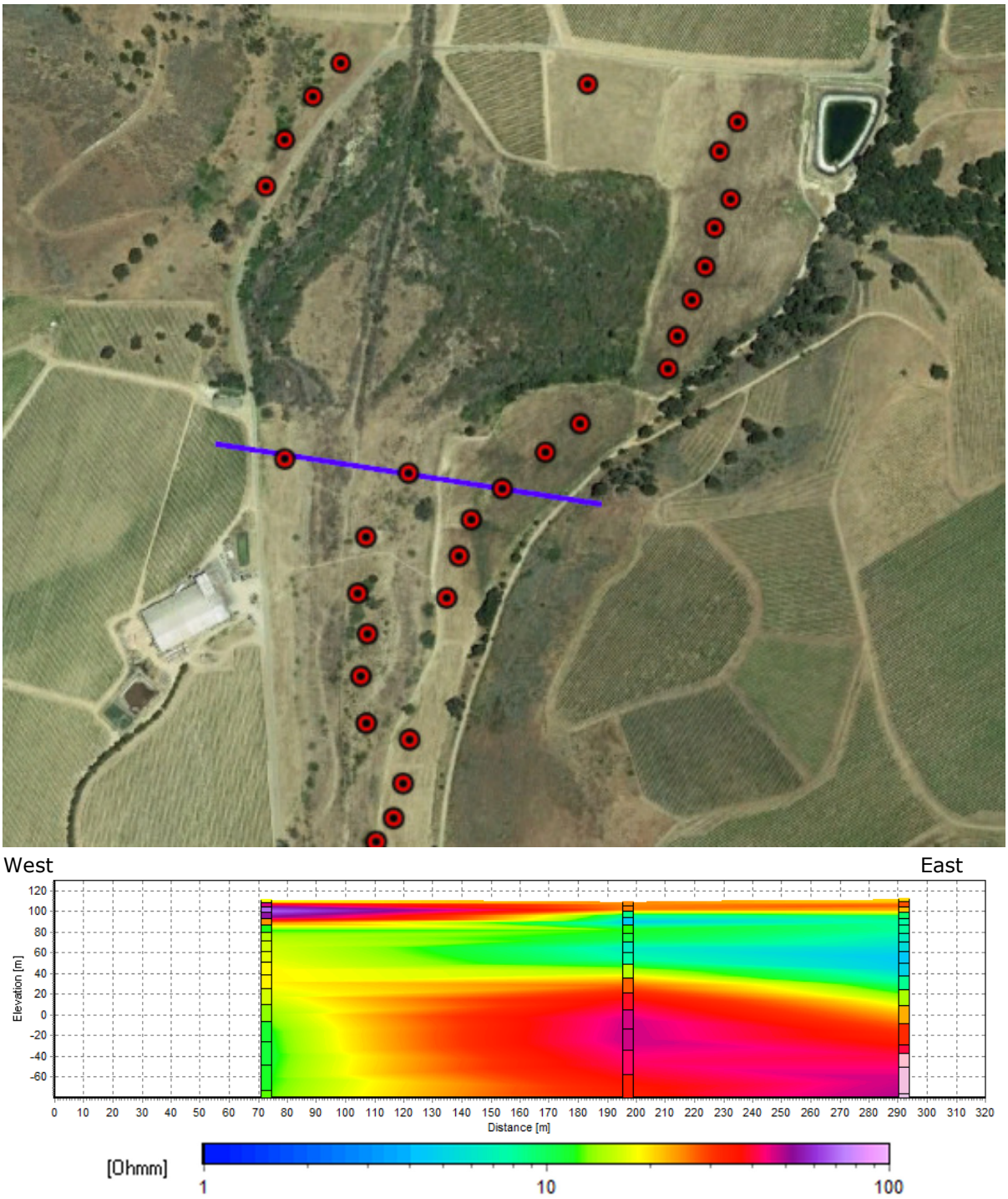


Figure 10 Model section 5

At Annex 2.01 and 2.02 the mean resistivity in depth intervals with a thickness of 10 m is shown. From Annex 1.01 the high resistive top layer is identified as soundings with high resistivity in the depth interval from 0 to 10 m. From depth 10 to 20 m, only a few sounding still have high resistivity especially in the southern part of the area (South part of section 1, Figure 6). From depth 30 m, some of the soundings are interpreted with high resistivity, indicating layers with higher hydraulic conductivity in depth.

The mean resistivity maps generally show large variations within short distances. This clearly indicates that the geology is highly variating from more or less impermeable layers to layers with higher hydraulic conductivity.

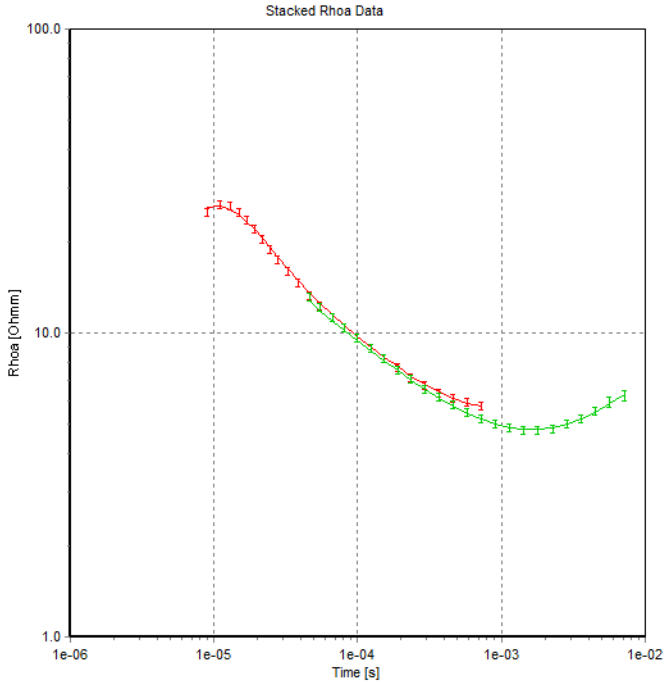
6. CONCLUSION

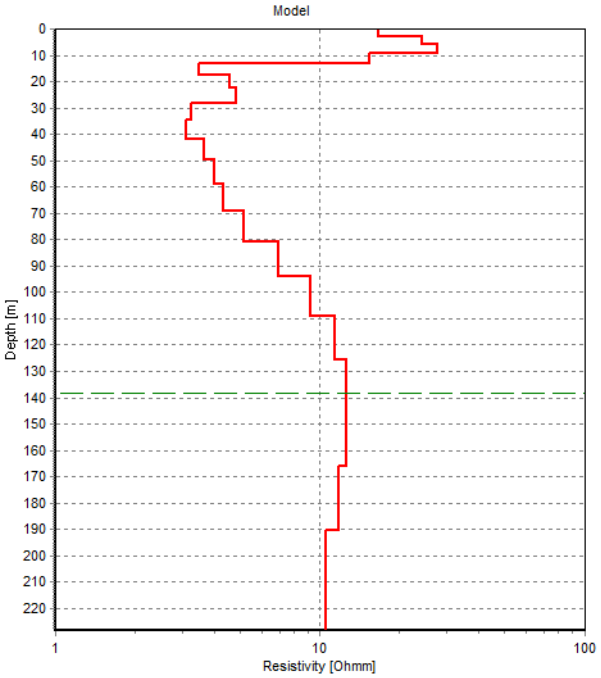
Based on the collected TDEM data a general understanding of a varying geology in the area is obtained. Result may indicate that there is a barrier between the upper part of that Cuyama River Valley Fringe and the Santa Maria Valley groundwater basin. By combining the TDEM results with borehole information it will be possible to obtain a more integrated interpretation of the hydrogeological settings.

Station 01

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5874601
UTMY: 2166039
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 138m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	16.7	1.30	2.72	1.001	2.72	1.001
2	24.1	1.42	3.07	1.001	5.79	1.001
3	27.7	1.47	3.47	1.001	9.26	1.001
4	15.4	1.37	3.91	1.001	13.2	1.000
5	3.48	1.13	4.42	1.001	17.6	1.000
6	4.57	1.24	4.99	1.001	22.6	1.000
7	4.8	1.32	5.63	1.001	28.2	1.000
8	3.27	1.28	6.36	1.001	34.6	1.000
9	3.12	1.31	7.18	1.001	41.7	1.000
10	3.65	1.38	8.1	1.001	49.8	1.000
11	4	1.42	9.15	1.001	59	1.000
12	4.3	1.44	10.3	1.001	69.3	1.000
13	5.18	1.48	11.7	1.001	81	1.000
14	6.92	1.55	13.2	1.001	94.2	1.000
15	9.24	1.62	14.9	1.001	109	1.000
16	11.4	1.67	16.8	1.001	126	1.000
17	12.6	1.72	19	1.001	145	1.000
18	12.6	1.83	21.4	1.001	166	1.000
19	11.7	2.05	24.1	1.001	190	1.000
20	10.5	2.46				





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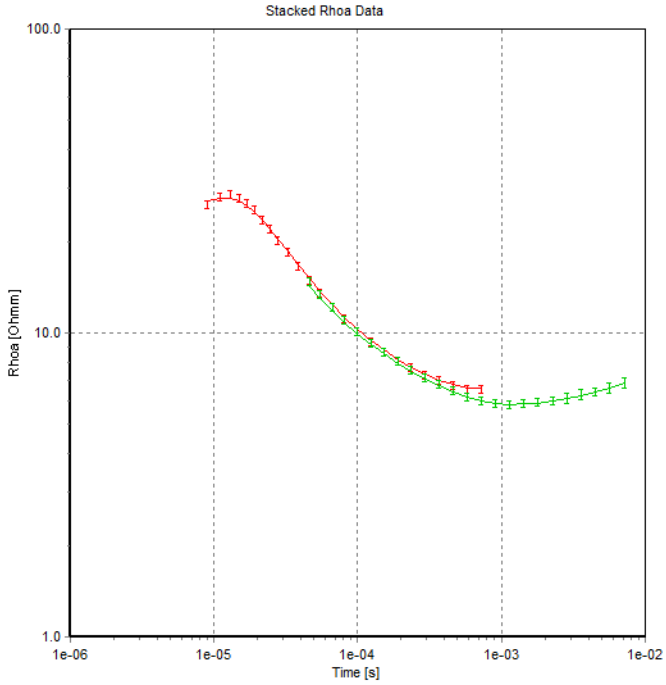
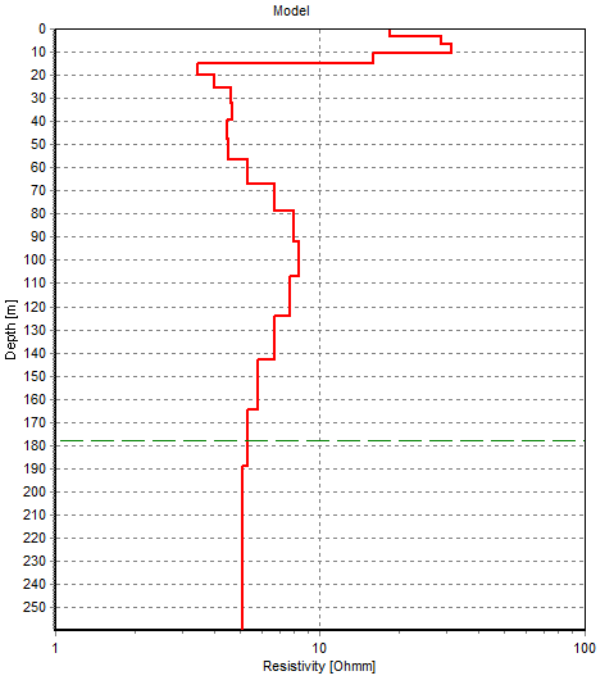
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 178m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	18.3	1.29	3.1	1.001	3.1	1.001
2	28.5	1.41	3.49	1.001	6.59	1.001
3	31.4	1.44	3.95	1.001	10.5	1.001
4	15.9	1.35	4.45	1.001	15	1.000
5	3.46	1.11	5.03	1.001	20	1.000
6	4	1.20	5.68	1.001	25.7	1.000
7	4.62	1.30	6.41	1.001	32.1	1.000
8	4.65	1.34	7.24	1.001	39.3	1.000
9	4.45	1.36	8.17	1.001	47.5	1.000
10	4.49	1.38	9.23	1.001	56.7	1.000
11	5.34	1.44	10.4	1.001	67.2	1.000
12	6.75	1.51	11.8	1.001	78.9	1.000
13	7.94	1.56	13.3	1.001	92.2	1.000
14	8.28	1.59	15	1.001	107	1.000
15	7.72	1.58	16.9	1.001	124	1.000
16	6.74	1.55	19.1	1.001	143	1.000
17	5.85	1.58	21.6	1.001	165	1.000
18	5.3	1.77	24.4	1.001	189	1.000
19	5.09	2.23	27.5	1.001	217	1.000
20	5.12	2.98				





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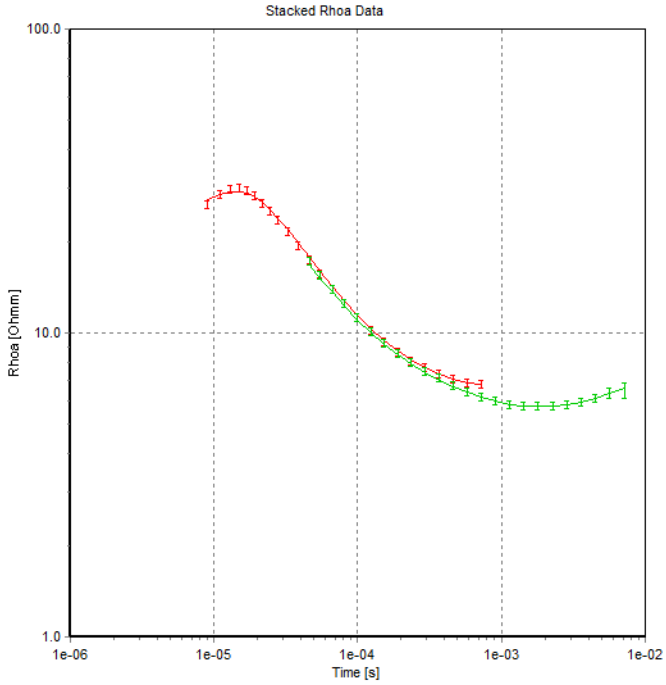
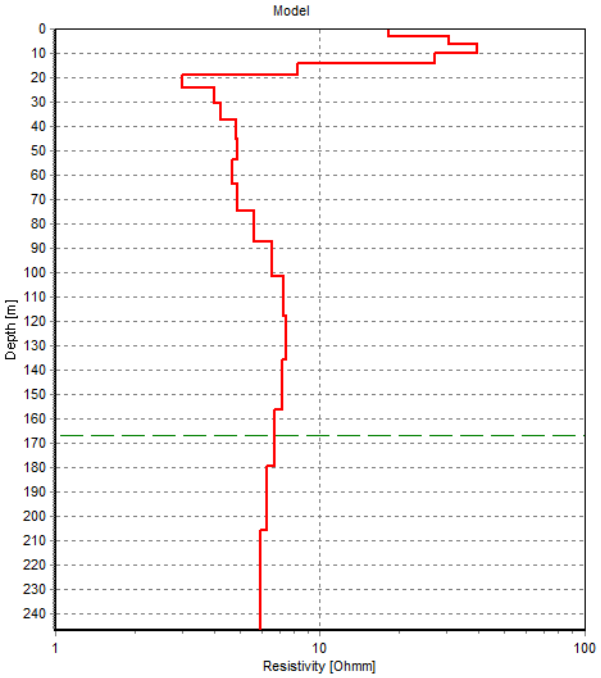
UTMY: 2166306
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 167m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	18.2	1.26	2.94	1.001	2.94	1.001
2	30.8	1.47	3.32	1.001	6.26	1.001
3	39.4	1.54	3.75	1.001	10	1.001
4	27	1.43	4.23	1.001	14.2	1.000
5	8.22	1.24	4.78	1.001	19	1.000
6	3.03	1.12	5.4	1.001	24.4	1.000
7	3.97	1.24	6.09	1.001	30.5	1.000
8	4.2	1.30	6.88	1.001	37.4	1.000
9	4.83	1.36	7.77	1.001	45.2	1.000
10	4.88	1.39	8.77	1.001	53.9	1.000
11	4.64	1.41	9.9	1.001	63.8	1.000
12	4.86	1.44	11.2	1.001	75	1.000
13	5.64	1.48	12.6	1.001	87.6	1.000
14	6.6	1.53	14.3	1.001	102	1.000
15	7.28	1.57	16.1	1.001	118	1.000
16	7.47	1.58	18.2	1.001	136	1.000
17	7.22	1.63	20.5	1.001	157	1.000
18	6.75	1.82	23.1	1.001	180	1.000
19	6.29	2.23	26.1	1.001	206	1.000
20	5.97	2.92				





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Version:	Not Available
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No. of Layers:	20
DOI:	166m
Program:	SPIA.exe, version 2.3.1.0

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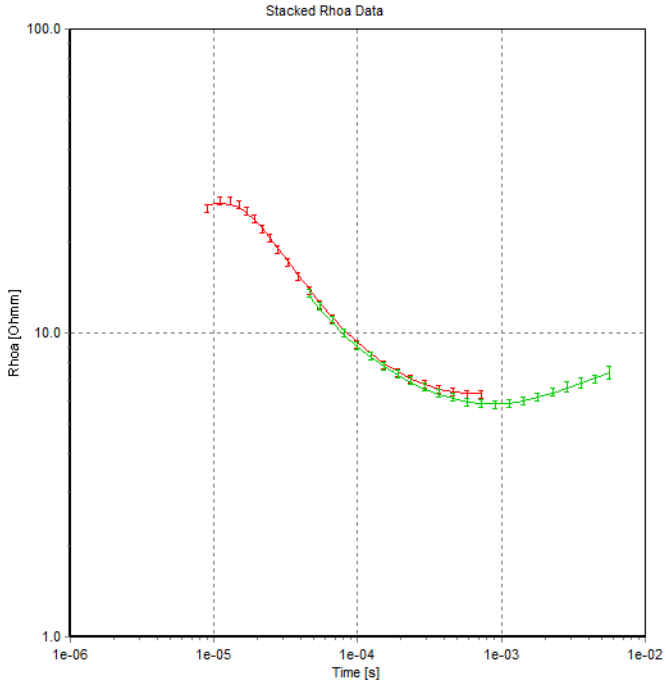
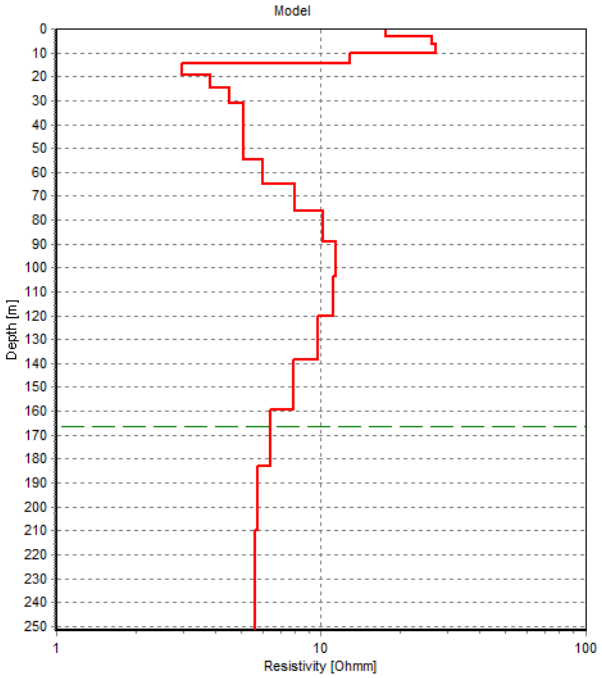
1	17.6	1.30	3	1.001	3	1.001
2	26.1	1.40	3.38	1.001	6.38	1.001
3	27.1	1.43	3.82	1.001	10.2	1.001
4	12.8	1.32	4.31	1.001	14.5	1.000
5	2.98	1.11	4.87	1.001	19.4	1.000
6	3.8	1.21	5.5	1.001	24.9	1.000
7	4.51	1.32	6.21	1.001	31.1	1.000
8	5.11	1.37	7.01	1.001	38.1	1.000
9	5.11	1.38	7.91	1.001	46	1.000
10	5.07	1.40	8.93	1.001	55	1.000
11	6.03	1.46	10.1	1.001	65	1.000
12	7.99	1.54	11.4	1.001	76.4	1.000
13	10.1	1.61	12.9	1.001	89.3	1.000
14	11.4	1.64	14.5	1.001	104	1.000
15	11.2	1.64	16.4	1.001	120	1.000
16	9.71	1.61	18.5	1.001	139	1.000
17	7.88	1.62	20.9	1.001	160	1.000
18	6.45	1.80	23.6	1.001	183	1.000
19	5.74	2.26	26.6	1.001	210	1.000
20	5.62	3.01				





Station 05

Print Date: 13-12-2017
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UTMY: 2165807
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 216m
Program: SPIA.exe, version 2.3.1.0

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1	19.1	1.21	3.64	1.001	3.64	1.001
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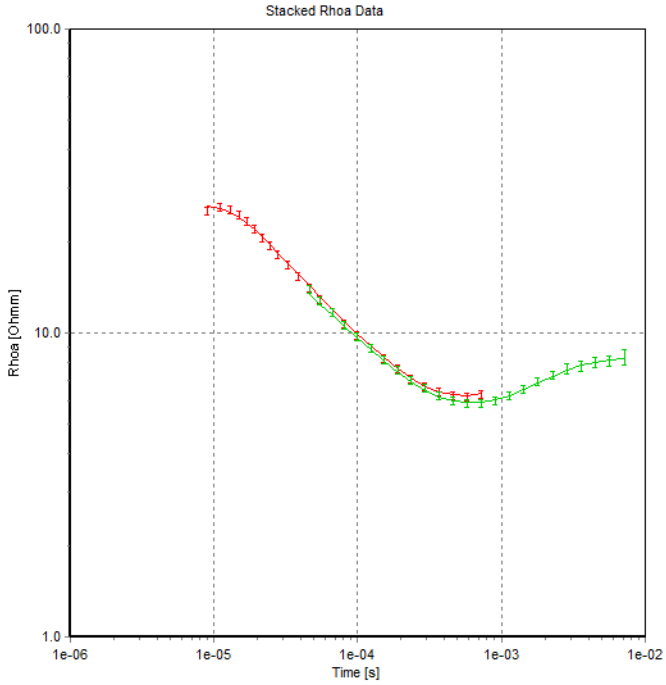
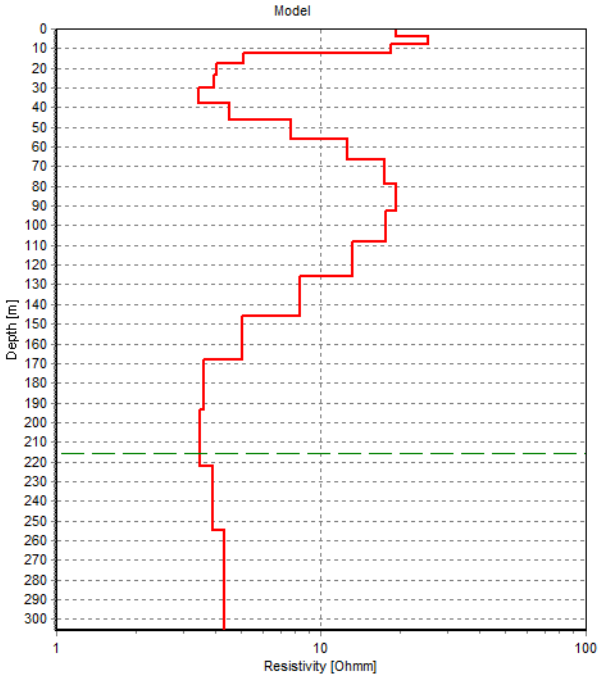
3	18.4	1.35	4.64	1.001	12.4	1.001
4	5.09	1.14	5.24	1.001	17.6	1.000
5	4.04	1.17	5.91	1.001	23.5	1.000
6	3.93	1.24	6.68	1.001	30.2	1.000
7	3.43	1.26	7.54	1.001	37.8	1.000
8	4.5	1.34	8.51	1.001	46.3	1.000
9	7.66	1.46	9.61	1.001	55.9	1.000
10	12.6	1.57	10.9	1.001	66.7	1.000
11	17.3	1.67	12.3	1.001	79	1.000
12	19.3	1.74	13.8	1.001	92.8	1.000
13	17.5	1.76	15.6	1.001	108	1.000
14	13.1	1.73	17.6	1.001	126	1.000
15	8.35	1.67	19.9	1.001	146	1.000
16	5.05	1.61	22.5	1.001	168	1.000
17	3.59	1.68	25.4	1.001	194	1.000
18	3.47	2.05	28.6	1.001	222	1.000
19	3.91	2.78	32.3	1.001	255	1.000
20	4.33	3.78				





Station 06

Print Date: 13-12-2017
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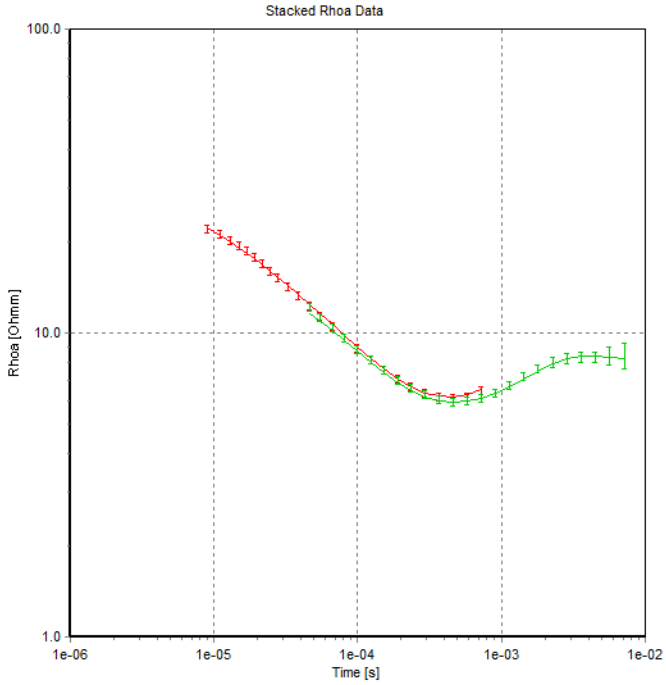
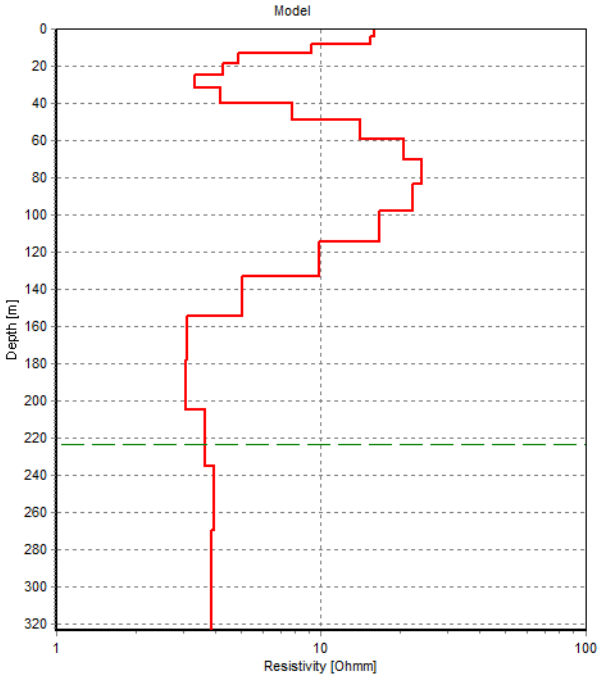
UTMY: 2165694
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 224m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	15.9	1.22	3.85	1.001	3.85	1.001
2	15.4	1.30	4.35	1.001	8.2	1.001
3	9.17	1.25	4.91	1.001	13.1	1.001
4	4.87	1.16	5.54	1.001	18.7	1.000
5	4.26	1.21	6.26	1.001	24.9	1.000
6	3.32	1.24	7.07	1.001	32	1.000
7	4.16	1.30	7.98	1.001	40	1.000
8	7.78	1.43	9.01	1.001	49	1.000
9	14	1.58	10.2	1.001	59.1	1.000
10	20.5	1.71	11.5	1.001	70.6	1.000
11	24	1.79	13	1.001	83.6	1.000
12	22.3	1.82	14.6	1.001	98.2	1.000
13	16.5	1.80	16.5	1.001	115	1.000
14	9.78	1.76	18.6	1.001	133	1.000
15	5.05	1.73	21	1.001	154	1.000
16	3.11	1.82	23.8	1.001	178	1.000
17	3.08	2.23	26.8	1.001	205	1.000
18	3.65	3.09	30.3	1.001	235	1.000
19	3.93	4.27	34.2	1.001	270	1.000
20	3.86	5.44				

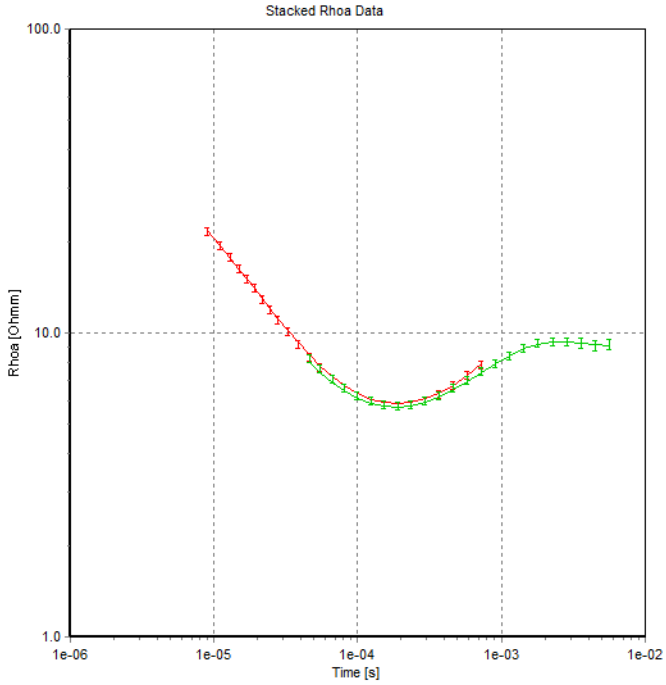


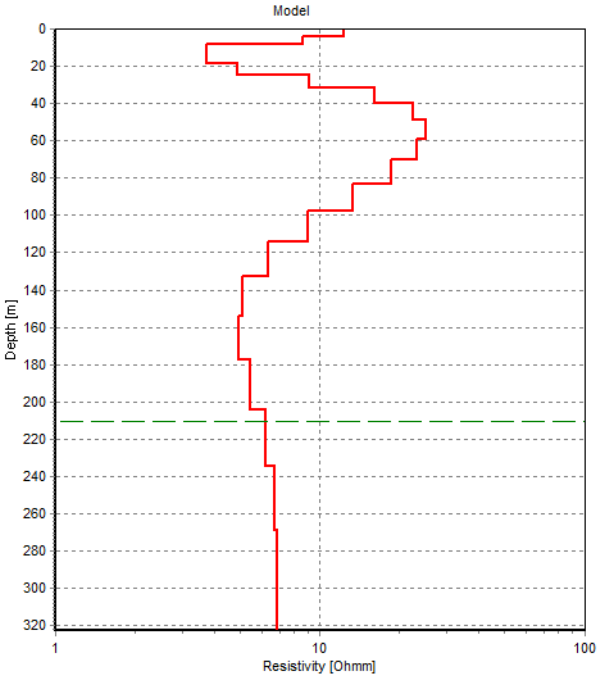


Station 07

Print Date:	13-12-2017
Database Name:	TDEM_SLO_EPSG2229.gdb
UTMX:	5874407
UTMY:	2165572
EPSG:	NAD83/California zone 5, EPSG:2229
Importer:	Not Available
Version:	Not Available
Data Residual:	0.4
No. of Layers:	20
DOI:	211m
Program:	SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	12.3	1.14	3.84	1.001	3.84	1.001
2	8.57	1.23	4.34	1.001	8.18	1.001
3	3.73	1.13	4.9	1.001	13.1	1.001
4	3.75	1.19	5.53	1.001	18.6	1.000
5	4.87	1.28	6.24	1.001	24.8	1.000
6	9.13	1.42	7.05	1.001	31.9	1.000
7	16	1.54	7.96	1.001	39.9	1.000
8	22.4	1.63	8.98	1.001	48.8	1.000
9	25	1.68	10.1	1.001	59	1.000
10	23.2	1.68	11.4	1.001	70.4	1.000
11	18.5	1.65	12.9	1.001	83.4	1.000
12	13.2	1.60	14.6	1.001	97.9	1.000
13	9.03	1.54	16.5	1.001	114	1.000
14	6.37	1.50	18.6	1.001	133	1.000
15	5.1	1.46	21	1.001	154	1.000
16	4.9	1.48	23.7	1.001	178	1.000
17	5.43	1.65	26.8	1.001	205	1.000
18	6.2	2.12	30.2	1.001	235	1.000
19	6.75	2.88	34.1	1.001	269	1.000
20	6.9	3.84				

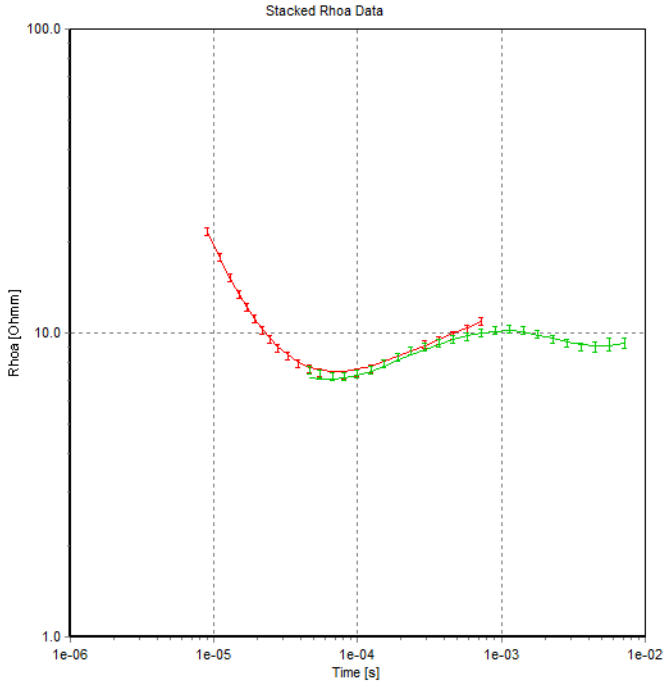


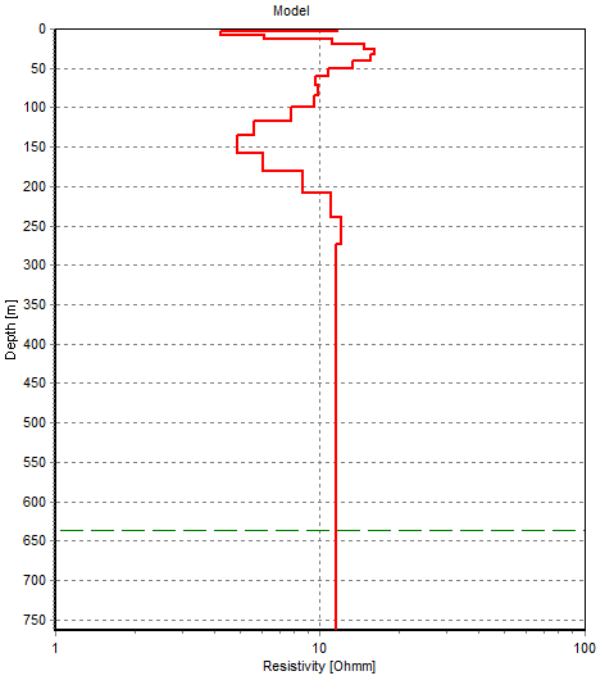


Station 08

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5874373
UTMY: 2165462
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 636m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	11.6	1.11	3.92	1.001	3.92	1.001
2	4.23	1.11	4.42	1.001	8.34	1.001
3	6.12	1.22	4.99	1.001	13.3	1.001
4	11.1	1.37	5.64	1.001	19	1.000
5	14.6	1.44	6.37	1.001	25.3	1.000
6	16.1	1.50	7.19	1.001	32.5	1.000
7	15.6	1.52	8.12	1.001	40.6	1.000
8	13.4	1.48	9.16	1.001	49.8	1.000
9	10.8	1.44	10.3	1.001	60.2	1.000
10	9.65	1.46	11.7	1.001	71.8	1.000
11	9.79	1.49	13.2	1.001	85	1.000
12	9.54	1.49	14.9	1.001	99.9	1.000
13	7.79	1.47	16.8	1.001	117	1.000
14	5.61	1.43	19	1.001	136	1.000
15	4.89	1.42	21.4	1.001	157	1.000
16	6.12	1.46	24.2	1.001	181	1.000
17	8.61	1.61	27.3	1.001	209	1.000
18	11	1.99	30.8	1.001	239	1.000
19	12	2.67	34.8	1.001	274	1.000
20	11.5	3.61				

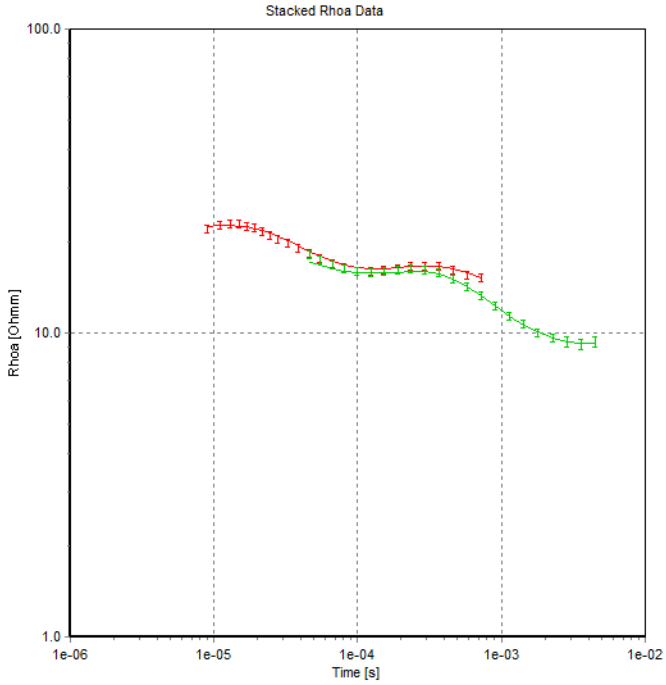


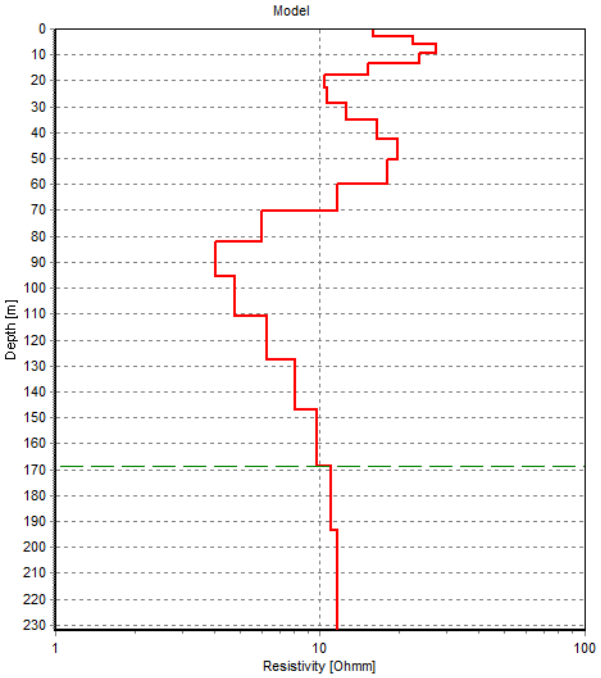


Station 09

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5874078
UTMY: 2165283
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 168m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	15.9	1.27	2.76	1.001	2.76	1.001
2	22.3	1.44	3.12	1.001	5.88	1.001
3	27.4	1.48	3.52	1.001	9.4	1.001
4	23.8	1.40	3.98	1.001	13.4	1.000
5	15.2	1.37	4.49	1.001	17.9	1.000
6	10.4	1.29	5.07	1.001	22.9	1.000
7	10.7	1.34	5.72	1.001	28.7	1.000
8	12.6	1.37	6.46	1.001	35.1	1.000
9	16.4	1.44	7.29	1.001	42.4	1.000
10	19.6	1.50	8.23	1.001	50.7	1.000
11	18	1.50	9.3	1.001	59.9	1.000
12	11.7	1.44	10.5	1.001	70.4	1.000
13	6	1.35	11.9	1.001	82.3	1.000
14	4.02	1.31	13.4	1.001	95.7	1.000
15	4.74	1.37	15.1	1.001	111	1.000
16	6.32	1.43	17	1.001	128	1.000
17	8.05	1.48	19.3	1.001	147	1.000
18	9.68	1.57	21.7	1.001	169	1.000
19	11	1.81	24.5	1.001	193	1.000
20	11.7	2.28				

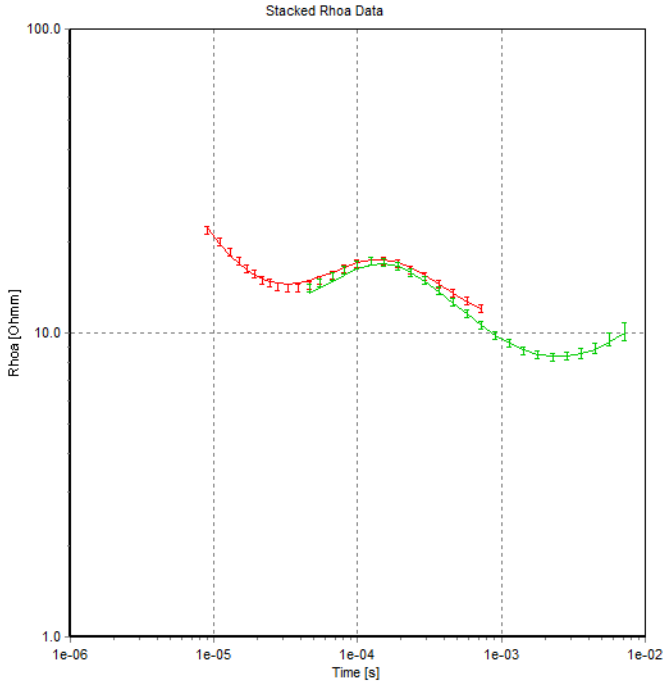


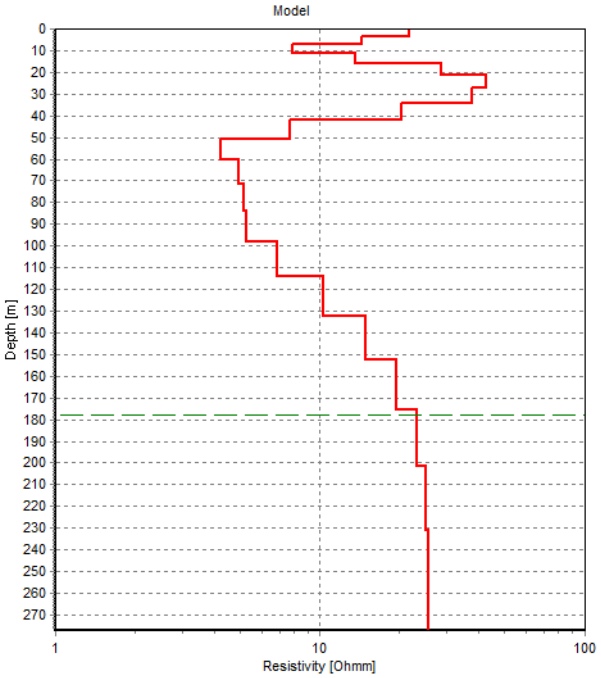


Station 10

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873961
UTMY: 2165191
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.6
No. of Layers: 20
DOI: 178m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	21.7	1.31	3.3	1.001	3.3	1.001
2	14.4	1.35	3.73	1.001	7.03	1.001
3	7.89	1.14	4.21	1.001	11.2	1.001
4	13.6	1.13	4.75	1.001	16	1.000
5	28.8	1.44	5.36	1.001	21.3	1.000
6	42.3	1.51	6.05	1.001	27.4	1.000
7	37.3	1.56	6.84	1.001	34.2	1.000
8	20.2	1.49	7.72	1.001	42	1.000
9	7.68	1.33	8.71	1.001	50.7	1.000
10	4.23	1.26	9.84	1.001	60.5	1.000
11	4.9	1.34	11.1	1.001	71.6	1.000
12	5.13	1.36	12.5	1.001	84.1	1.000
13	5.28	1.38	14.1	1.001	98.3	1.000
14	6.91	1.43	16	1.001	114	1.000
15	10.3	1.53	18	1.001	132	1.000
16	14.9	1.63	20.4	1.001	153	1.000
17	19.5	1.71	23	1.001	176	1.000
18	23.1	1.74	26	1.001	202	1.000
19	25.2	1.68	29.3	1.001	231	1.000
20	25.6	1.57				

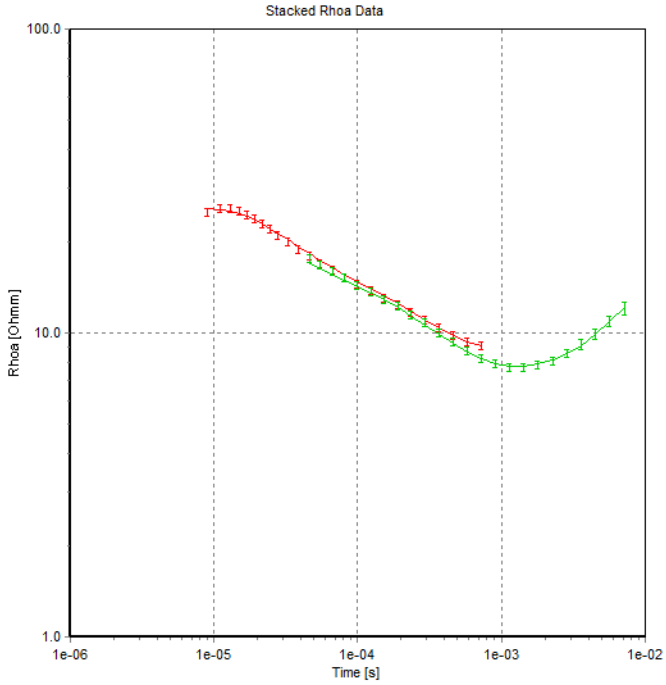


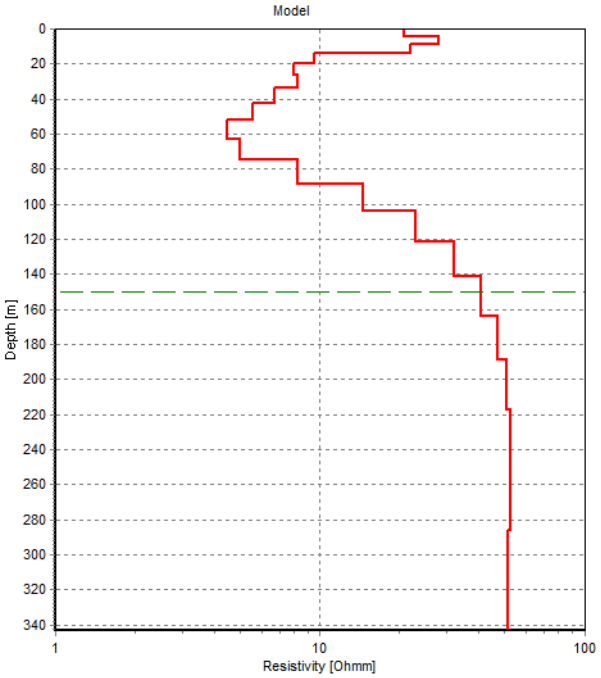


Station 11

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873818
UTMY: 2165073
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 150m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	20.7	1.14	4.09	1.001	4.09	1.001
2	28	1.29	4.61	1.001	8.7	1.001
3	22	1.33	5.21	1.001	13.9	1.001
4	9.51	1.20	5.88	1.001	19.8	1.000
5	7.97	1.21	6.64	1.001	26.4	1.000
6	8.22	1.29	7.5	1.001	33.9	1.000
7	6.71	1.29	8.47	1.001	42.4	1.000
8	5.54	1.31	9.56	1.001	52	1.000
9	4.45	1.30	10.8	1.001	62.7	1.000
10	4.96	1.35	12.2	1.001	74.9	1.000
11	8.25	1.45	13.8	1.001	88.7	1.000
12	14.5	1.57	15.5	1.001	104	1.000
13	22.9	1.68	17.5	1.001	122	1.000
14	32.2	1.76	19.8	1.001	142	1.000
15	40.6	1.84	22.3	1.001	164	1.000
16	46.9	1.95	25.2	1.001	189	1.000
17	50.8	2.12	28.5	1.001	218	1.000
18	52.4	2.38	32.2	1.001	250	1.000
19	52.3	2.76	36.3	1.001	286	1.000
20	51.1	3.27				

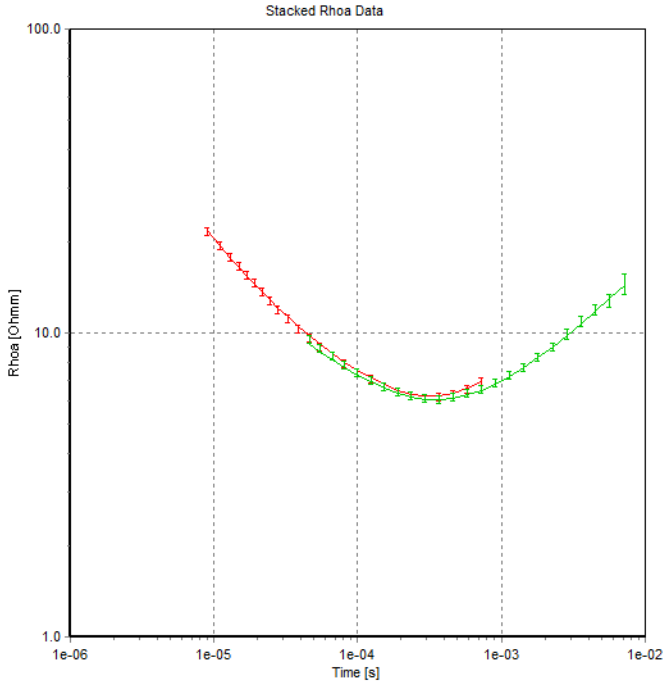


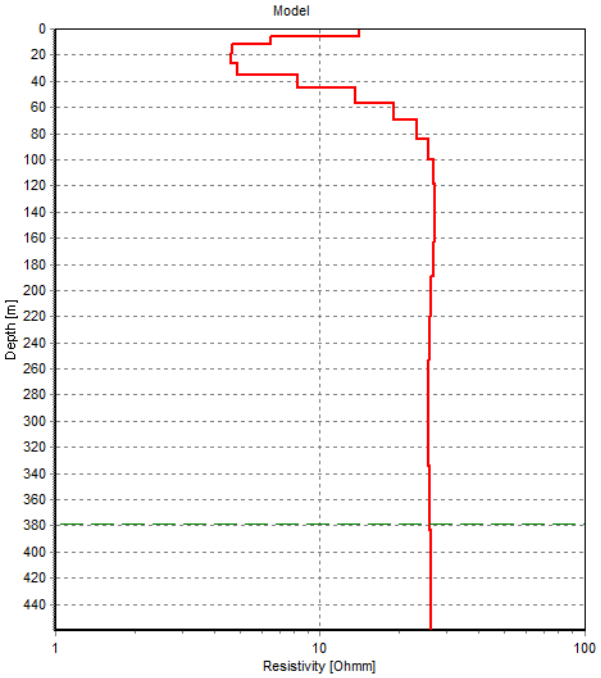


Station 12

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873714
UTMY: 2164973
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 379m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	14.1	1.06	5.48	1.001	5.48	1.001
2	6.5	1.08	6.18	1.001	11.7	1.001
3	4.66	1.11	6.98	1.001	18.6	1.001
4	4.61	1.18	7.88	1.001	26.5	1.000
5	4.85	1.26	8.9	1.001	35.4	1.000
6	8.25	1.40	10.1	1.001	45.5	1.000
7	13.5	1.50	11.3	1.001	56.8	1.000
8	19	1.57	12.8	1.001	69.6	1.000
9	23.2	1.61	14.5	1.001	84.1	1.000
10	25.7	1.64	16.3	1.001	100	1.000
11	26.9	1.69	18.4	1.001	119	1.000
12	27.2	1.73	20.8	1.001	140	1.000
13	27.1	1.74	23.5	1.001	163	1.000
14	26.8	1.72	26.5	1.001	190	1.000
15	26.3	1.69	29.9	1.001	220	1.000
16	25.9	1.68	33.8	1.001	253	1.000
17	25.6	1.70	38.2	1.001	292	1.000
18	25.6	1.72	43.1	1.001	335	1.000
19	25.8	1.70	48.7	1.001	383	1.000
20	26.2	1.68				

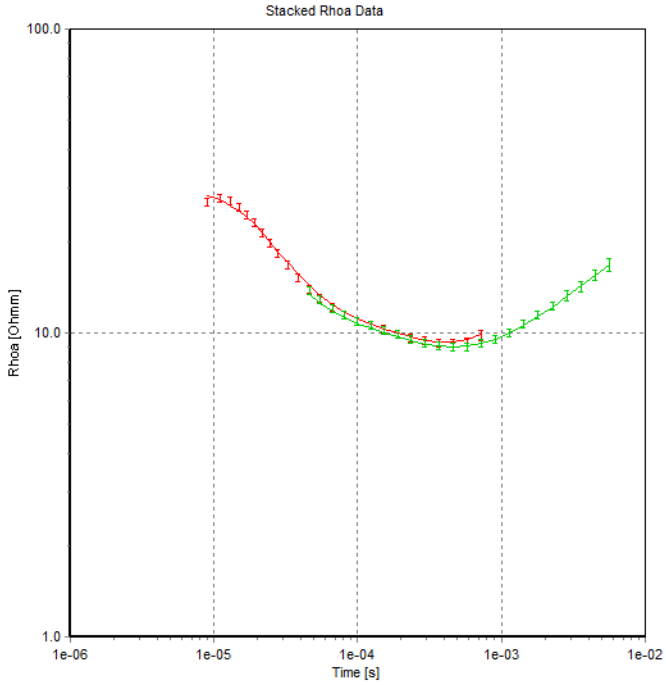


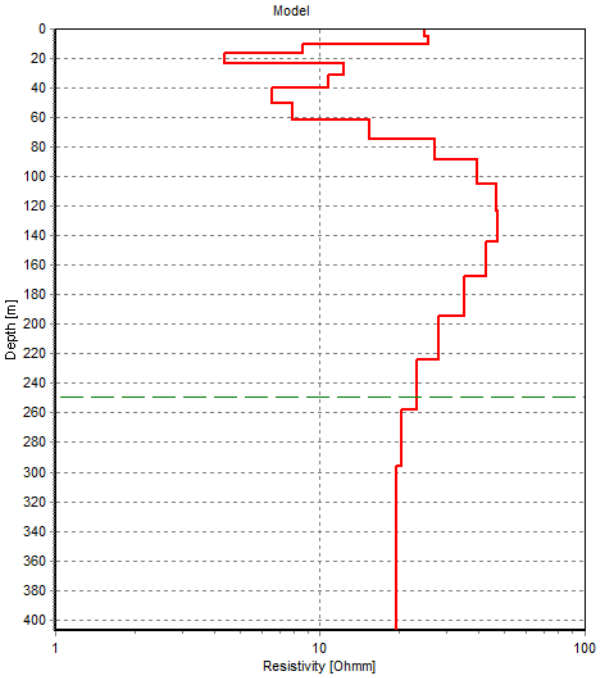


Station 13

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873512
UTMY: 2165134
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 250m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	24.9	1.19	4.85	1.001	4.85	1.001
2	25.7	1.39	5.47	1.001	10.3	1.001
3	8.57	1.12	6.18	1.001	16.5	1.001
4	4.33	1.09	6.98	1.001	23.5	1.000
5	12.3	1.36	7.88	1.001	31.4	1.000
6	10.8	1.37	8.9	1.001	40.3	1.000
7	6.57	1.30	10	1.001	50.3	1.000
8	7.89	1.36	11.3	1.001	61.6	1.000
9	15.4	1.50	12.8	1.001	74.4	1.000
10	27.2	1.63	14.4	1.001	88.9	1.000
11	39	1.72	16.3	1.001	105	1.000
12	46.2	1.78	18.4	1.001	124	1.000
13	46.9	1.79	20.8	1.001	144	1.000
14	42.2	1.76	23.5	1.001	168	1.000
15	35.1	1.71	26.5	1.001	194	1.000
16	28.2	1.67	29.9	1.001	224	1.000
17	23.1	1.66	33.8	1.001	258	1.000
18	20.3	1.65	38.2	1.001	296	1.000
19	19.4	1.56	43.1	1.001	339	1.000
20	19.5	1.33				

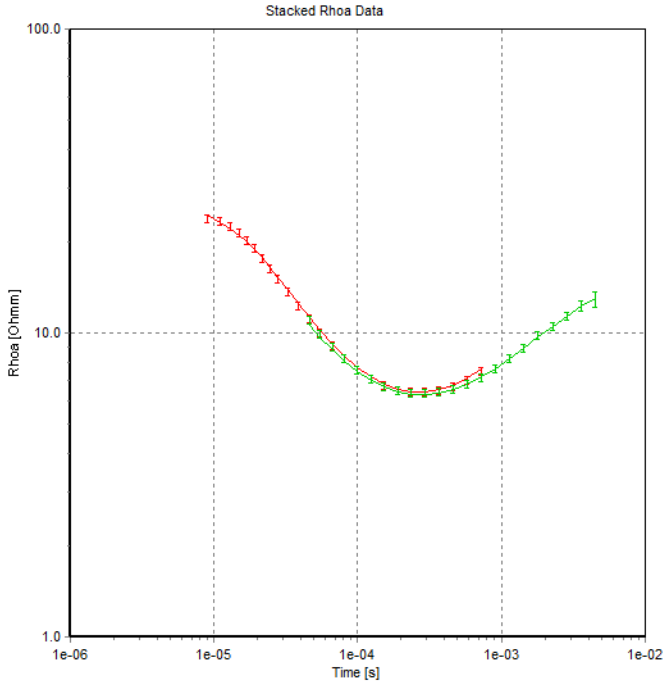


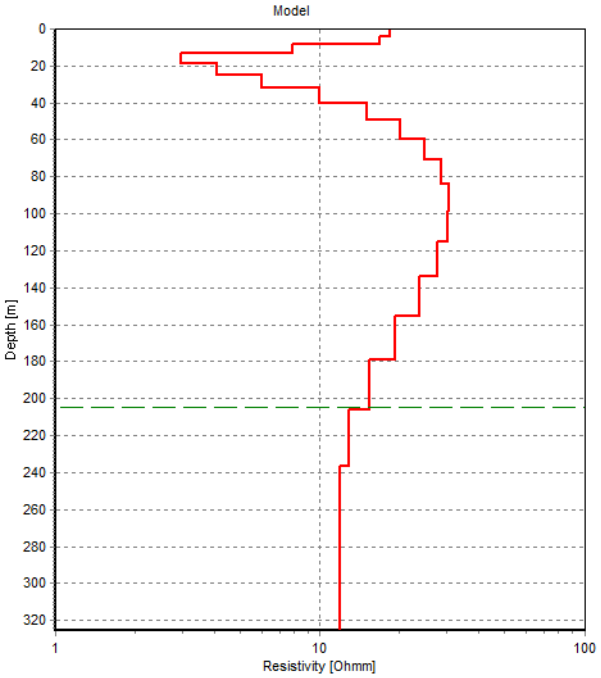


Station 14

Print Date:	13-12-2017
Database Name:	TDEM_SLO_EPSG2229.gdb
UTMX:	5873672
UTMY:	2164854
EPSG:	NAD83/California zone 5, EPSG:2229
Importer:	Not Available
Version:	Not Available
Data Residual:	0.4
No. of Layers:	20
DOI:	204m
Program:	SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	18.3	1.20	3.88	1.001	3.88	1.001
2	16.7	1.37	4.38	1.001	8.25	1.001
3	7.85	1.17	4.94	1.001	13.2	1.001
4	3	1.09	5.58	1.001	18.8	1.000
5	4.09	1.21	6.3	1.001	25.1	1.000
6	6.03	1.34	7.11	1.001	32.2	1.000
7	9.98	1.43	8.02	1.001	40.2	1.000
8	14.9	1.53	9.06	1.001	49.3	1.000
9	20.1	1.61	10.2	1.001	59.5	1.000
10	24.9	1.67	11.6	1.001	71	1.000
11	28.7	1.71	13	1.001	84.1	1.000
12	30.7	1.74	14.7	1.001	98.8	1.000
13	30.4	1.75	16.6	1.001	115	1.000
14	27.8	1.74	18.8	1.001	134	1.000
15	23.7	1.70	21.2	1.001	155	1.000
16	19.2	1.68	23.9	1.001	179	1.000
17	15.4	1.73	27	1.001	206	1.000
18	12.9	1.99	30.5	1.001	237	1.000
19	11.8	2.56	34.4	1.001	271	1.000
20	11.9	3.43				

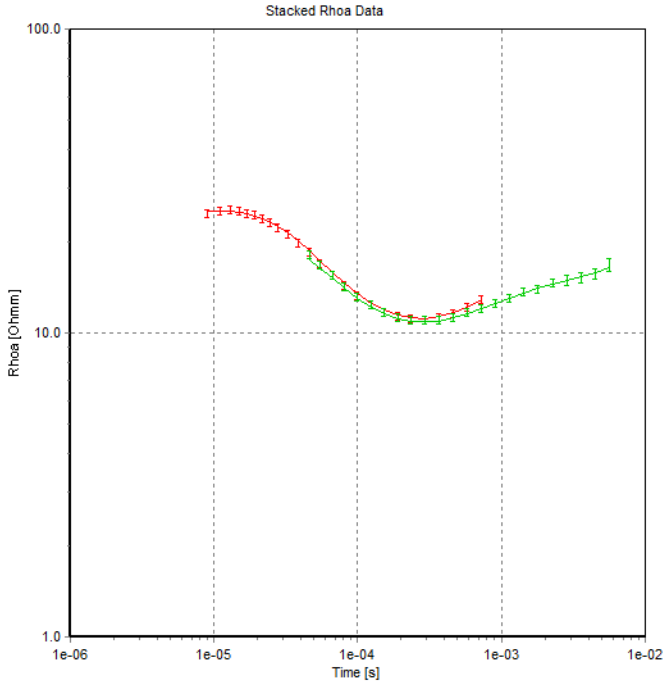


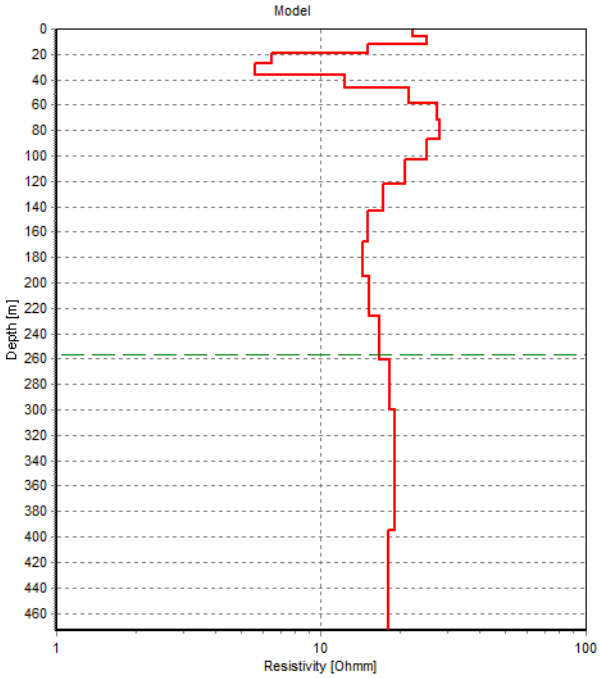


Station 15

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873370
UTMY: 2164925
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 256m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	22.1	1.12	5.64	1.001	5.64	1.001
2	25.1	1.31	6.37	1.001	12	1.001
3	15	1.22	7.19	1.001	19.2	1.001
4	6.5	1.12	8.12	1.001	27.3	1.000
5	5.61	1.16	9.16	1.001	36.5	1.000
6	12.3	1.37	10.4	1.001	46.8	1.000
7	21.5	1.47	11.7	1.001	58.5	1.000
8	27.4	1.55	13.2	1.001	71.7	1.000
9	28.2	1.58	14.9	1.001	86.6	1.000
10	25	1.57	16.8	1.001	103	1.000
11	20.7	1.55	19	1.001	122	1.000
12	17.1	1.52	21.4	1.001	144	1.000
13	15	1.51	24.2	1.001	168	1.000
14	14.4	1.51	27.3	1.001	195	1.000
15	15.2	1.54	30.8	1.001	226	1.000
16	16.7	1.66	34.8	1.001	261	1.000
17	18.2	1.90	39.3	1.001	300	1.000
18	19.1	2.24	44.4	1.001	345	1.000
19	18.9	2.62	50.1	1.001	395	1.000
20	18	3.01				

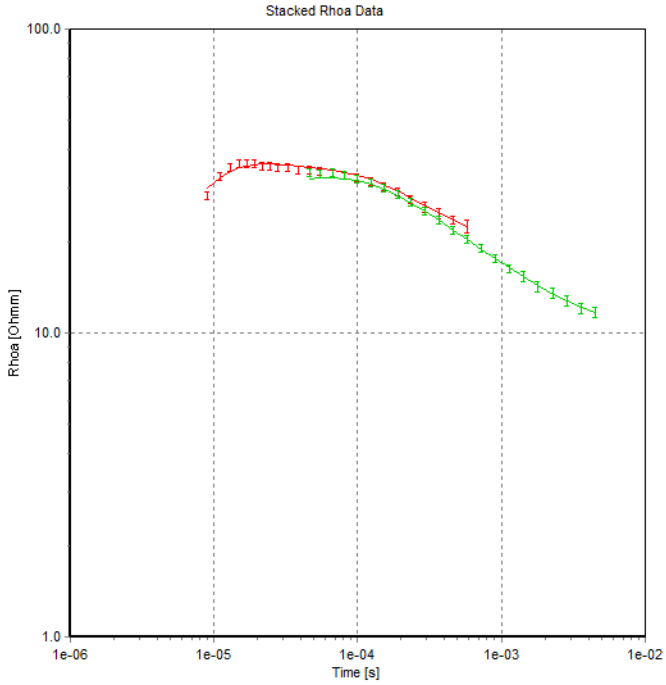


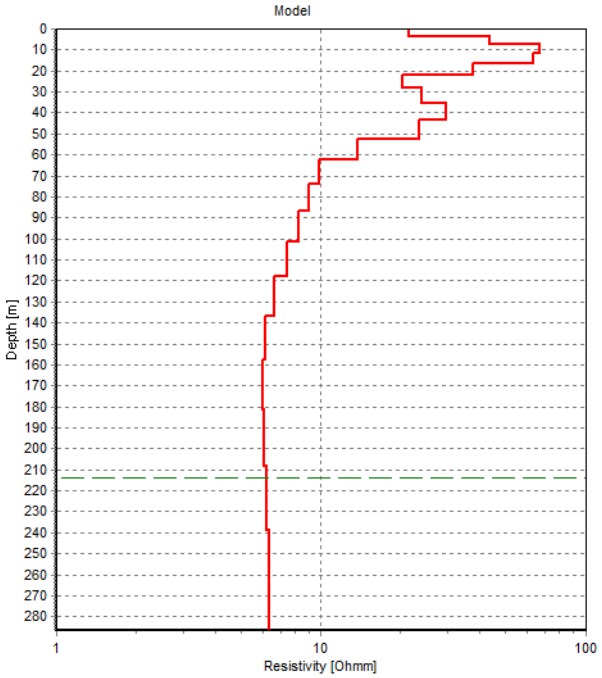


Station 16

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5871425
UTMY: 2160087
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.6
No. of Layers: 20
DOI: 214m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	21.5	1.22	3.41	1.001	3.41	1.001
2	43.1	1.49	3.85	1.001	7.27	1.001
3	66.7	1.56	4.35	1.001	11.6	1.001
4	63	1.49	4.91	1.001	16.5	1.000
5	37.6	1.42	5.54	1.001	22.1	1.000
6	20.2	1.31	6.26	1.001	28.3	1.000
7	24.1	1.36	7.07	1.001	35.4	1.000
8	29.8	1.43	7.98	1.001	43.4	1.000
9	23.4	1.40	9.01	1.001	52.4	1.000
10	13.7	1.34	10.2	1.001	62.6	1.000
11	9.83	1.31	11.5	1.001	74	1.000
12	8.95	1.33	13	1.001	87	1.000
13	8.26	1.36	14.6	1.001	102	1.000
14	7.47	1.39	16.5	1.001	118	1.000
15	6.67	1.42	18.6	1.001	137	1.000
16	6.14	1.44	21.1	1.001	158	1.000
17	6	1.50	23.8	1.001	182	1.000
18	6.09	1.76	26.8	1.001	208	1.000
19	6.24	2.37	30.3	1.001	239	1.000
20	6.37	3.28				

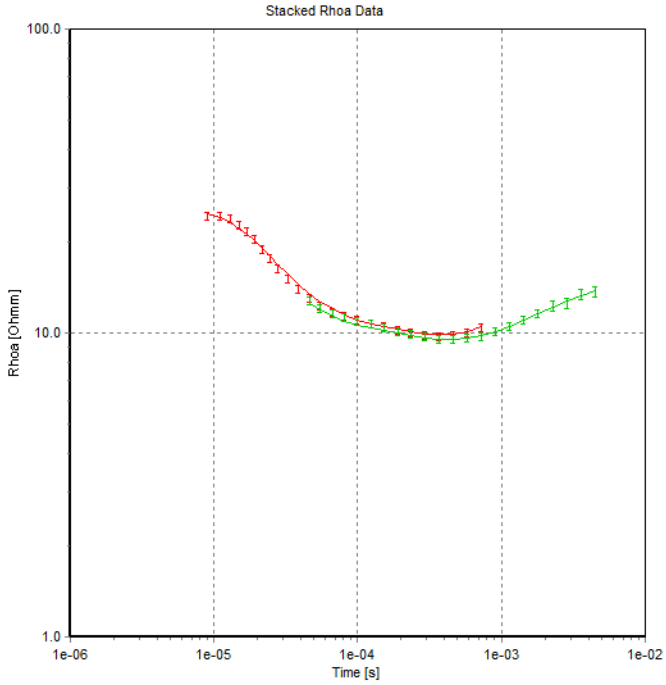


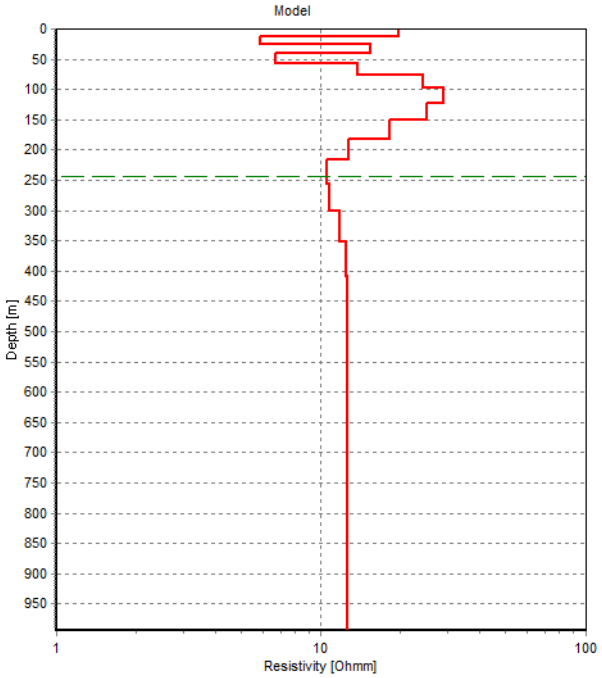


Station 17

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873629
UTMY: 2164718
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 244m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	19.5	1.02	11.8	1.001	11.8	1.001
2	5.91	1.03	13.4	1.001	25.2	1.001
3	15.4	1.21	15.1	1.001	40.3	1.001
4	6.77	1.16	17	1.001	57.3	1.000
5	13.7	1.37	19.2	1.001	76.6	1.000
6	24.3	1.49	21.7	1.001	98.3	1.000
7	28.9	1.57	24.5	1.001	123	1.000
8	25.2	1.60	27.7	1.001	150	1.000
9	18.1	1.60	31.2	1.001	182	1.000
10	12.7	1.68	35.3	1.001	217	1.000
11	10.6	2.08	39.8	1.001	257	1.000
12	10.8	2.92	45	1.001	302	1.000
13	11.7	4.01	50.8	1.001	352	1.000
14	12.4	5.05	57.3	1.001	410	1.000
15	12.6	5.95	64.7	1.001	474	1.000
16	12.6	6.79	73	1.001	548	1.000
17	12.6	7.64	82.5	1.001	630	1.000
18	12.6	8.56	93.1	1.001	723	1.000
19	12.6	9.54	105	1.001	828	1.000
20	12.6	10.58				

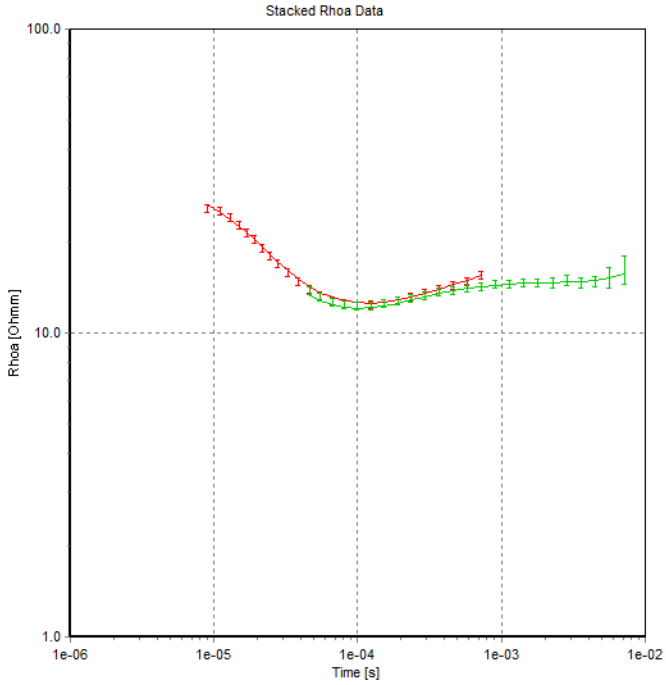


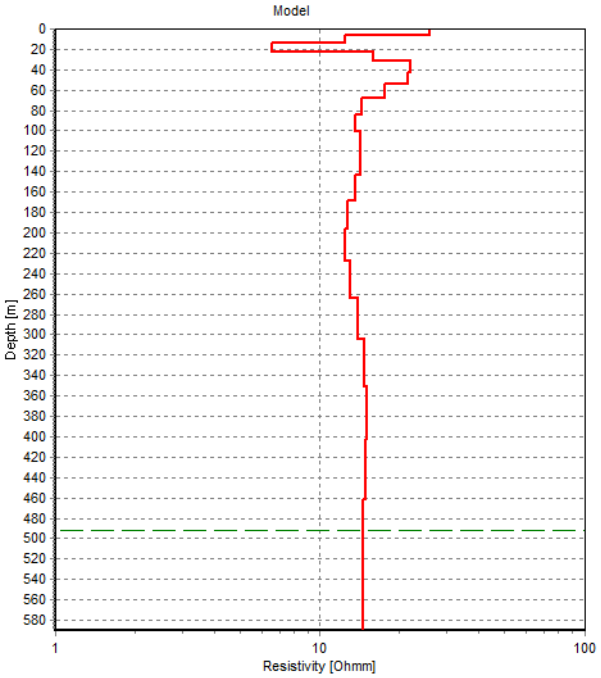


Station 18

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873341
UTMY: 2164739
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 492m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	25.9	1.09	6.59	1.001	6.59	1.001
2	12.4	1.10	7.44	1.001	14	1.001
3	6.62	1.08	8.4	1.001	22.4	1.001
4	15.9	1.28	9.48	1.001	31.9	1.000
5	21.9	1.40	10.7	1.001	42.6	1.000
6	21.5	1.43	12.1	1.001	54.7	1.000
7	17.6	1.41	13.6	1.001	68.4	1.000
8	14.4	1.41	15.4	1.001	83.8	1.000
9	13.6	1.43	17.4	1.001	101	1.000
10	14.1	1.46	19.6	1.001	121	1.000
11	14.3	1.47	22.2	1.001	143	1.000
12	13.5	1.47	25	1.001	168	1.000
13	12.6	1.48	28.3	1.001	196	1.000
14	12.4	1.50	31.9	1.001	228	1.000
15	12.9	1.55	36	1.001	264	1.000
16	13.9	1.61	40.7	1.001	305	1.000
17	14.7	1.66	45.9	1.001	351	1.000
18	15.1	1.69	51.8	1.001	403	1.000
19	14.9	1.80	58.5	1.001	461	1.000
20	14.5	2.06				

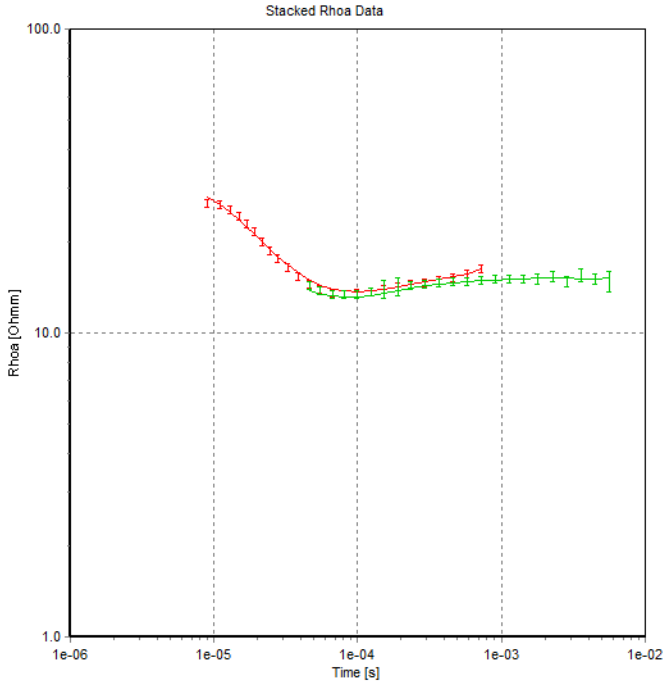


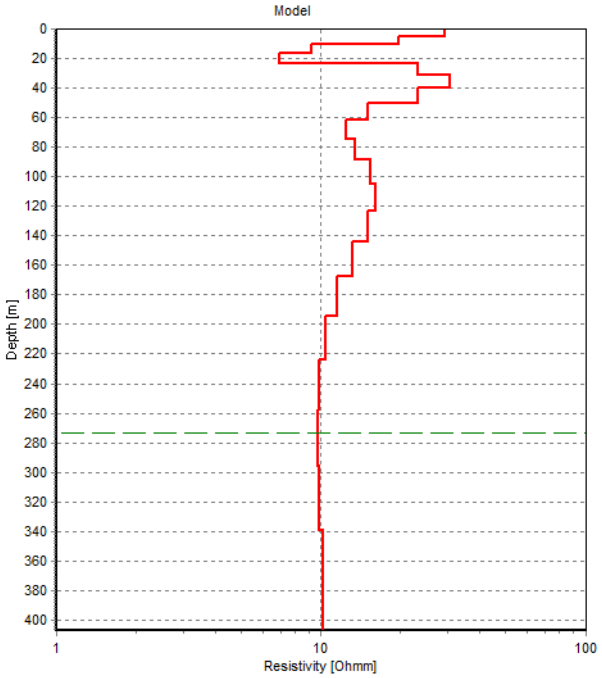


Station 19

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873371
UTMY: 2164606
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 274m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	29.2	1.26	4.85	1.001	4.85	1.001
2	19.6	1.33	5.47	1.001	10.3	1.001
3	9.2	1.14	6.18	1.001	16.5	1.001
4	6.99	1.13	6.98	1.001	23.5	1.000
5	23.1	1.45	7.88	1.001	31.4	1.000
6	30.6	1.49	8.89	1.001	40.2	1.000
7	23.1	1.47	10	1.001	50.3	1.000
8	15.1	1.41	11.3	1.001	61.6	1.000
9	12.4	1.40	12.8	1.001	74.4	1.000
10	13.4	1.44	14.4	1.001	88.9	1.000
11	15.3	1.48	16.3	1.001	105	1.000
12	16	1.51	18.4	1.001	124	1.000
13	15	1.52	20.8	1.001	144	1.000
14	13.2	1.52	23.5	1.001	168	1.000
15	11.6	1.53	26.5	1.001	194	1.000
16	10.4	1.58	29.9	1.001	224	1.000
17	9.86	1.81	33.8	1.001	258	1.000
18	9.72	2.36	38.1	1.001	296	1.000
19	9.88	3.21	43	1.001	339	1.000
20	10.2	4.25				

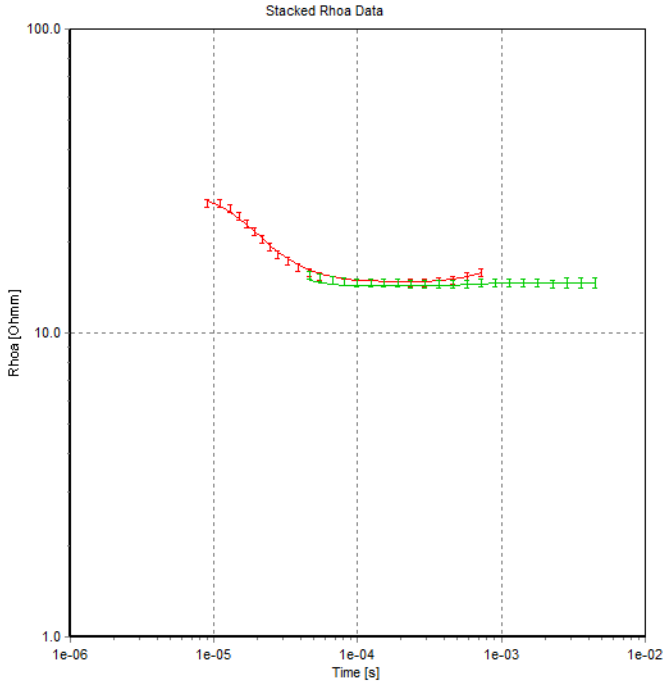


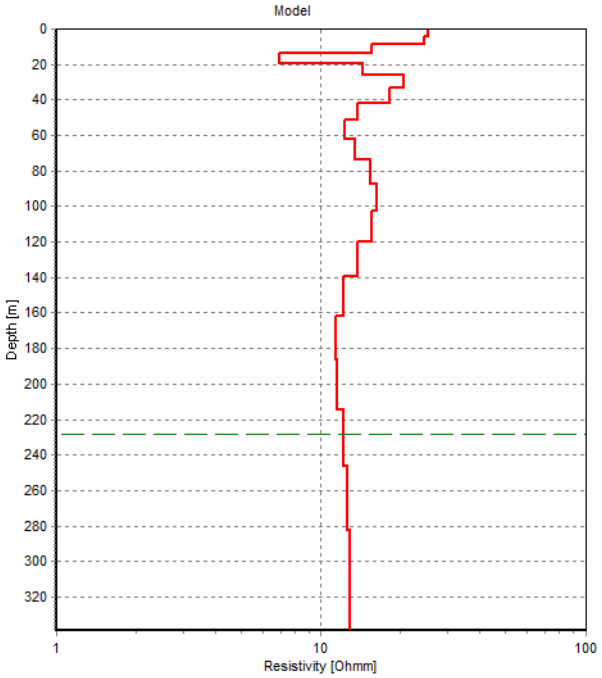


Station 20

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873348
UTMY: 2164469
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 228m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	25.3	1.25	4.03	1.001	4.03	1.001
2	24.7	1.38	4.56	1.001	8.59	1.001
3	15.6	1.26	5.14	1.001	13.7	1.001
4	7	1.16	5.81	1.001	19.5	1.000
5	14.4	1.34	6.56	1.001	26.1	1.000
6	20.6	1.42	7.4	1.001	33.5	1.000
7	18.2	1.42	8.36	1.001	41.9	1.000
8	13.8	1.40	9.43	1.001	51.3	1.000
9	12.2	1.40	10.6	1.001	61.9	1.000
10	13.4	1.43	12	1.001	74	1.000
11	15.3	1.48	13.6	1.001	87.5	1.000
12	16.3	1.51	15.3	1.001	103	1.000
13	15.6	1.51	17.3	1.001	120	1.000
14	13.8	1.51	19.5	1.001	140	1.000
15	12.1	1.49	22.1	1.001	162	1.000
16	11.4	1.49	24.9	1.001	187	1.000
17	11.5	1.53	28.1	1.001	215	1.000
18	12.1	1.77	31.7	1.001	247	1.000
19	12.6	2.31	35.8	1.001	282	1.000
20	12.8	3.14				

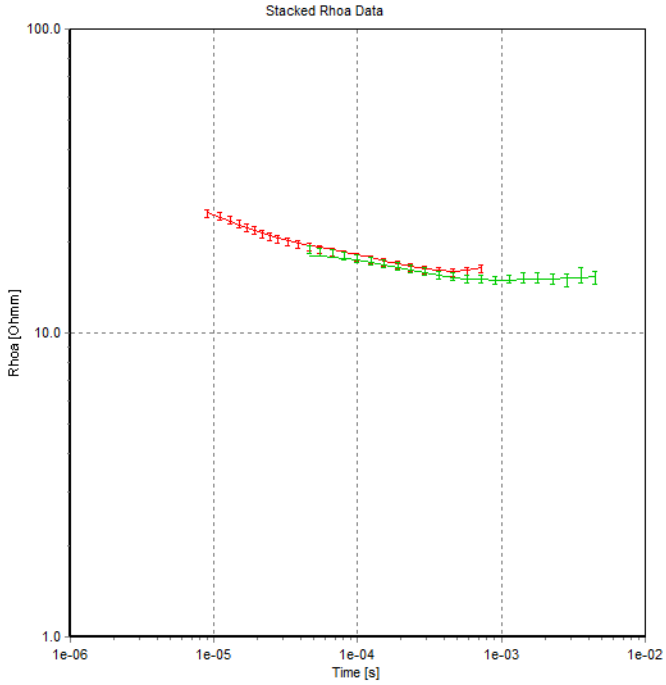


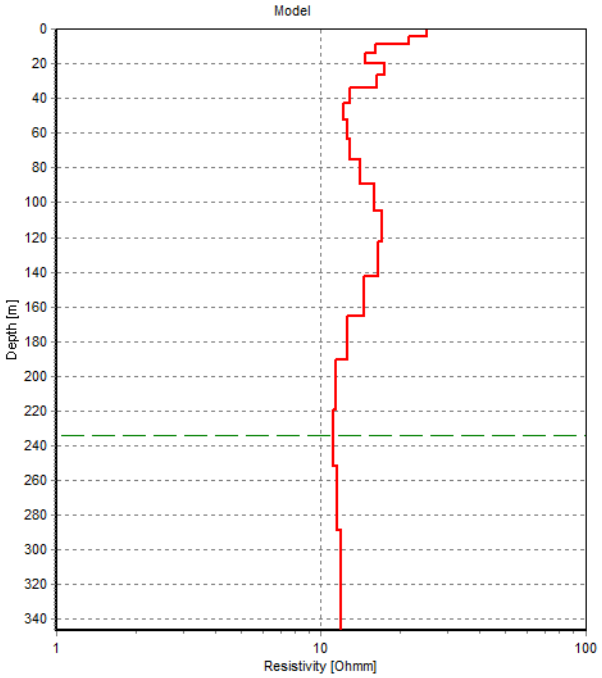


Station 21

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873363
UTMY: 2164318
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 234m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	25	1.28	4.12	1.001	4.12	1.001
2	21.5	1.36	4.66	1.001	8.78	1.001
3	16.1	1.25	5.26	1.001	14	1.001
4	14.6	1.29	5.93	1.001	20	1.000
5	17.4	1.33	6.7	1.001	26.7	1.000
6	16.2	1.36	7.56	1.001	34.2	1.000
7	12.9	1.34	8.54	1.001	42.8	1.000
8	12.1	1.36	9.64	1.001	52.4	1.000
9	12.5	1.38	10.9	1.001	63.3	1.000
10	12.9	1.41	12.3	1.001	75.6	1.000
11	14	1.45	13.9	1.001	89.5	1.000
12	15.8	1.49	15.7	1.001	105	1.000
13	17	1.52	17.7	1.001	123	1.000
14	16.4	1.53	20	1.001	143	1.000
15	14.5	1.53	22.5	1.001	165	1.000
16	12.5	1.54	25.5	1.001	191	1.000
17	11.3	1.61	28.7	1.001	220	1.000
18	11.1	1.92	32.4	1.001	252	1.000
19	11.5	2.57	36.6	1.001	289	1.000
20	11.9	3.50				

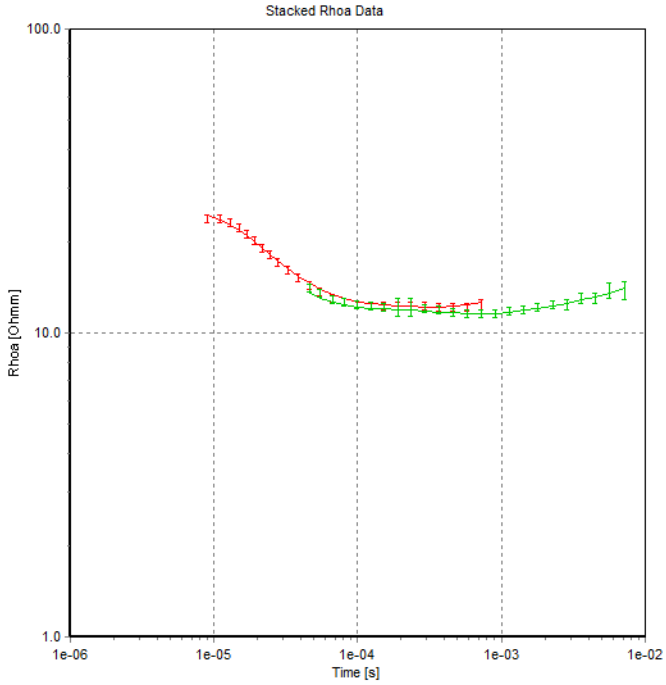


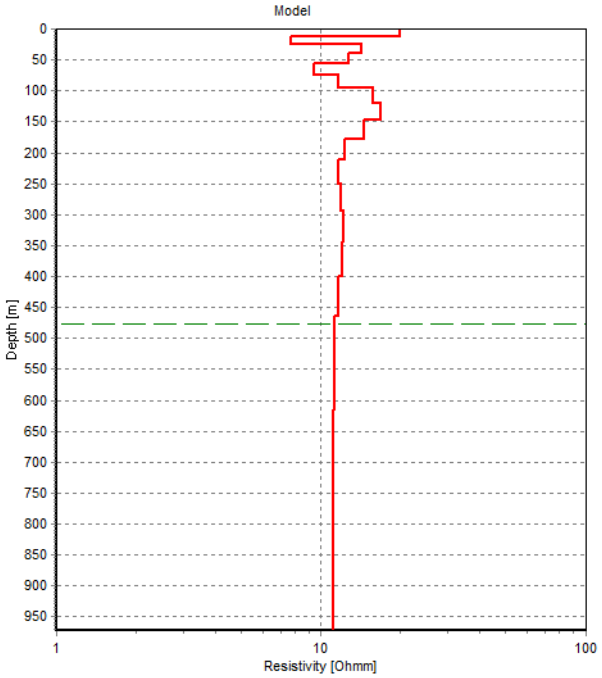


Station 22

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873502
UTMY: 2164261
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 477m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	19.9	1.02	11.6	1.001	11.6	1.001
2	7.73	1.03	13.1	1.001	24.6	1.001
3	14.2	1.16	14.8	1.001	39.4	1.001
4	12.7	1.27	16.7	1.001	56.1	1.000
5	9.37	1.27	18.8	1.001	74.9	1.000
6	11.7	1.37	21.2	1.001	96.1	1.000
7	15.8	1.44	24	1.001	120	1.000
8	16.8	1.47	27.1	1.001	147	1.000
9	14.6	1.47	30.5	1.001	178	1.000
10	12.3	1.46	34.5	1.001	212	1.000
11	11.6	1.52	39	1.001	251	1.000
12	11.9	1.65	44	1.001	295	1.000
13	12.2	1.84	49.6	1.001	345	1.000
14	12	2.08	56	1.001	401	1.000
15	11.6	2.42	63.3	1.001	464	1.000
16	11.3	2.87	71.4	1.001	535	1.000
17	11.2	3.42	80.7	1.001	616	1.000
18	11.2	4.03	91.1	1.001	707	1.000
19	11.2	4.71	103	1.001	810	1.000
20	11.2	5.45				

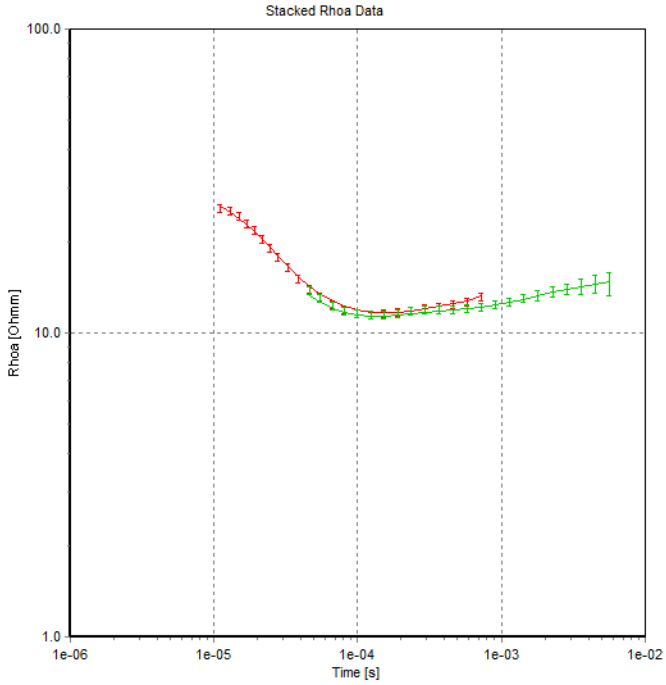


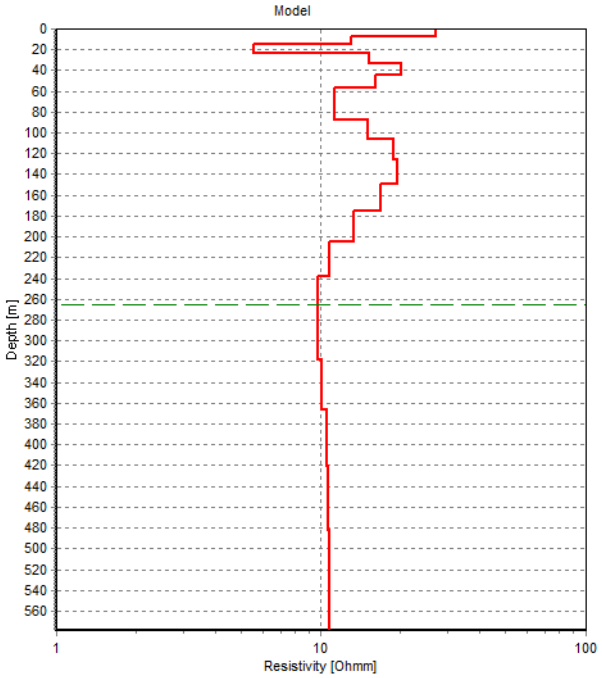


Station 24

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873446
UTMY: 2164011
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 265m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	27	1.14	6.89	1.001	6.89	1.001
2	13	1.15	7.78	1.001	14.7	1.001
3	5.54	1.08	8.78	1.001	23.5	1.001
4	15.2	1.31	9.92	1.001	33.4	1.000
5	20.1	1.40	11.2	1.001	44.6	1.000
6	16.1	1.41	12.6	1.001	57.2	1.000
7	11.3	1.36	14.3	1.001	71.5	1.000
8	11.2	1.39	16.1	1.001	87.6	1.000
9	15.1	1.47	18.2	1.001	106	1.000
10	18.9	1.54	20.5	1.001	126	1.000
11	19.5	1.58	23.2	1.001	149	1.000
12	16.8	1.59	26.2	1.001	176	1.000
13	13.2	1.62	29.5	1.001	205	1.000
14	10.7	1.76	33.4	1.001	239	1.000
15	9.68	2.17	37.7	1.001	276	1.000
16	9.67	2.92	42.5	1.001	319	1.000
17	10.1	3.91	48	1.001	367	1.000
18	10.5	4.95	54.2	1.001	421	1.000
19	10.7	5.91	61.2	1.001	482	1.000
20	10.8	6.80				

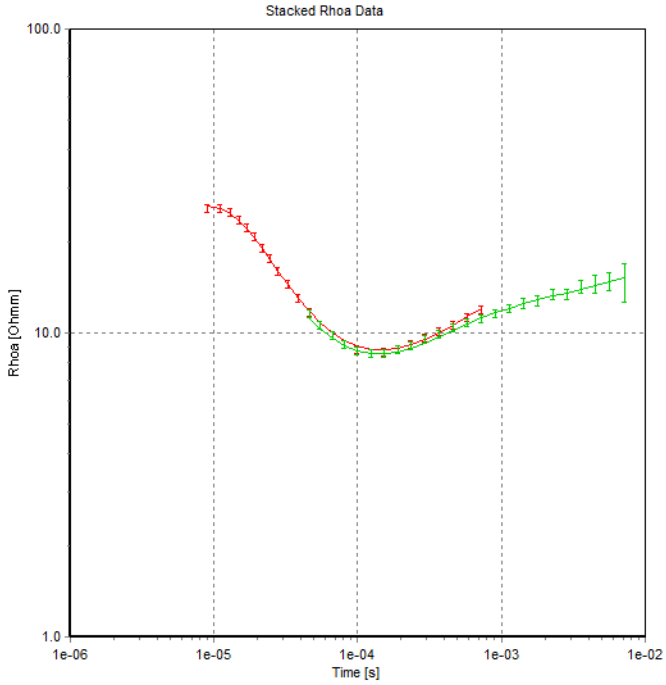


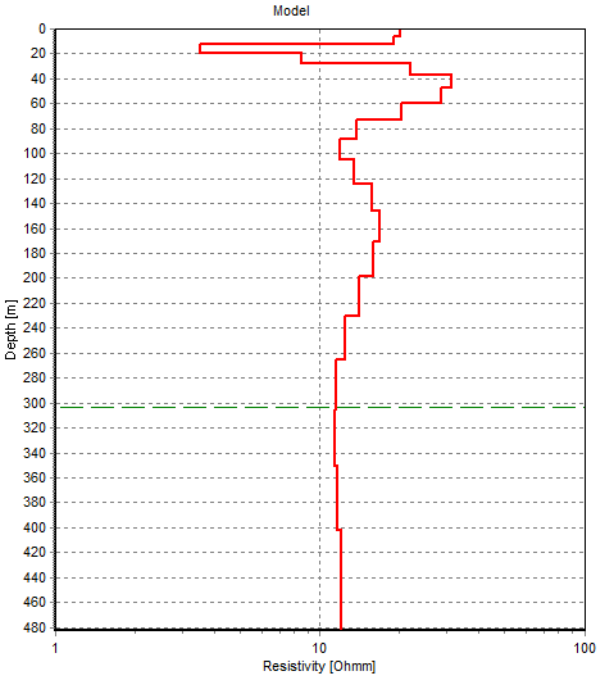


Station 25

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873387
UTMY: 2163936
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 304m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	20	1.09	5.74	1.001	5.74	1.001
2	19	1.20	6.49	1.001	12.2	1.001
3	3.53	1.05	7.32	1.001	19.6	1.001
4	8.52	1.21	8.27	1.001	27.8	1.000
5	21.9	1.46	9.34	1.001	37.2	1.000
6	31.3	1.56	10.5	1.001	47.7	1.000
7	28.8	1.57	11.9	1.001	59.6	1.000
8	20.3	1.52	13.4	1.001	73	1.000
9	13.8	1.46	15.2	1.001	88.2	1.000
10	11.9	1.45	17.1	1.001	105	1.000
11	13.4	1.49	19.3	1.001	125	1.000
12	15.7	1.54	21.8	1.001	146	1.000
13	16.7	1.57	24.6	1.001	171	1.000
14	15.8	1.58	27.8	1.001	199	1.000
15	14	1.62	31.4	1.001	230	1.000
16	12.4	1.76	35.5	1.001	266	1.000
17	11.5	2.07	40	1.001	306	1.000
18	11.3	2.46	45.2	1.001	351	1.000
19	11.6	2.80	51	1.001	402	1.000
20	12	3.11				

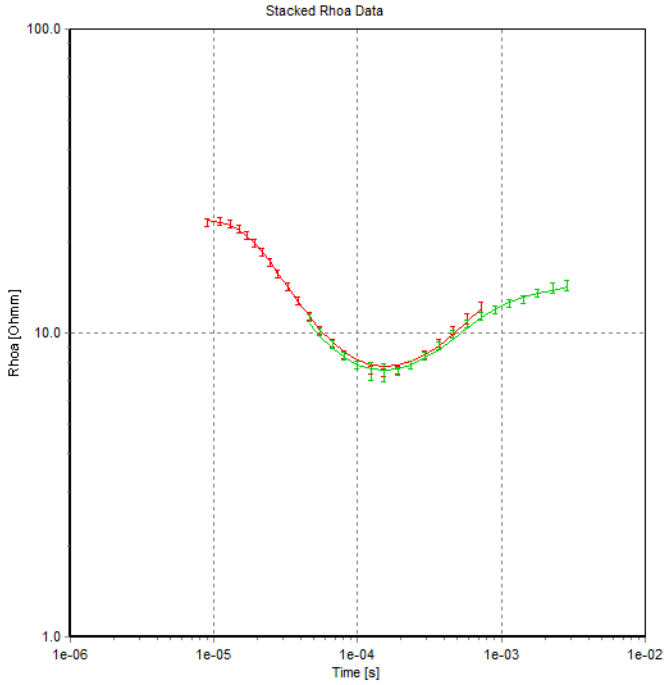


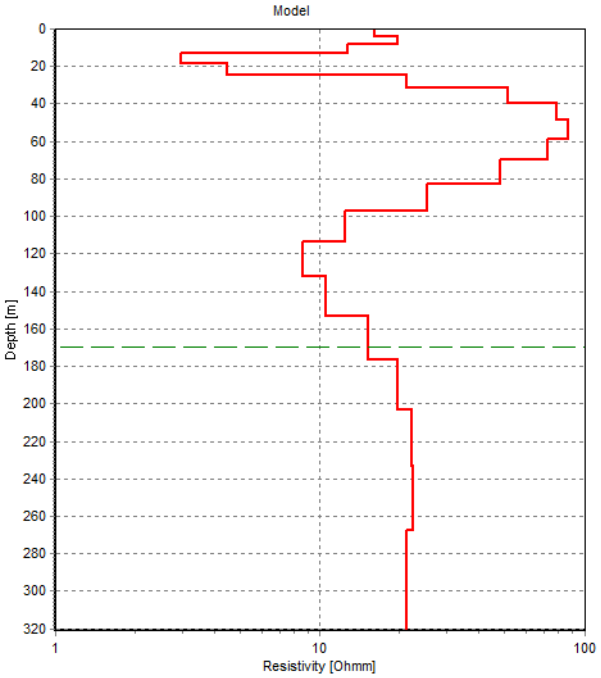


Station 26

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873425
UTMY: 2163714
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.6
No. of Layers: 20
DOI: 169m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	16	1.16	3.82	1.001	3.82	1.001
2	19.7	1.37	4.31	1.001	8.14	1.001
3	12.7	1.25	4.87	1.001	13	1.001
4	2.99	1.08	5.5	1.001	18.5	1.000
5	4.45	1.15	6.21	1.001	24.7	1.000
6	21.1	1.55	7.01	1.001	31.7	1.000
7	51.5	1.77	7.91	1.001	39.6	1.000
8	78.4	1.90	8.93	1.001	48.6	1.000
9	86.2	1.94	10.1	1.001	58.7	1.000
10	72.6	1.90	11.4	1.001	70.1	1.000
11	47.8	1.79	12.9	1.001	82.9	1.000
12	25.3	1.63	14.5	1.001	97.4	1.000
13	12.4	1.48	16.4	1.001	114	1.000
14	8.59	1.43	18.5	1.001	132	1.000
15	10.5	1.49	20.9	1.001	153	1.000
16	15.1	1.63	23.6	1.001	177	1.000
17	19.7	1.91	26.6	1.001	203	1.000
18	22.2	2.39	30.1	1.001	233	1.000
19	22.4	3.06	33.9	1.001	267	1.000
20	21.3	3.88				

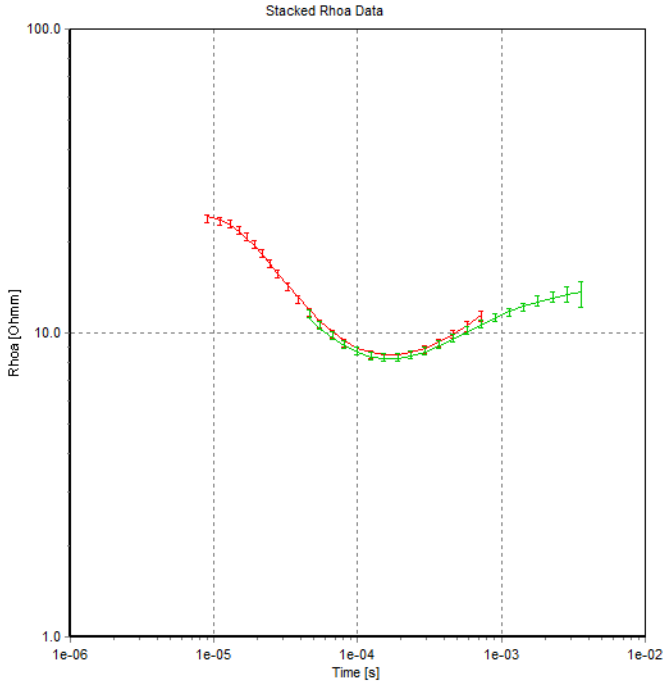


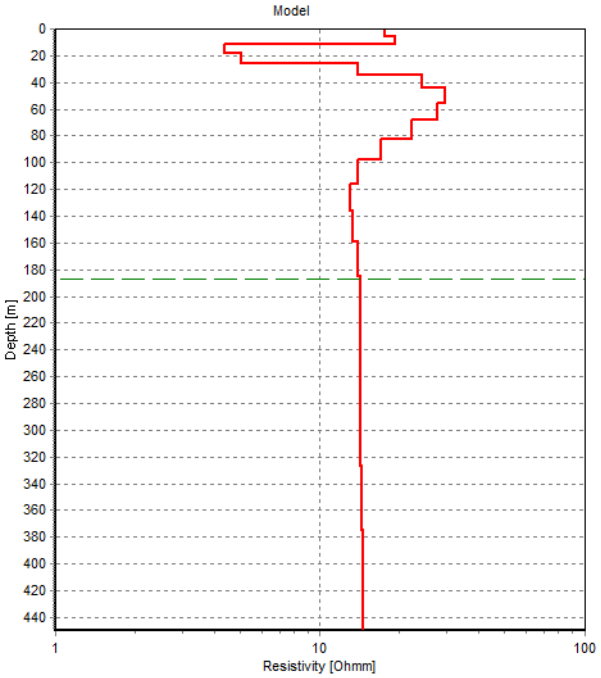


Station 27

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5874136
UTMY: 2166453
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 187m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	17.5	1.10	5.36	1.001	5.36	1.001
2	19.2	1.26	6.05	1.001	11.4	1.001
3	4.35	1.08	6.83	1.001	18.2	1.001
4	5.03	1.14	7.71	1.001	25.9	1.000
5	13.9	1.41	8.7	1.001	34.6	1.000
6	24.3	1.51	9.82	1.001	44.5	1.000
7	29.5	1.58	11.1	1.001	55.6	1.000
8	27.7	1.60	12.5	1.001	68.1	1.000
9	22.2	1.58	14.1	1.001	82.2	1.000
10	17	1.53	16	1.001	98.2	1.000
11	13.9	1.50	18	1.001	116	1.000
12	13	1.51	20.3	1.001	137	1.000
13	13.4	1.57	23	1.001	160	1.000
14	13.9	1.73	25.9	1.001	185	1.000
15	14.2	2.09	29.3	1.001	215	1.000
16	14.2	2.69	33	1.001	248	1.000
17	14.1	3.50	37.3	1.001	285	1.000
18	14.2	4.43	42.1	1.001	327	1.000
19	14.4	5.36	47.6	1.001	375	1.000
20	14.6	6.25				

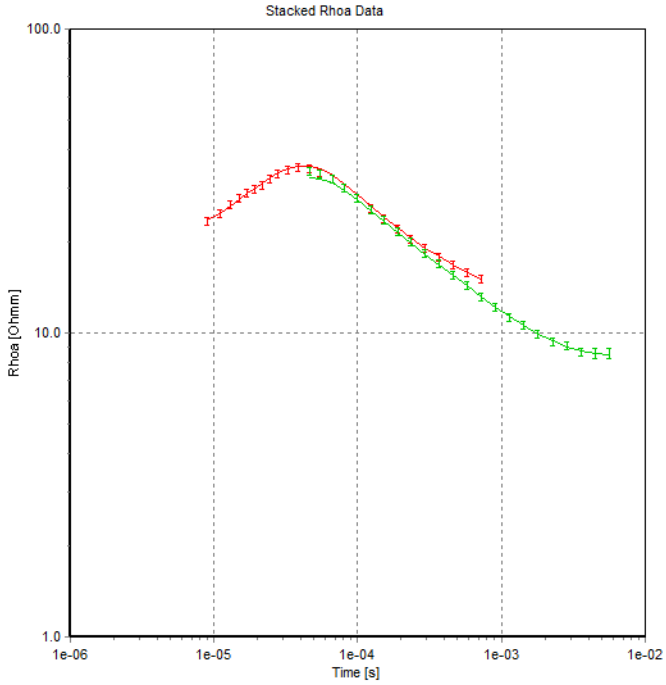


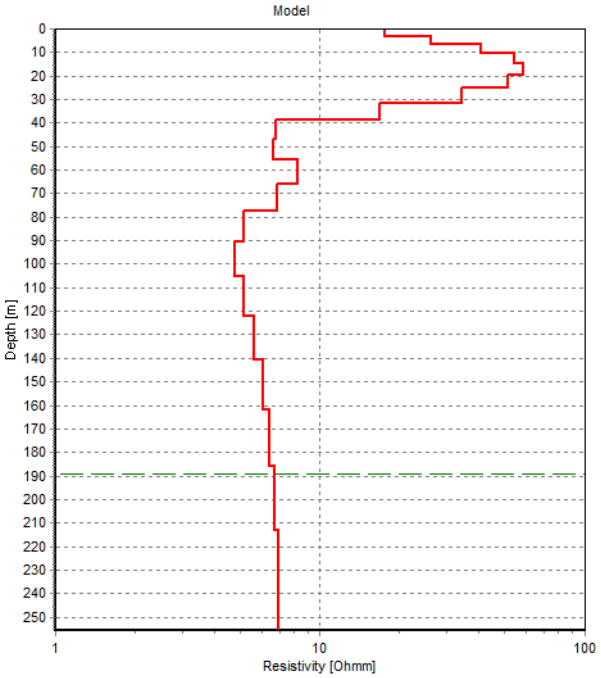


Station 28

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873307
UTMY: 2166547
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 189m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	17.6	1.25	3.05	1.001	3.05	1.001
2	26.4	1.43	3.44	1.001	6.48	1.001
3	40.7	1.49	3.88	1.001	10.4	1.001
4	54.1	1.50	4.38	1.001	14.7	1.000
5	58.8	1.54	4.95	1.001	19.7	1.000
6	51.2	1.53	5.59	1.001	25.3	1.000
7	34.4	1.46	6.3	1.001	31.6	1.000
8	16.8	1.37	7.12	1.001	38.7	1.000
9	6.8	1.22	8.04	1.001	46.7	1.000
10	6.65	1.27	9.07	1.001	55.8	1.000
11	8.2	1.35	10.2	1.001	66	1.000
12	6.88	1.35	11.6	1.001	77.6	1.000
13	5.13	1.33	13.1	1.001	90.7	1.000
14	4.78	1.36	14.7	1.001	105	1.000
15	5.17	1.40	16.6	1.001	122	1.000
16	5.66	1.44	18.8	1.001	141	1.000
17	6.08	1.47	21.2	1.001	162	1.000
18	6.43	1.59	24	1.001	186	1.000
19	6.73	1.96	27	1.001	213	1.000
20	6.95	2.61				

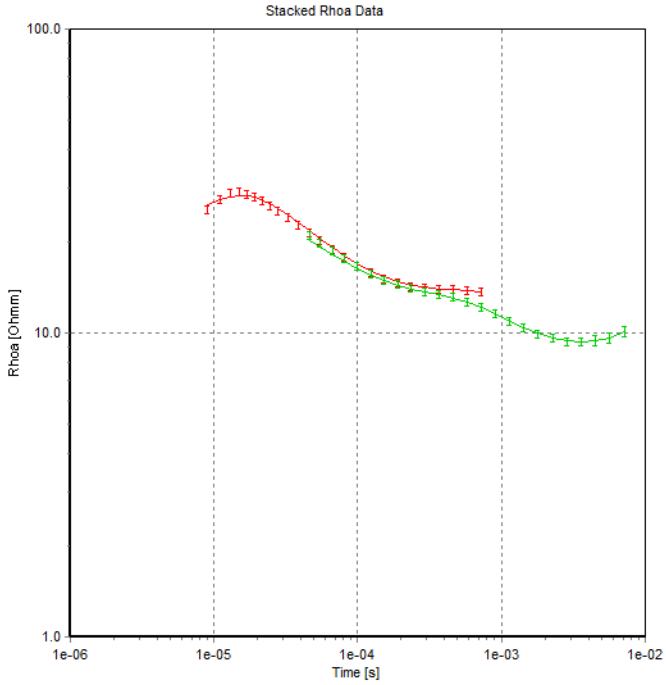


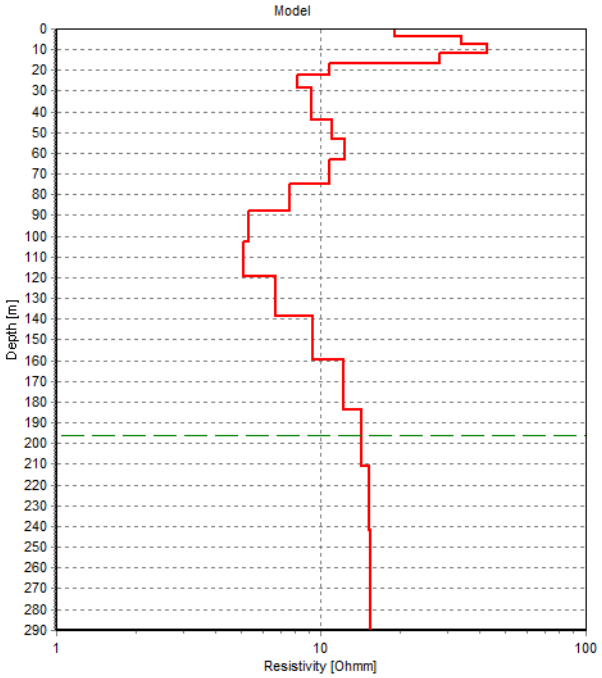


Station 29

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873212
UTMY: 2166430
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 196m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	19	1.21	3.46	1.001	3.46	1.001
2	34	1.46	3.9	1.001	7.36	1.001
3	42.2	1.48	4.41	1.001	11.8	1.001
4	28.1	1.40	4.97	1.001	16.7	1.000
5	10.8	1.25	5.61	1.001	22.4	1.000
6	8.14	1.24	6.34	1.001	28.7	1.000
7	9.16	1.30	7.16	1.001	35.8	1.000
8	9.15	1.33	8.08	1.001	43.9	1.000
9	11	1.39	9.12	1.001	53	1.000
10	12.3	1.44	10.3	1.001	63.3	1.000
11	10.8	1.44	11.6	1.001	75	1.000
12	7.57	1.40	13.1	1.001	88.1	1.000
13	5.32	1.37	14.8	1.001	103	1.000
14	5.12	1.38	16.7	1.001	120	1.000
15	6.7	1.44	18.9	1.001	139	1.000
16	9.34	1.51	21.3	1.001	160	1.000
17	12.1	1.57	24.1	1.001	184	1.000
18	14.2	1.68	27.2	1.001	211	1.000
19	15.2	1.93	30.7	1.001	242	1.000
20	15.3	2.37				

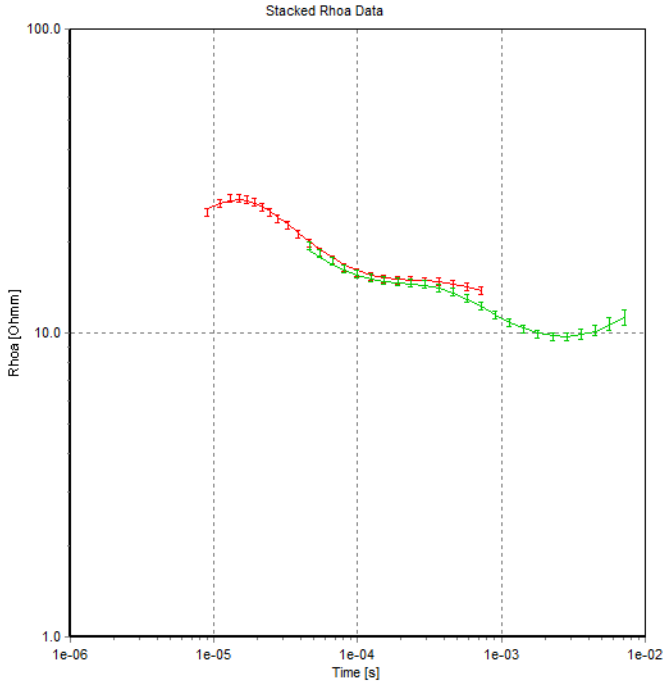


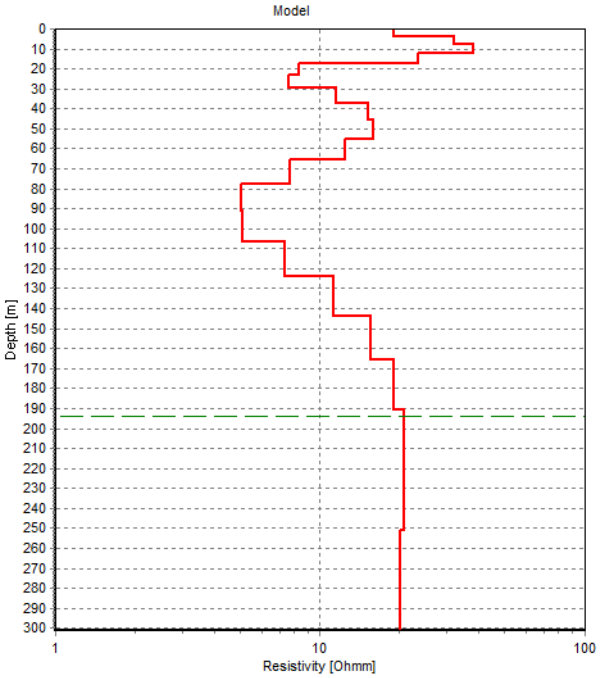


Station 30

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873116
UTMY: 2166280
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 194m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	18.9	1.20	3.59	1.001	3.59	1.001
2	32	1.45	4.05	1.001	7.64	1.001
3	37.8	1.44	4.57	1.001	12.2	1.001
4	23.3	1.36	5.16	1.001	17.4	1.000
5	8.35	1.21	5.83	1.001	23.2	1.000
6	7.65	1.23	6.58	1.001	29.8	1.000
7	11.5	1.35	7.43	1.001	37.2	1.000
8	15.2	1.42	8.38	1.001	45.6	1.000
9	15.9	1.46	9.47	1.001	55	1.000
10	12.5	1.43	10.7	1.001	65.7	1.000
11	7.73	1.38	12.1	1.001	77.8	1.000
12	5.03	1.34	13.6	1.001	91.4	1.000
13	5.07	1.35	15.4	1.001	107	1.000
14	7.4	1.44	17.4	1.001	124	1.000
15	11.3	1.53	19.6	1.001	144	1.000
16	15.6	1.60	22.1	1.001	166	1.000
17	19	1.67	25	1.001	191	1.000
18	20.8	1.81	28.2	1.001	219	1.000
19	20.8	2.09	31.9	1.001	251	1.000
20	20	2.55				

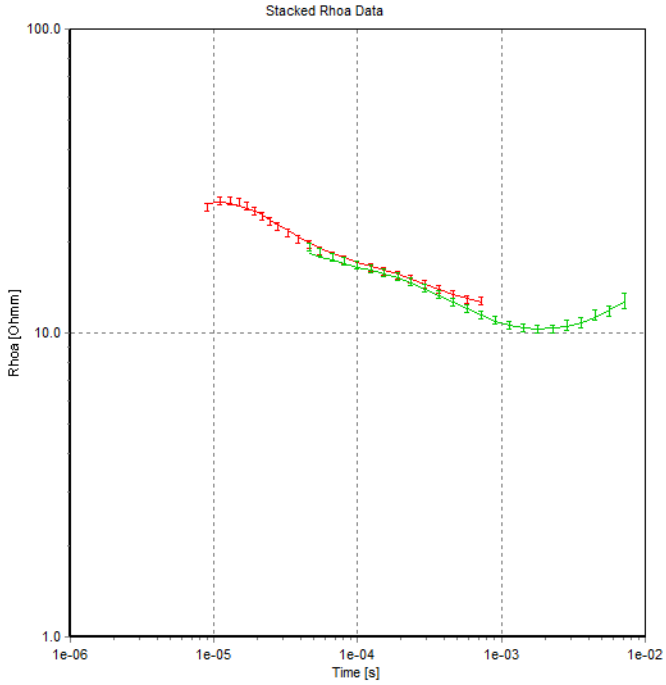


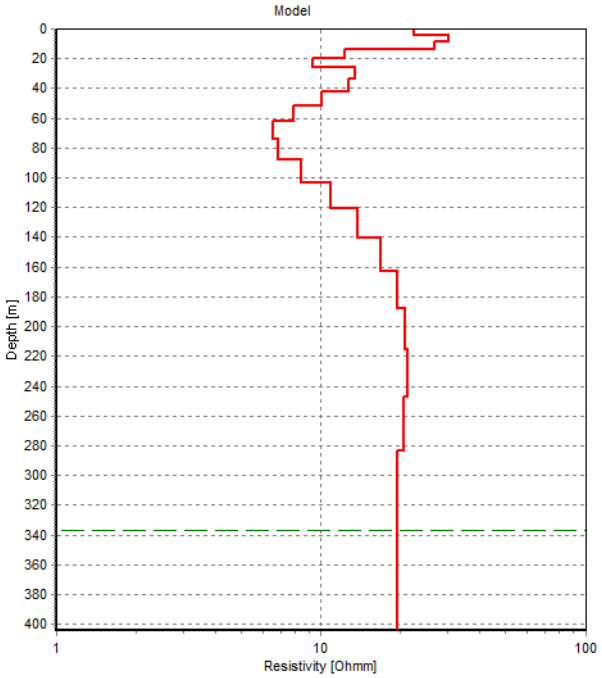


Station 31

Print Date:	13-12-2017
Database Name:	TDEM_SLO_EPSG2229.gdb
UTMX:	5873052
UTMY:	2166119
EPSG:	NAD83/California zone 5, EPSG:2229
Importer:	Not Available
Version:	Not Available
Data Residual:	0.5
No. of Layers:	20
DOI:	337m
Program:	SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	22.3	1.24	4.05	1.001	4.05	1.001
2	30.4	1.40	4.57	1.001	8.63	1.001
3	26.9	1.35	5.17	1.001	13.8	1.001
4	12.3	1.26	5.83	1.001	19.6	1.000
5	9.28	1.21	6.58	1.001	26.2	1.000
6	13.4	1.33	7.43	1.001	33.6	1.000
7	12.6	1.36	8.39	1.001	42	1.000
8	10	1.36	9.48	1.001	51.5	1.000
9	7.82	1.34	10.7	1.001	62.2	1.000
10	6.61	1.34	12.1	1.001	74.3	1.000
11	6.89	1.37	13.6	1.001	87.9	1.000
12	8.43	1.42	15.4	1.001	103	1.000
13	10.8	1.48	17.4	1.001	121	1.000
14	13.8	1.55	19.6	1.001	140	1.000
15	16.8	1.59	22.1	1.001	162	1.000
16	19.3	1.63	25	1.001	187	1.000
17	20.8	1.73	28.2	1.001	216	1.000
18	21.1	2.00	31.9	1.001	248	1.000
19	20.5	2.46	36	1.001	284	1.000
20	19.4	3.08				

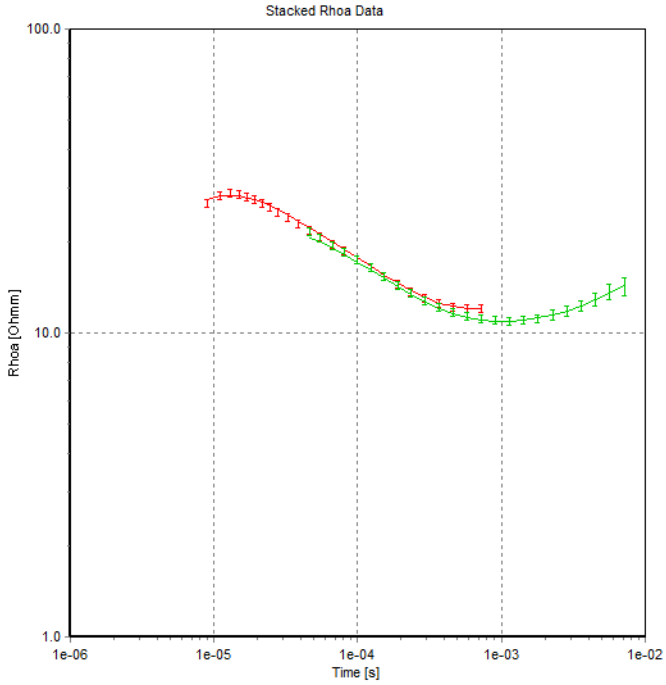


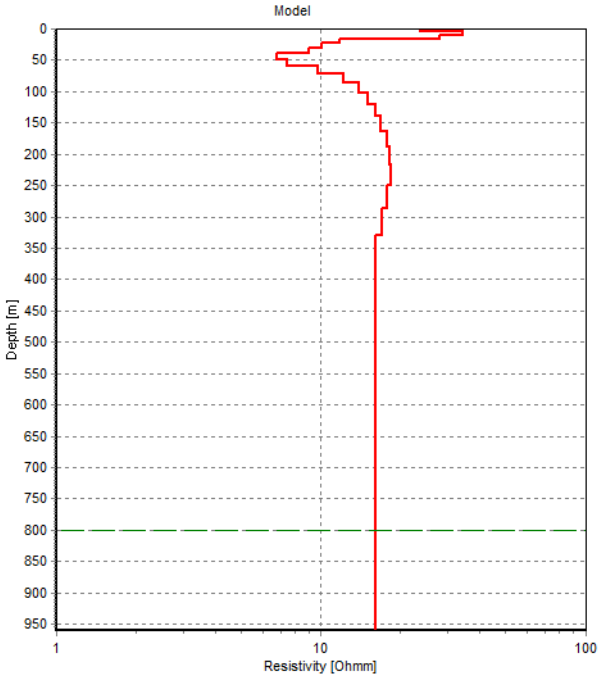


Station 32

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5872749
UTMY: 2161098
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 800m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	23.8	1.17	4.7	1.001	4.7	1.001
2	34.2	1.40	5.31	1.001	10	1.001
3	27.9	1.33	5.99	1.001	16	1.001
4	11.7	1.21	6.76	1.001	22.8	1.000
5	10	1.23	7.64	1.001	30.4	1.000
6	8.96	1.27	8.62	1.001	39	1.000
7	6.79	1.26	9.73	1.001	48.8	1.000
8	7.46	1.32	11	1.001	59.8	1.000
9	9.69	1.39	12.4	1.001	72.2	1.000
10	12.1	1.45	14	1.001	86.2	1.000
11	13.9	1.49	15.8	1.001	102	1.000
12	15.1	1.52	17.9	1.001	120	1.000
13	16	1.55	20.2	1.001	140	1.000
14	16.8	1.58	22.8	1.001	163	1.000
15	17.7	1.60	25.7	1.001	188	1.000
16	18.2	1.66	29	1.001	217	1.000
17	18.3	1.75	32.8	1.001	250	1.000
18	17.9	1.80	37	1.001	287	1.000
19	17	1.68	41.8	1.001	329	1.000
20	16	1.14				

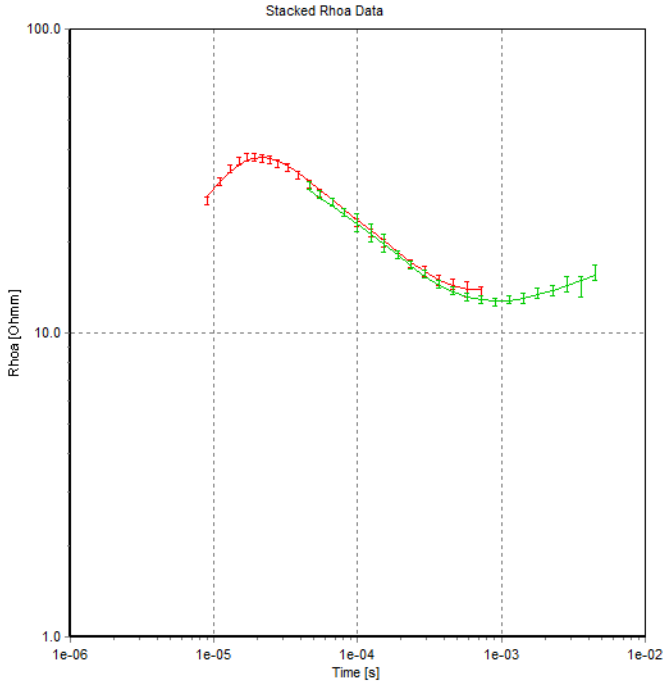


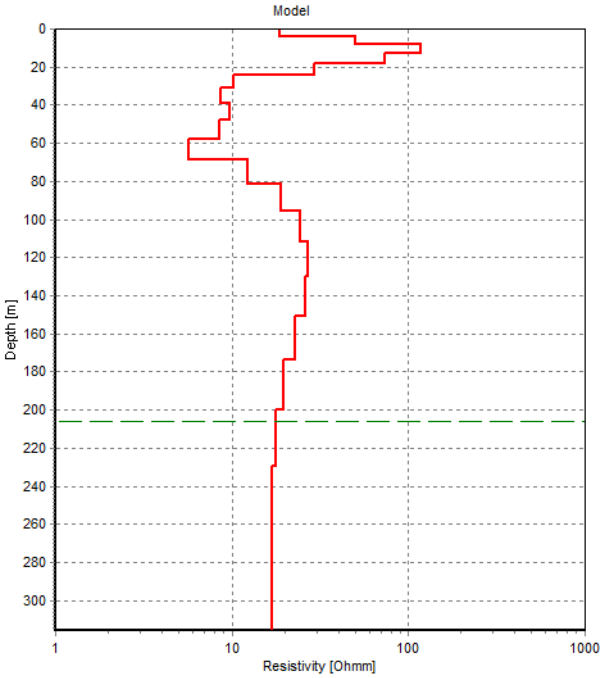


Station 33

Print Date:	13-12-2017
Database Name:	TDEM_SLO_EPSG2229.gdb
UTMX:	5873093
UTMY:	2161727
EPSG:	NAD83/California zone 5, EPSG:2229
Importer:	Not Available
Version:	Not Available
Data Residual:	0.5
No. of Layers:	20
DOI:	206m
Program:	SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	18.6	1.14	3.76	1.001	3.76	1.001
2	50.1	1.51	4.24	1.001	8	1.001
3	118	1.62	4.79	1.001	12.8	1.001
4	73.3	1.51	5.41	1.001	18.2	1.000
5	29.4	1.38	6.11	1.001	24.3	1.000
6	10.3	1.21	6.89	1.001	31.2	1.000
7	8.69	1.24	7.78	1.001	39	1.000
8	9.72	1.31	8.79	1.001	47.8	1.000
9	8.53	1.33	9.92	1.001	57.7	1.000
10	5.67	1.26	11.2	1.001	68.9	1.000
11	12.2	1.45	12.6	1.001	81.5	1.000
12	19.1	1.55	14.3	1.001	95.8	1.000
13	24.5	1.61	16.1	1.001	112	1.000
14	26.9	1.64	18.2	1.001	130	1.000
15	25.9	1.64	20.5	1.001	151	1.000
16	22.9	1.63	23.2	1.001	174	1.000
17	19.7	1.65	26.2	1.001	200	1.000
18	17.6	1.79	29.6	1.001	230	1.000
19	16.8	2.15	33.4	1.001	263	1.000
20	16.9	2.78				

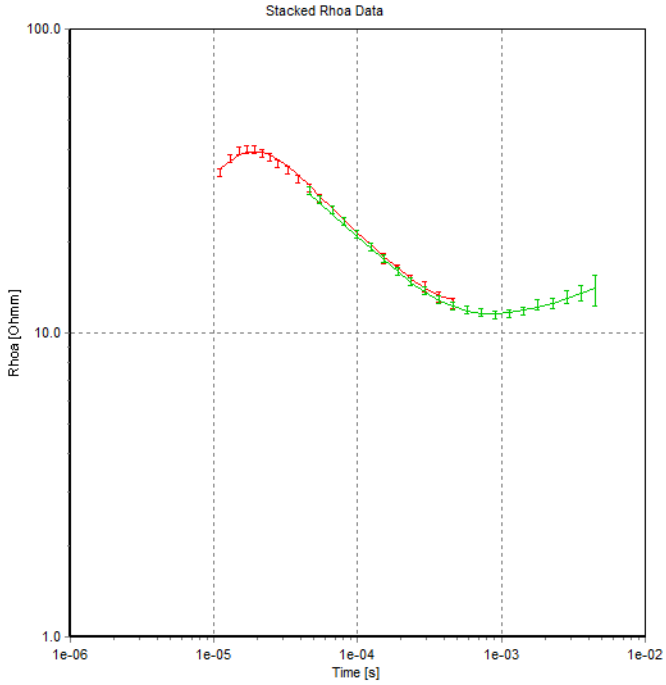


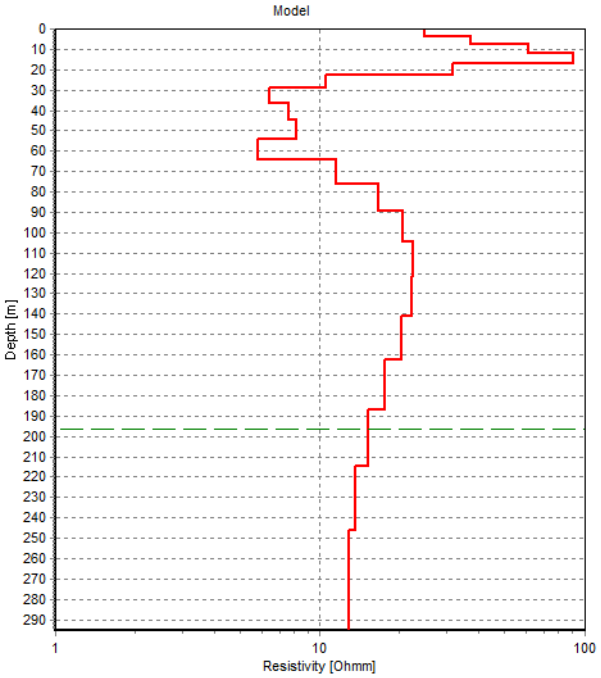


Station 34

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873031
UTMY: 2161619
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.6
No. of Layers: 20
DOI: 197m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	25	1.32	3.52	1.001	3.52	1.001
2	37	1.44	3.97	1.001	7.49	1.001
3	61.1	1.61	4.48	1.001	12	1.001
4	90.7	1.61	5.06	1.001	17	1.000
5	31.8	1.41	5.71	1.001	22.7	1.000
6	10.5	1.24	6.45	1.001	29.2	1.000
7	6.4	1.19	7.28	1.001	36.5	1.000
8	7.57	1.27	8.22	1.001	44.7	1.000
9	8.1	1.34	9.28	1.001	54	1.000
10	5.81	1.28	10.5	1.001	64.5	1.000
11	11.5	1.46	11.8	1.001	76.3	1.000
12	16.7	1.54	13.4	1.001	89.6	1.000
13	20.6	1.59	15.1	1.001	105	1.000
14	22.5	1.63	17	1.001	122	1.000
15	22.2	1.65	19.2	1.001	141	1.000
16	20.2	1.66	21.7	1.001	163	1.000
17	17.5	1.73	24.5	1.001	187	1.000
18	15.2	1.95	27.7	1.001	215	1.000
19	13.6	2.41	31.2	1.001	246	1.000
20	12.9	3.13				

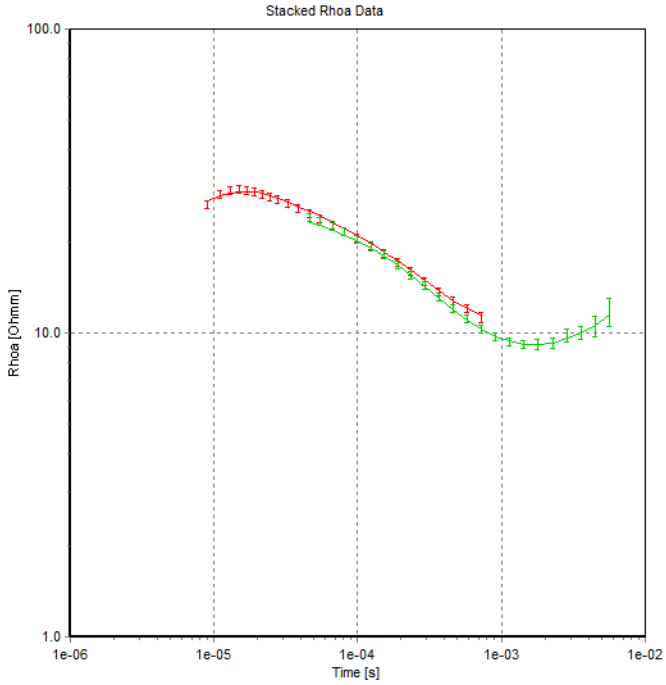


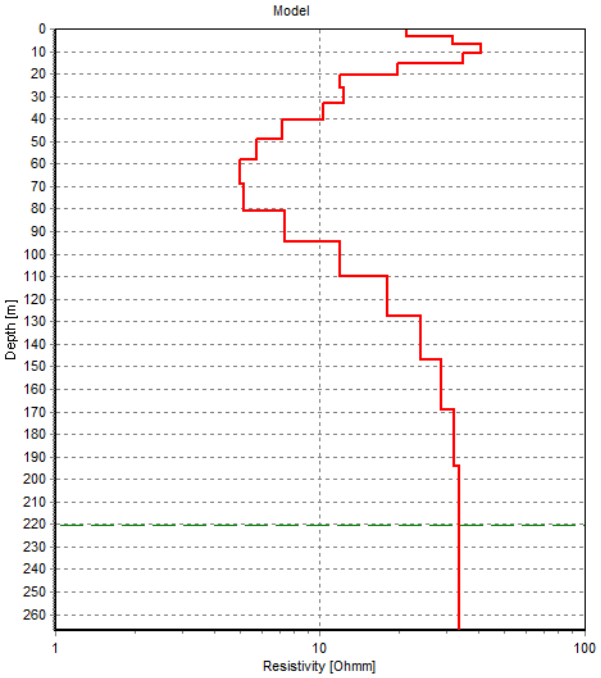


Station 35

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873108
UTMY: 2165190
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 220m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	21.2	1.27	3.18	1.001	3.18	1.001
2	31.6	1.45	3.59	1.001	6.77	1.001
3	40.3	1.51	4.05	1.001	10.8	1.001
4	34.5	1.42	4.58	1.001	15.4	1.000
5	19.6	1.36	5.17	1.001	20.6	1.000
6	11.9	1.27	5.83	1.001	26.4	1.000
7	12.2	1.33	6.59	1.001	33	1.000
8	10.3	1.32	7.44	1.001	40.4	1.000
9	7.2	1.30	8.4	1.001	48.8	1.000
10	5.76	1.30	9.48	1.001	58.3	1.000
11	4.95	1.31	10.7	1.001	69	1.000
12	5.13	1.34	12.1	1.001	81.1	1.000
13	7.36	1.42	13.6	1.001	94.7	1.000
14	11.9	1.52	15.4	1.001	110	1.000
15	17.9	1.63	17.4	1.001	128	1.000
16	23.9	1.74	19.6	1.001	147	1.000
17	28.8	1.87	22.2	1.001	169	1.000
18	32	2.04	25	1.001	194	1.000
19	33.4	2.27	28.3	1.001	223	1.000
20	33.6	2.55				

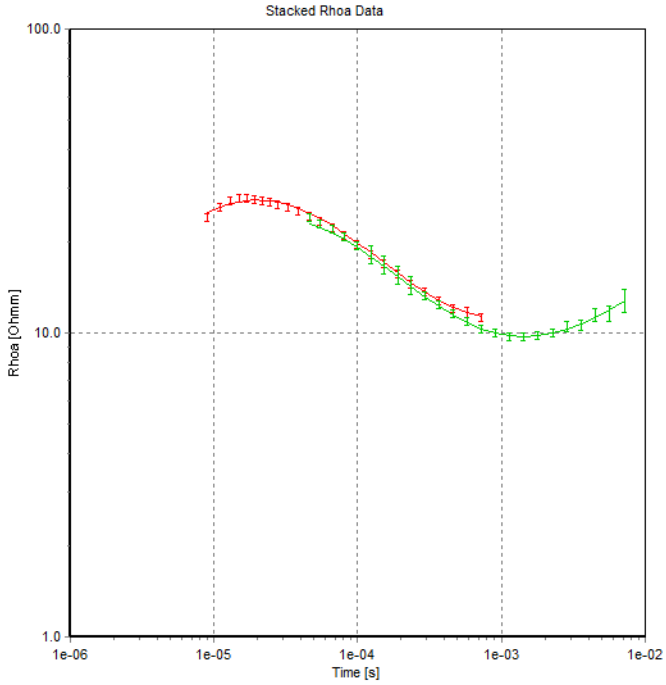


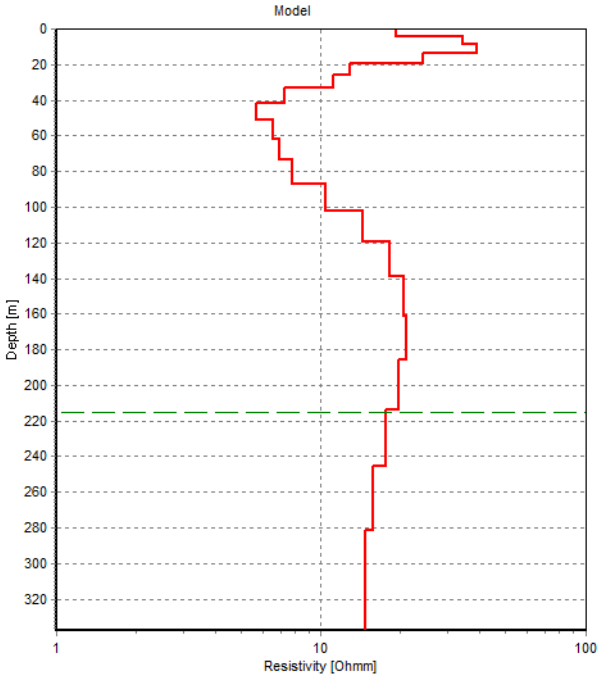


Station 36

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5873478
UTMY: 2164121
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.5
No. of Layers: 20
DOI: 215m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	19.1	1.17	4.02	1.001	4.02	1.001
2	34.2	1.44	4.54	1.001	8.56	1.001
3	38.6	1.41	5.12	1.001	13.7	1.001
4	24.4	1.35	5.79	1.001	19.5	1.000
5	12.9	1.25	6.53	1.001	26	1.000
6	11.1	1.29	7.37	1.001	33.4	1.000
7	7.26	1.25	8.32	1.001	41.7	1.000
8	5.66	1.25	9.4	1.001	51.1	1.000
9	6.57	1.34	10.6	1.001	61.7	1.000
10	6.95	1.37	12	1.001	73.7	1.000
11	7.78	1.40	13.5	1.001	87.2	1.000
12	10.4	1.47	15.3	1.001	102	1.000
13	14.3	1.55	17.2	1.001	120	1.000
14	18.2	1.61	19.5	1.001	139	1.000
15	20.6	1.65	22	1.001	161	1.000
16	20.9	1.68	24.8	1.001	186	1.000
17	19.6	1.76	28	1.001	214	1.000
18	17.6	1.97	31.6	1.001	246	1.000
19	15.8	2.39	35.7	1.001	281	1.000
20	14.7	3.04				

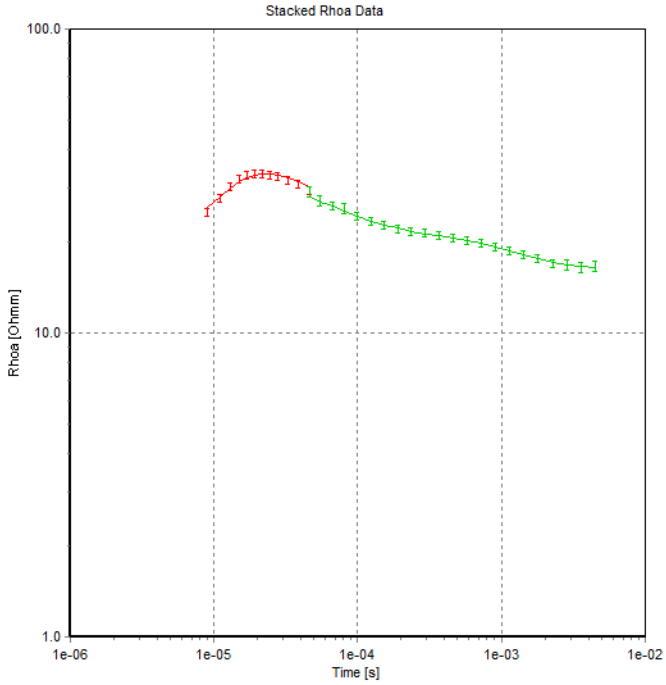


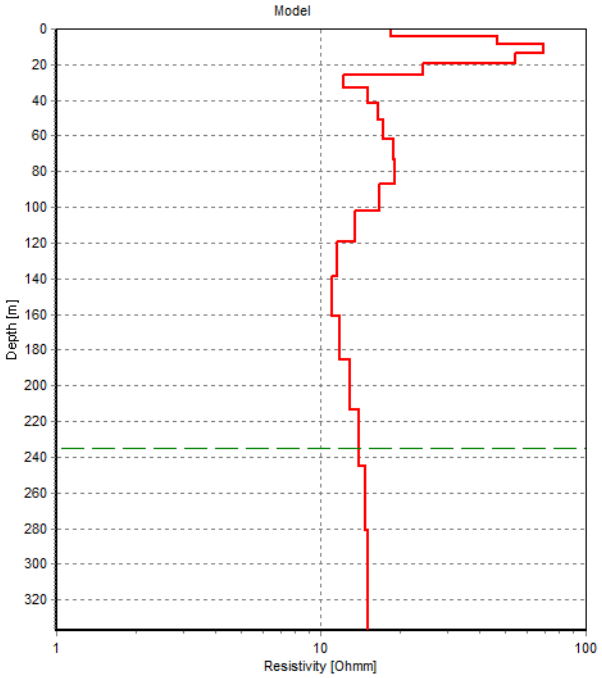


Station 37

Print Date: 13-12-2017
Database Name: TDEM_SLO_EPSG2229.gdb
UTMX: 5872852
UTMY: 2161191
EPSG: NAD83/California zone 5, EPSG:2229
Importer: Not Available
Version: Not Available
Data Residual: 0.4
No. of Layers: 20
DOI: 235m
Program: SPIA.exe, version 2.3.1.0

#	Res	ResSTD	Thk	ThkSTD	Dep	DepSTD
1	18.4	1.14	4.01	1.001	4.01	1.001
2	46.4	1.49	4.53	1.001	8.55	1.001
3	69.3	1.50	5.12	1.001	13.7	1.001
4	54.1	1.44	5.78	1.001	19.4	1.000
5	24.3	1.36	6.52	1.001	26	1.000
6	12.2	1.23	7.36	1.001	33.3	1.000
7	15	1.33	8.31	1.001	41.6	1.000
8	16.5	1.37	9.39	1.001	51	1.000
9	17.2	1.40	10.6	1.001	61.6	1.000
10	18.7	1.44	12	1.001	73.6	1.000
11	18.9	1.47	13.5	1.001	87.1	1.000
12	16.6	1.47	15.3	1.001	102	1.000
13	13.5	1.45	17.2	1.001	120	1.000
14	11.5	1.44	19.4	1.001	139	1.000
15	11.1	1.45	21.9	1.001	161	1.000
16	11.7	1.46	24.8	1.001	186	1.000
17	12.9	1.50	28	1.001	214	1.000
18	14	1.66	31.6	1.001	245	1.000
19	14.8	2.08	35.7	1.001	281	1.000
20	15.1	2.79				





Depth 0 to 10 m

Depth 10 to 20 m

Depth 20 to 30 m

Depth 30 to 40 m

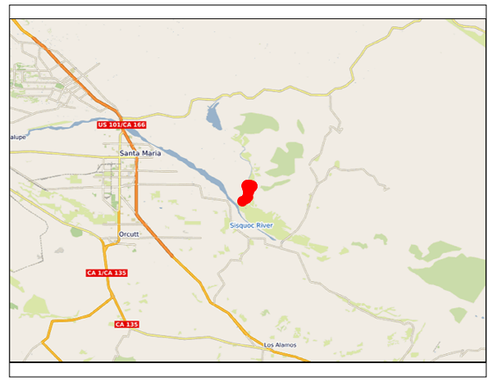
Depth 40 to 50 m

Depth 50 to 60 m

Depth 60 to 70 m

Depth 70 to 80 m

San Luis Obispo County



Rev.: 01
Date: 2017-12-11
By: PRT
QC: MAXH
Project: 1100030175

Annex 2.01

Mean resisitivity 0 to 80 mbsl.

Cuyama River Valley Fringe Area - TDEM

RAMBØLL

Olof Palmes Allé 22
Dk 8200 Aarhus N

Depth 80 to 90 m

Depth 90 to 100 m

Depth 100 to 110 m

Depth 110 to 120 m

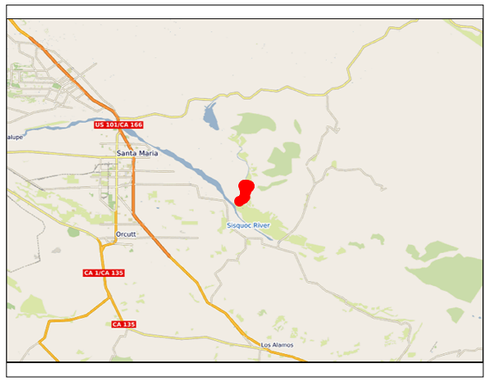
Depth 120 to 130 m

Depth 130 to 140 m

Depth 140 to 150 m

Depth 150 to 160 m

San Luis Obispo County



Rev.: 01
Date: 2017-12-11
By: PRT
QC: MAXH
Project: 1100030175

Annex 2.02

Mean resisitivity 80 to 160 mbsl.

Cuyama River Valley Fringe Area - TDEM

RAMBØLL

Olof Palmes Allé 22
Dk 8200 Aarhus N