Kennedy/Jenks Consultants

10850 Gold Center Drive, Suite 350
Rancho Cordova, California 95670
916-858-2700
FAX: 916-858-2754

SOUTH Y PRE-DESIGN INVESTIGATION WORKPLAN [Agreement D1712508]

(FINAL)

March 23, 2018

Prepared for

South Tahoe Public Utilities District
1275 Meadow Crest Drive
South Lake Tahoe, CA 96150

K/J Project No. 1770027.00

Certification

The following work plan was prepared by:

SACHIKO ITAGAKI
C50221
EXP. 6/30/19
CIVIL

Sachiko Itagaki, PE 50221, Expires 6/30/19
Kennedy/Jenks Consultants, Inc.

MICHAEL LAWRENCE MC LEOD
No 5977

Michael L. McLeod, PG 5977, Expires 9/30/19
Kennedy/Jenks Consultants, Inc.

IVO BERGSOHN
No. 519
CERTIFIED HYDROGEOLOGIST

Ivo Bergsohn, PG 5995, HG 519, PG/HG Expire 9/30/19
South Tahoe Public Utility District

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Section 1: Introduction

South Tahoe Public Utility District (District) has contracted with Kennedy/Jenks Consultants (Kennedy Jenks), to conduct a Pre-Design Investigation (PDI) and a Feasibility Study of Remedial Alternatives (FS) to address tetrachloroethylene (PCE) contamination found in groundwater within the South “Y” Area of the City of South Lake Tahoe, El Dorado County, California; herein referred to as the South “Y” Plume. The FS is detailed in the District’s Proposition 1 Groundwater Grant Program Final Application (FAAST # 36772) submitted for review and evaluation by the State Water Resources Control Board Department of Financial Assistance (SWRCB-DOFA) in November 2016. The PDI has been added to augment the existing hydrologic and groundwater quality data for use in the FS.

The objective of the PDI is to collect specific capacity, aquifer characterization and water quality data that can be used to design strategies for the purpose of hydraulic control and/or removal of PCE contamination from groundwater. As detailed in the sections that follow, the PDI will involve the drilling and installation of a new test well for the collection of soil and groundwater samples for lithologic description and vertical delineation of PCE contamination. The new test well will also be used for aquifer characterization. Monitoring of existing wells neighboring the test well will be used as observation wells to calculate hydraulic properties; identify groundwater contaminant pathways; determine horizontal and vertical hydraulic gradients; and groundwater flow directions. These data will then be integrated and evaluated with the existing hydrologic and contaminant distribution data in the FS.

1.1 Work Plan Organization

This work plan consists of the following sections and appendices:

- **Section 1.0, Introduction,** contains the introduction; statement of objectives; background information, including the site description, site history, and previous investigations. Project organization, responsibilities and schedule are also presented in Section 1.0.
- **Section 2.0, Sampling and Analysis Plan,** outlines the field investigation to be performed, the objective of each phase of work, and the sampling and analysis activities to be completed. Section 2.0 also describes all methods and procedures to be followed by Kennedy/Jenks and the District to evaluate the existing well and build a new test well.
- **Section 3.0, Decontamination Procedures,** outlines procedures used to decontaminate equipment, including several options for the removal of PCE.
- **Section 4.0, Investigation-Derived Waste,** outlines how wastes will be characterized, tested and disposed.
- **Section 5.0, Quality Assurance Project Plan,** specifies the procedures to be followed to maintain field and laboratory data of consistent quality.
- **Section 6.0, Pre-Design Investigation Report Topics,** includes analysis and evaluation of data in addition to all laboratory reports and daily field notes, drilling logs, subcontractor reports and photographs.
- Appendix A- 903 and 953 Eloise Site Photos
- Appendix B - Lithologic and Well Construction Logs

- Appendix C- Analytical Results Summary
- Appendix D, Standard Operating Procedures and Field Forms, provides standard operating procedures (SOPs) for drilling and sampling, and forms for these procedures.
- Appendix E, District Laboratory Water Quality Assurance Program, provides the District's quality assurance procedures used for sampling procedures, analysis preparation, analysis, maintenance of laboratory equipment and supplies, as well as the reporting of analytical results.

For the purposes of this document, the following terms will be used to differentiate the specific wells involved in the PDI:

South Y Area wells: Existing groundwater wells within the area referred to as the South Y. These wells encompass public water system wells (PWS wells), monitoring wells (MW wells), and private domestic supply wells (private wells).

PWS wells: Wells operated by the local public/community water suppliers, including the District, Lukins Brothers Water Company (LBWC), and Tahoe Keys Water Company (TKWC), for the purposes of supplying drinking water to their customers.

monitoring wells: Wells operated for the purposes of monitoring the groundwater aquifer, including water levels and water quality.

private wells: Wells owned and operated privately for domestic supply and do not tie into the PWS.

observation wells: PWS wells and MW wells that will be used in the PDI during aquifer testing.

Test well: the new well that will be drilled for aquifer testing.

Wells: Refers to groundwater wells.

1.2 Background Information

The South "Y" Plume occurs within the west central portion of the Tahoe Valley South Sub-basin (6-5.01), herein referred to as the Tahoe Valley South Basin (TVS Basin). The TVS Basin has an area of approximately 23 square miles (14,814 acres) in El Dorado County, California (Figure 1-1). The TVS Basin is roughly triangular in aerial extent and is bounded on the southwest by the Sierra Nevada, on the southeast by the Carson Range, and on the north by the southern shore of Lake Tahoe. The Basin generally conforms to the valleys of the Upper Truckee River and Trout Creek. The City of South Lake Tahoe (CSLT) overlies the northern portion of the TVS Basin. The southern boundary extends about 3 miles south of the town of Meyers. The northeast boundary of the TVS Basin is defined by the California-Nevada state line.

Groundwater is the primary source of drinking water for the communities overlying the TVS Basin. Most wells drilled in the TVS Basin are completed in basin-fill deposits that generally consist of unconsolidated glacial, lake and stream sediments. These sedimentary deposits fill the lower reaches of the canyons that drain toward Lake Tahoe and underlie the relatively flat lying valley floors. For ease of description, the TVS Basin is subdivided into six geographically based sub-areas, herein referred to as the Tahoe Keys, South Lake Tahoe, Bijou, Angora, Meyers and Christmas Valley sub-areas. The location and extent of these sub-areas are shown on Figure 1-1.

The District is recognized as the exclusive Groundwater Sustainability Agency (GSA) for the TVS Basin. In 2014, the District, in collaboration with a Stakeholders Advisory Group (SAG) composed of local water purveyors, regulatory agency, municipal and county representatives; and rate payers identified the South “Y” Plume as a significant groundwater concern requiring immediate action (KJC, 2014). The South “Y” Plume has impaired groundwater pumped by PWS wells operating in this area since at least 1989, when PCE was first tested in raw water samples collected from these wells. Since 1989, this contaminant problem has been addressed in PWS wells by either removing the impaired well from service; installing wellhead treatment or well abandonment.

In 2016, the District in partnership with Lukins Brothers Water Company (LBWC) and the Tahoe Keys Property Owners Association (TKPOA) undertook renewed investigations to describe the extent of PCE contamination and identify remedial measures that could be used to remove this contamination from groundwater to protect existing groundwater sources used for drinking water supply. This included completion of an engineering assessment of an inactive water supply well (LBWC #4) for use as a potential extraction well (GEI, 2016a); compilation of historical data to show the spatial and temporal distribution of PCE contamination in the South Y Area (GEI, 2016b); and initial development of a modular three-dimensional multispecies transport model (MT3DMS) that could be used to evaluate various remedial alternatives designed to mitigate contamination from the South “Y” Plume.

Source(s) of PCE groundwater contamination for the South “Y” Plume are currently being investigated by the LRWQCB. Potential sources include commercial facilities (repair shops and dry cleaners) that operated during the 1970s and where chlorinated solvents were used as part of their normal business activities.

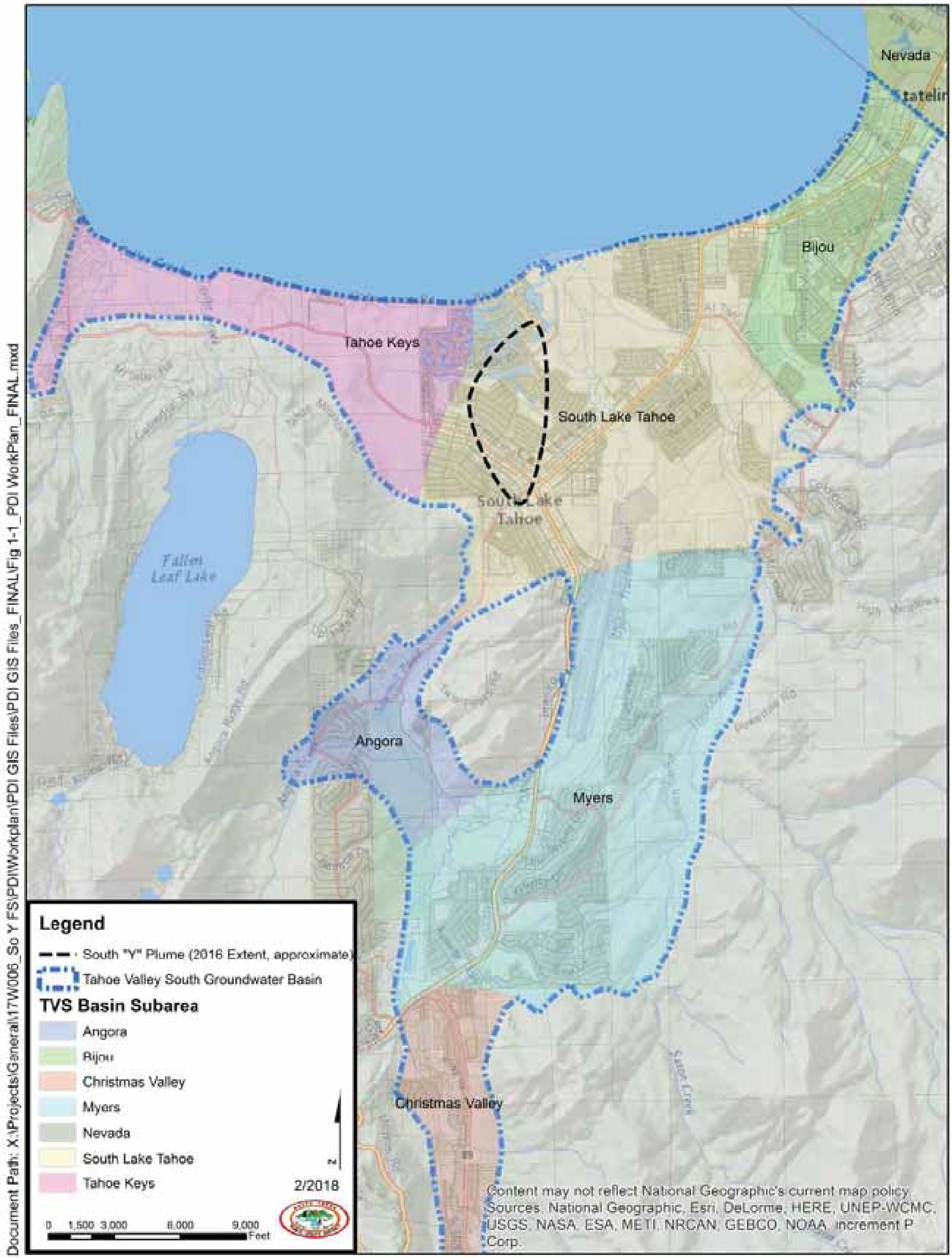


Figure 1-1: Regional location of the South "Y" Plume within the South Lake Tahoe subarea of the Tahoe Valley South Groundwater Basin.

1.2.1 Site Description

The boundaries of the South “Y” Plume have been generally defined using maximum PCE concentrations detected in groundwater samples collected from monitoring wells and PWS wells during 2011 through early 2016 (GEI, 2016b). These data indicate that the South “Y” Plume covers an area of approximately 465 acres extending from the South “Y” in a northerly direction toward Lake Tahoe (Figure 1-2). The South “Y” is a local term used to describe the intersection of Highway 50 and 89 located in the west side of the CSLT.

The South “Y” Plume has impaired three PWS wells (LBWC #2, LBWC #5 and TKWC #2) with a combined source capacity of 3.25 million gallons per day (MGD). Trace levels of PCE below maximum contaminant levels (MCLs) are presently detected in one PWS well (TKWC #1). This well is located about ½-mile south of the south shore of Lake Tahoe, near the leading edge of the contaminant plume. Since June 2016, PCE concentrations in raw water samples collected from this well have generally ranged from 1.5 to 4 µg/L. Potential impairment of TKWC #1 would further reduce the total production capacity of area drinking water sources by an additional 1.44 MGD.

Two other PWS wells (LBWC #1 and TKWC #3) west of the South “Y” plume are presently non-detect (ND) for PCE. The District has mutual aid and assistance agreements for the emergency provision of drinking water using inter-tie connections from its water distribution system to both the LBWC and TKPOA water systems. During the 2016 WY, the District provided 8.73 million gallons through its inter-tie connection to LBWC, which was about 10% of its total water production.

1.2.2 Project Site

Two parcels are currently being considered as a potential project site for the PDI. These parcels are located in the southeast portion of the South “Y” Plume (Figure 1-2), near the intersection of Eloise Avenue and 5th Street (Figure 1-3). Both sites are situated within the SE 1/4 of the SE 1/4, Section 5, T 12 N, R 18 E, Mount Diablo Base Line Meridian. A brief description of each parcel is provided below. Google earth imagery and site photos for these parcels are provided in Appendix A.

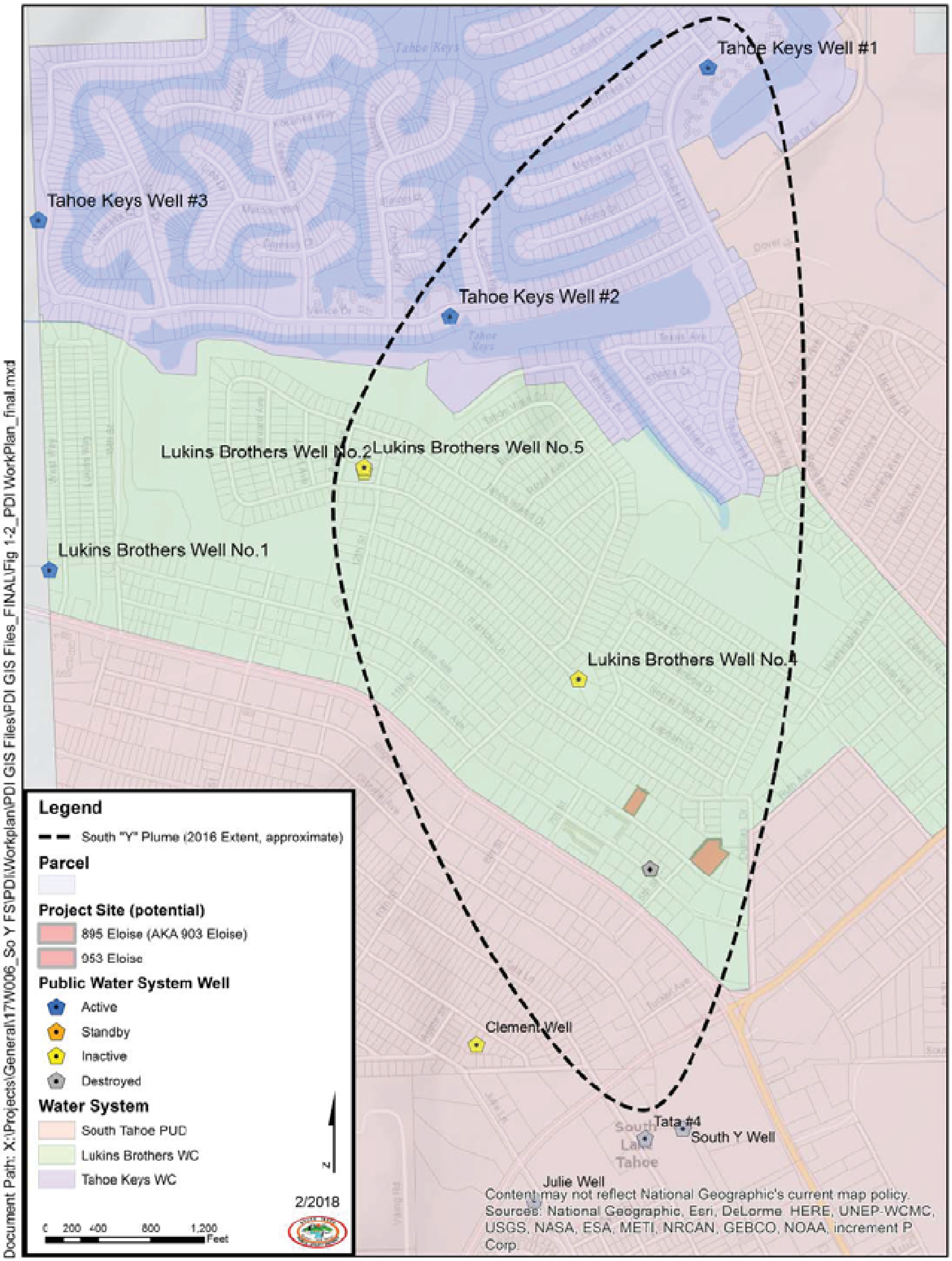


Figure 1-2: **The site area for the PDI will be located within the southeast quarter of the South "Y" Plume. Parcels at 903 Eloise and 953 Eloise Avenue are being considered as a potential location for the PDI.**

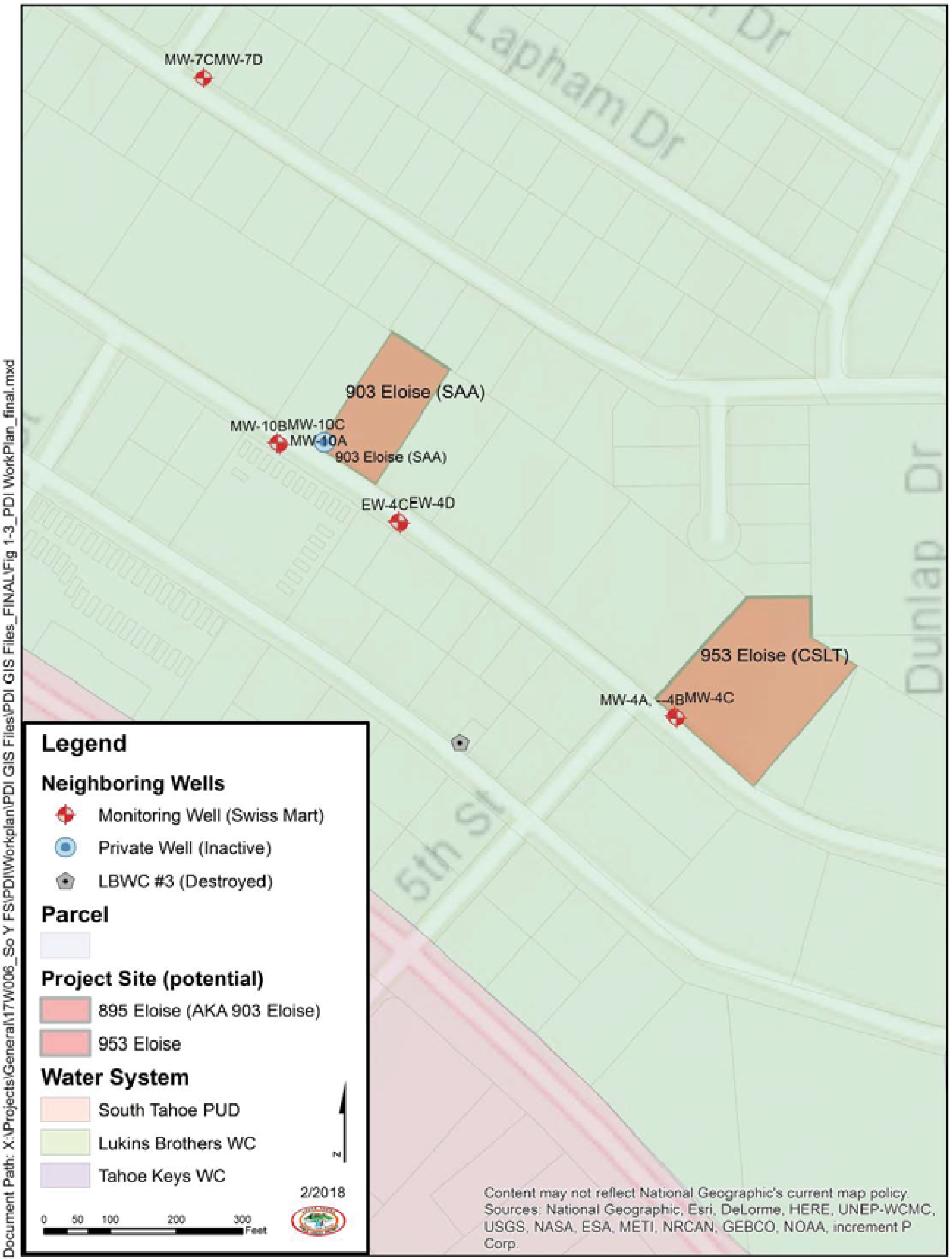


Figure 1-3: Potential parcels being considered for use as projects sites for the PDI.

1.2.2.1 903 Eloise Avenue

This proposed project site is located on a 0.52-acre parcel (APN 023-29-109) owned by the Stanford Alumni Association (SAA) at 903 Eloise Avenue (the property address for this parcel is identified as 895 Eloise Avenue in the El Dorado Country Parcel Layer). This site is located approximately 1,900 feet west of the intersection of Eloise Avenue and 5th Street and is presently used for employee parking. A shallow retention basin is constructed within the southwest quarter of the property to receive surface run-off from the parking area. A caretaker's residence is located at the north end of the property. The property is secured and fully enclosed by chain link fencing. An inactive private well is located in the southwest corner of the property, near the north shoulder of Eloise Avenue.

The Water Well Drillers Report for the private well (WWDR No. 49374) shows this well constructed using 6" diameter welded steel casing from ground surface to a depth of 76 feet (ft). Perforations were torch-cut (5" x ¼") through the bottom 20-feet of the well casing (56 to 76 ft). A 6-ft cement sanitary seal was installed around the top of the well casing. A 28-ft section of Sandy Clay occurs above the top of the perforated interval (20'-48'). The well was constructed in May 1958 using the Cable Tool drilling method.

Two monitoring well clusters are located along the south shoulder of Eloise Avenue about 70 feet west (MW-10) and 170 feet east (EW-4) of the private well at 903 Eloise Avenue. Both well clusters were installed in June 2001 as part off-site groundwater contamination assessment and remediation investigations for the Swiss Mart Gas Station Site, 913 Emerald Bay Road, South Lake Tahoe, CA (T0601700123). The Swiss Mart Gas Station Site is a former petroleum hydrocarbon release site that was formally closed by the LRWQCB in August 2010. Monitoring wells for this site were generally installed at four discrete zones based on depth, with the following zone designations;

- A zone from 15 – 30 feet;
- B zone from 35 – 50 ft;
- C zone from 60 – 80 feet; and the
- D zone from about 120 – 140 ft (Terra Vac, 2001).

MW-10 consists of three 2-inch PVC monitoring wells installed at the following depth zones; MW-10A from 15 – 25 feet; MW-10B from 35 -50 feet; and MW-10C from 65 – 80 feet. EW-4 consists of two 2-inch PVC monitoring wells installed at the following depth zones; EW-4C from 60 – 77.5 feet; and EW-4D from 120 – 140 feet. Monitoring wells EW-4A and EW-4B were found but not inspected and are not intended to be used in the PDI.

1.2.2.2 953 Eloise Avenue

This proposed project site is located on a 1.10-acre parcel (APN 023-30-109) owned by the CSLT at 953 Eloise Avenue. This site is located in the northeast corner of the intersection of Eloise Avenue and 5th Street and is the site of a CSLT storm water retention basin. Preliminary plans from the Tahoe Valley Drainage Basin Drainage Study show an open channel reach of the CSLT storm drain system crossing this parcel in 1978 (William F. Pillsbury, Inc., 1978). Engineering plans for the basin suggest that the Eloise Retention Basin was constructed sometime during the mid-1980's (William F. Pillsbury, Inc., 1987).

Monitoring well cluster (MW-4) located along the north shoulder of Eloise Avenue, in the southwest corner of the property. MW-4 consists of three 2-inch PVC monitoring wells installed at the following depth zones; MW-4A from 15 – 25 feet; MW-4B from 35 -50 feet; and MW-4C from 59 – 79 feet. This well cluster was also originally installed as part of groundwater contamination assessment and remediation investigations for the Swiss Mart Gas Station Site.

1.2.3 Geology/Hydrogeology

The following section presents geologic and hydrogeologic information pertinent to the PDI. Lithologic and well construction logs from South Y Area wells within the site area and are provided in Appendix B.

1.2.3.1 Geology

The regional geology for the Lake Tahoe Basin can be generalized as mountains composed mainly of granitic rocks and valleys filled with basin-fill sedimentary deposits. These basin-fill deposits in the valleys are the primary sources of groundwater in the Lake Tahoe Basin. The basin-fill deposits have been reworked by glacial activity, alluvial and fluvial processes, and by Lake Tahoe as the lake level fluctuates. Figure 1-4 shows the distribution of these deposits within the site area (Saucedo, 2008).

Geologic map units occurring within the site area are predominantly Lacustrine terrace deposits of Pleistocene age (Qlt?). These map units are generally described as consisting of poorly to moderately sorted silt, sand and gravel forming broad low terraces 5- 10 meters above lake level. Till (Qta) occurs south of these terrace deposits, forming the north flank of Gardner Mountain and are described as unconsolidated boulder till with distinct yellow-brown weathered matrix; preserved as larger moraines with more rounded and broader crests. Flood-plain deposits of Holocene age (Qfp?) occur immediately north and east of the terrace deposits. These map units are described as consisting of gravelly to silty sand and sandy to clayey silt. Artificial Fill (af) occurs north of the floodplain deposits over the area of the Tahoe Keys. These are described as man-made deposits of varying composition (Saucedo, 2008).

Figure 1-4 also shows the alignment of section lines constructed as part of the planning for the PDI. Two preliminary sketches (Section A-A’ and Section B-B’) were constructed using available lithologic and well construction logs from South Y Area wells within the Site area (Appendix B). Logs used in Section A-A’ show the vertical distribution of basin-fill materials near the proposed project sites being considered for the PDI. Section A-A’ shows the basin-fill near 903 Eloise Avenue composed predominantly of sand, silty sand and sandy clay to a depth of about 80 feet below ground surface (ft bgs). Logs for MW-4C show the basin-fill near 953 Eloise Avenue composed predominately of sand, gravel and silty sand, to a depth of about 80 ft bgs.

Logs used in Section B-B’ show the vertical distribution of basin-fill materials from the 903 Eloise Avenue property northwest to LBWC No. 5. Section B-B’ shows the basin-fill near 903 Eloise Avenue is composed predominantly of sand, silty sand and sandy clay to a depth of about 80 ft bgs. Logs for MW-7A, C, D and LBWC#4 shows the basin-fill composed predominately of sand, sandy gravel and clay to a depth of about 140 ft bgs. Logs for LBWC #5 shows the basin-fill composed predominately of sand, gravel and clay to a depth of about 250 ft bgs.

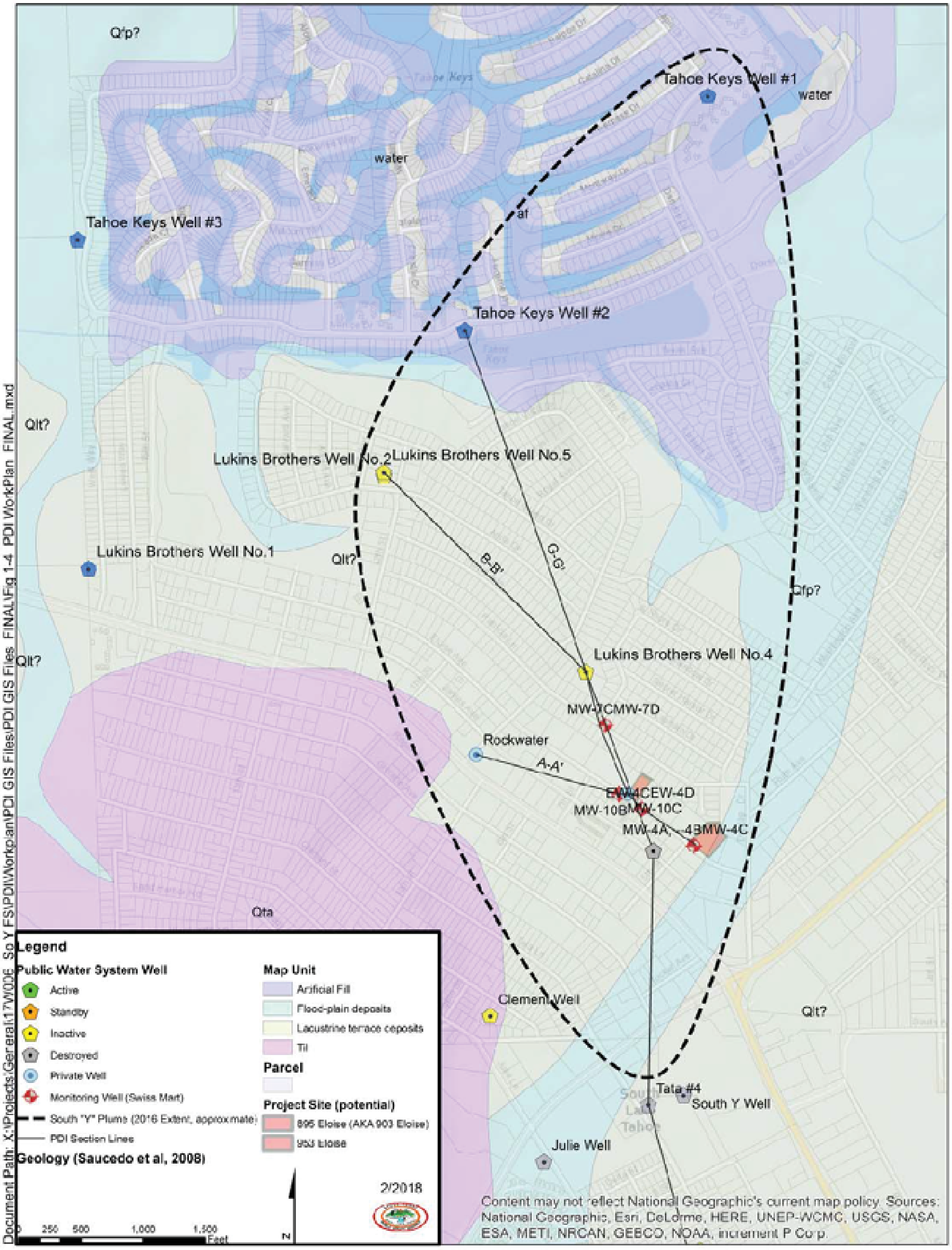


Figure 1-4: Geologic map units identified within the site area are from information compiled by the California Geological Survey (Saucedo, 2008). The orientations of subsurface sections described in this work plan are also shown.

1.2.3.2 Hydrogeologic Setting

Using the best available lithologic and geophysical log data, the District has developed a number of subsurface cross-sections throughout the TVS Basin. A copy of the South to North trending cross-section extending from the Industrial Well #2 through Tata Well #4 to the Tahoe Keys Well #2 (Section G- G’) is provided on Figure 1-5. The orientation for this cross-section is shown on Figure 1-4.

Based on evaluation of the subsurface data, the District has identified at least 26 water-bearing zones present within the basin-fill aquifer, of which 18 are actively used for drinking water supply. The water-bearing zones correlated across the South “Y” area are labeled on Section G-G’. PCE contaminated groundwater through the South “Y” Area is believed to occur predominantly in the two uppermost Tahoe Keys Water Zones (TKWZ4 and TKWZ5).

The District has performed many aquifer tests to define aquifer parameters throughout the TVS Basin. A summary of the available aquifer test data for South Y Area wells is presented below in Table 1-1.

Table 1-1: Aquifer Parameters from well tests performed near the South “Y” area.

WELL	Water-Bearing Zone	Saturated Thickness (b in ft)	Transmissivity (T in ft2/day)	Storativity (S)	Derived Hydraulic Conductivity (K in T/b)	Specific Capacity (gpm/ ft dd)
Clement	TKZ5 – 60’ Zone	31	321	0.0005	10.4	
Clement	TKZ5 – 100’ Zone	37	648	0.0003	17.5	
Clement	TKZ5	68				5.5
Industrial Well #2	TKZ5, SLTZ3	99	345		3.5	1.5
Julie	TKZ5	35	2540		72.6	
Tata Well #4	TKZ5	95	1337		14.1	
Lukins Brothers Well #4 (GEI, 2016a)	TKZ5/TKZ4	102	4866	0.05	47.7	15.55
EW-1, -2 and -3	TKZ5	60	1002	0.003	16.7	

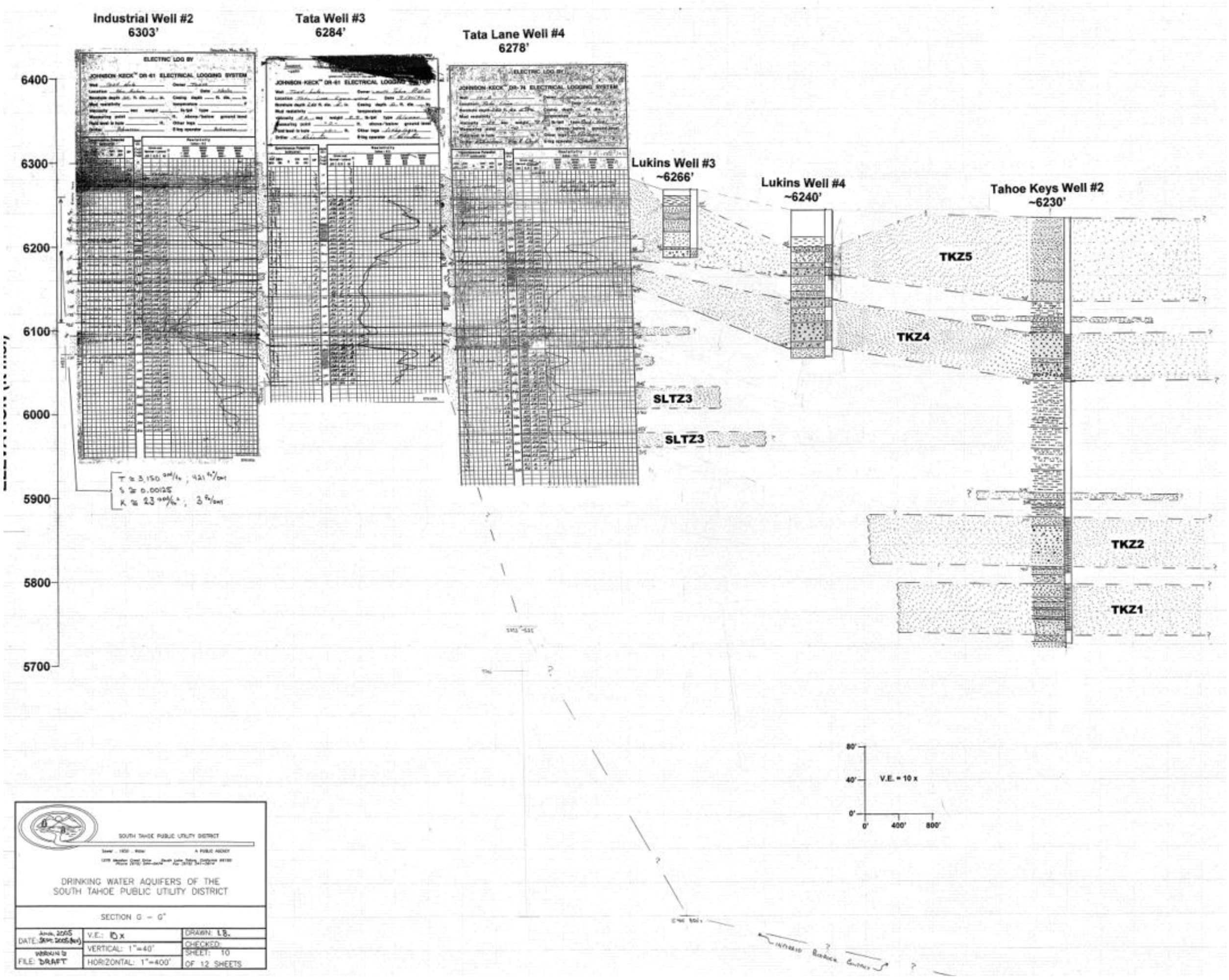


Figure 1-5: Subsurface Section G-G' showing the major water-bearing zones used for drinking water supply underlying the South "Y" Area (Fogg et al, 2007).

1.2.3.3 Groundwater Flow

Static water level elevation readings are collected annually from District PWS and monitoring wells during the spring and fall as part of the TVS Basin Monitoring Program. Groundwater level readings from District PWS and monitoring wells indicate that the horizontal direction of groundwater flow across the South “Y” Area is generally to the north north-east toward Lake Tahoe (Figure 1-6). The apparent groundwater velocity (Darcy velocity) can be derived using an average hydraulic conductivity value of 26 feet per day (ft/day), based on the values listed in Table 1-1; and an average horizontal gradient of 0.01. The hydraulic gradient is derived from groundwater level readings measured in District PWS and monitoring wells during the spring and fall of 2016 and 2017. Using these values the apparent groundwater velocity across the South “Y” Area is estimated at about 0.26 ft/day. Assuming an effective porosity of 0.20, the average linear velocity (seepage velocity) is estimated at 1.30 ft/day,

Groundwater level elevation readings from monitoring well clusters situated within the South “Y” Area show a downward directed vertical hydraulic gradient with vertical movement of groundwater flow from shallow to deeper water-bearing zones within this portion of the TVS Basin. Vertical gradients based on groundwater levels measured in CL-1 and CL-3 at the Clement Well site; show vertical gradients on the order of 0.10, which is an order of magnitude greater than the horizontal gradient.

The South Y Area wells currently used for defining groundwater flow across the South Y Area are situated south and east with respect to the South “Y” Plume. During the PDI, additional groundwater elevation readings will be collected from wells located directly within the South “Y” Plume to provide interpretations of groundwater flow directions within the contaminant plume. Wells identified for groundwater elevation survey (observation wells) include the following PWS and monitoring wells (see Figures 1-3 and 1-4 for locations):

- MW-10A, -10B, and -10C;
- MW-4A, -4B, and -4C;
- MW-7C and -7D;
- TKWC #1, #2 and #3;
- LBWC #1, #2, #4 and #5;and
- Rockwater Apartment Well.

1.2.4 PCE Contamination

Chlorinated hydrocarbons have been detected in PWS, monitoring, and private wells north and south of the South “Y” Area since 1989, when these compounds were required to be first tested in regulated drinking water sources. Many of the PWS wells have since ceased operating due to PCE concentrations exceeding the drinking water standard of 5 µg/L. Such PWS wells have included three District wells (Tata #4 - destroyed, South “Y”-destroyed, and Julie-destroyed), two Lukins Brothers Water Company (LBWC) wells (LBWC #3- destroyed and LBWC #4-offline, abandoned). A PWS well (Rockwater Well, offline-abandoned), a mobile home park well on James Avenue, and private wells on Eloise and Dunlap Avenues (LRWQCB, 2016a). The majority of these South Y Area wells have been disconnected and many have been abandoned.

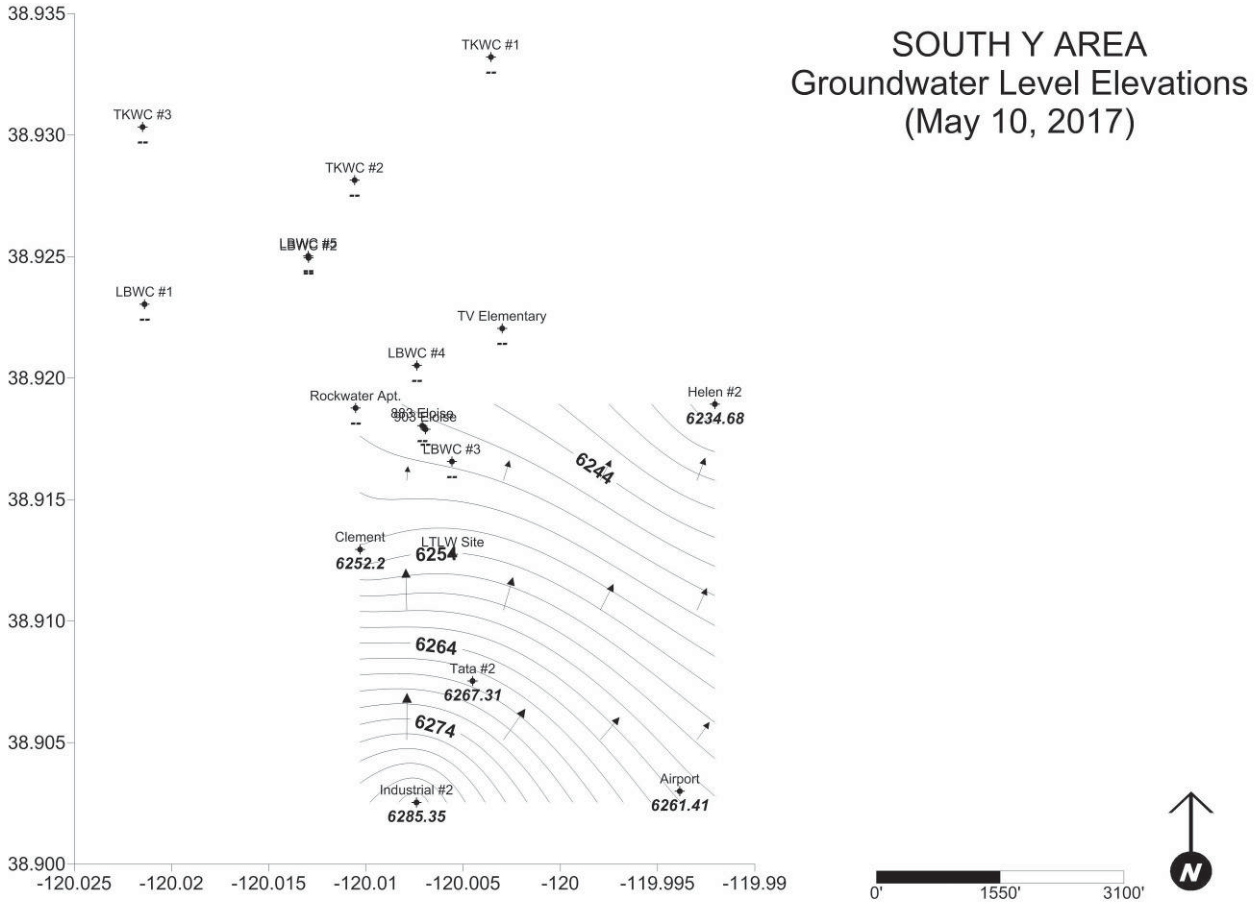


Figure 1-6: **Groundwater elevation contours from static water level readings collected from South Y Area wells indicate that the regional direction of groundwater flow is directed to the north-northeast across the South Y Area.**

A brief chronology of PCE impacts to South Y Area wells is summarized in Table 1-2.

Table 1-2: Summary of PCE Impacts to South Y Area Wells

Year	PCE Contaminant Impact(s)
1989	First detections of PCE are found in groundwater samples collected from three District PWS wells located west of the “Y” (Clement, Julie and Tata Well No. 4) and two LBWC PWS wells located north of the “Y” (LBWC Well No. 3 and LBWC Well No. 4). LBWC Well No. 3 is disconnected from the LBWC water system.
1991	The District installs a centrally located Packed Column Air Stripper to remove PCE from groundwater pumped from the Clement, Julie, Tata Well No. 4 and other South “Y” Area wells. PCE concentrations in groundwater pumped to the treatment system ranged from less than the MCLs to as high as 200 μg/L.
1994	LBWC Well No. 4 is disconnected from the LBWC water system.
1999	The District’s PCE groundwater treatment system is removed from service due to MTBE contamination.
2000	Groundwater samples collected from LBWC Well No. 3 contain PCE (16 ug/L) and high levels of fuel oxygenates (MTBE at 920 ug/L; t-Butyl Alcohol at 100 ug/L; and t-Amyl Methyl Ether at 11 ug/L).
2005	First detections of PCE are found in groundwater samples collected from LBWC Well No. 2 (0.99 ug/L) and LBWC Well No. 5 (1.5 ug/L).
2006	The District’s Julie, Tata Well No. 4 and other South “Y” Area wells are abandoned.
2008	Low levels of PCE contamination below MCLs is detected in groundwater samples collected from TKWC Well No. 1 (0.9 μg/L) and TKWC Well No. 3 (0.7 μg/L); and above MCLs in TKWC Well No. 2 (14 μg/L).
2013	LBWC Well No. 3 is abandoned.
2014	LBWC Well No. 2 (27 ug/L) and LBWC Well No. 5 (63 ug/L) are removed from service due to the presence of PCE above MCLs.
2015	Groundwater samples collected from LBWC Well No. 4 contain PCE (34 ug/L) and TCE (0.55 ug/L).

1.2.4.1 2016/2017 Water Quality Monitoring

During the second half of 2016 through 2017, multiple parties have been engaged in the collection of water quality data to show the occurrence and distribution of PCE within the South “Y” Plume. Recent sampling has been performed by the water purveyors (District, LBWC and TKPOA); LRWQCB staff and environmental consultants retained by Seven Springs Limited Partnership (Seven Springs) and Fox Capital Management Corporation (Fox). These sampling events are summarized below in Table 1-3.

1.2.4.1.1 Water Purveyors

In order to provide up to date information on the extent of PCE concentrations for use in the fate and transport modeling prior to embarking on the Feasibility Study the District in partnership with LBWC, collected groundwater samples from five South Y Area wells, including the deep monitoring well at the District’s Clement Well (CL-1), the LBWC #2 Well (Offline, impaired), the LBWC #4 Well (Offline, abandoned), the Rockwater Apartment Well (Offline, abandoned) and the Tahoe Valley Elementary School Well (Offline, abandoned). During the most recent sampling event (October 2017), a groundwater sample was collected from the LBWC #5 Well (Offline, impaired) and a sample was not collected from Tahoe Valley Elementary School Well. Groundwater samples from the 2016 and the first half of 2017 sampling events were collected using a HydraSleeve which is a no-purge (passive) grab sampling device. Groundwater samples from the most recent sampling event in October 2017 were collected using an in-place pump present at the well after a limited well purging.

To supplement this sampling, TKWC provided monitoring results for its three active PWS wells (TKWC #1, TKWC#2, and TKWC #3). These samples were collected using in-place plumbing following well purging.

1.2.4.1.2 LRWQCB

During the fall of 2016 and the spring of 2017, LRWQCB staff collected groundwater samples from monitoring wells located within the South Y Plume (LRWQCB, 2016b; LRWQCB, 2017).

Many of these samples were collected from existing multi-depth monitoring wells to show the vertical extent of PCE contamination through the South “Y” Plume. All of these monitoring wells are located between the “Y” and Eloise Avenue. Groundwater samples were collected from these wells using either low-flow purging or a Snap Sampler which is a passive/no purge groundwater sampling system (LRWCB, 2017).

1.2.4.1.3 Seven Springs/Fox

During the summer of 2017, environmental consultants for Seven Springs/Fox conducted an investigation to identify potential sources for PCE contamination present in the South “Y” Plume. The investigation involved the collection of grab groundwater samples at multiple depths between 17 and 80 ft bgs using Cone Penetrometer Test (CPT) and Membrane Interface Probe (MIP) screening, followed by groundwater sample collection using a hydropunch-type sampling technique (EKI, 2017).

Table 1-3: Recent sampling events to determine the extent of PCE contamination in the South "Y" Plume.

Sampling Event	Affiliation	# of Sites / # of Samples	Sampling Method(s)	Source
9/26/2016 – 10/12/2016	LRWQCB	7/14	Not specified	LRWQCB, 2016b
12/7/2016 – 12/29/2016	STPUD/LBWC	4/5	HydraSleeve Sampler	STPUD Lab
3/16/2017 – 7/6/2017	STPUD/LBWC	5/6	HydraSleeve Sampler	STPUD Lab
10/25/2017 – 10/26/2017	STPUD/LBWC	5/5	Pump	STPUD Lab
12/6/2016 – 10/24/2017	TKWC	3/10	Pump	TKPOA
6/26/2017 – 7/20/2017	Seven Springs LLP/ Fox Capital Mngmnt. Corp.	19/80	CPT/MIP	EKI,2017
6/26/2017 – 6/20/2017	LRWQCB	5/9	Snap Sampler /Low Flow Purging	LRWQCB, 2017
12/20/2016; 5/8/2017	Seven Springs LLP/ Fox Capital Mngmnt. Corp.	3/6	Low Flow Purging/Hand Bailing	Geotracker (SL0601754315)

1.2.4.2 2016/2017 Water Quality Monitoring Results

Analytical results from the water purveyors sampling, LRWQCB sampling and recent PCE results for the former Lake Tahoe Laundry Works (LTLW site (SL0601754315) available through Geotracker were grouped together for presentation purposes and are discussed separately from the Off-Site Groundwater Investigation Results (EKI, 2017) completed for Seven Springs/Fox.

Analytical results from all of the sampling events are presented in a bubble map provided at the end of this section as Figure 1-9 and are provided in Appendix C.

1.2.4.2.1 Water Purveyors/LRWQCB Results

Figure 1-7 is a plot showing the analytical results from the water purveyors sampling, LRWQCB sampling and recent PCE results for the former Lake Tahoe Laundry Works (LTLW site (SL0601754315) available through Geotracker. These results are presented as a cross-plot of log PCE Concentration (in micrograms/liter (µg/L)) in reference to the bottom of the screen sample depth interval (in ftbgs), from which the sample was collected. The purpose of the cross-plot is to help identify where maximum PCE concentrations are found at varying depths through the South Y Plume.

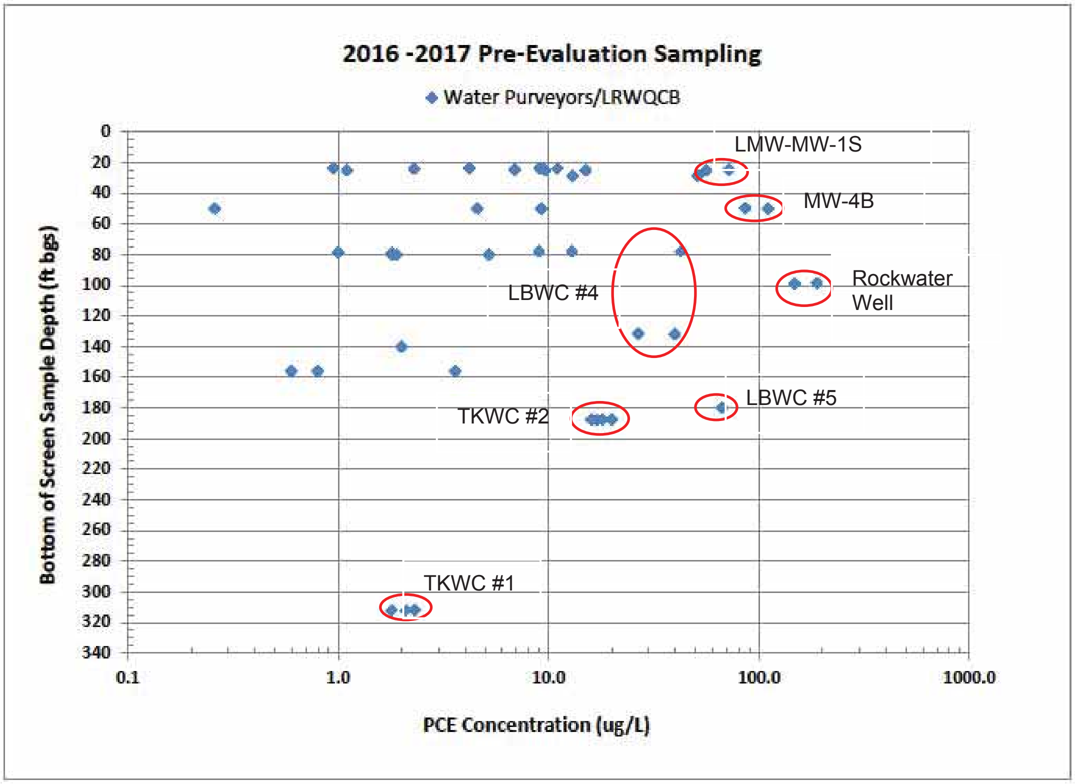


Figure 1-7: Cross plot of PCE concentration (µg/L) versus bottom of screen sample depth for groundwater samples collected by the water purveyors, LRWQCB staff and recent PCE data available through Geotracker for the former Lake Tahoe Laundry Works (LTLW) site (SL0601754315).

Inspection of Figure 1-7 shows the following;

- 15 to 25-foot Sample Depth: Highest PCE concentrations (56 – 72 µg/L) were found in LMW-MW-1S collected from the former LTLW site.
- 35 to 50-foot Sample Depth: Highest PCE concentrations (86 – 110 µg/L) were found in MW-4B collected near the intersection of 5th Street and Eloise Avenue;
- 77 to 90-foot Sample Depth: Highest PCE concentrations (147 – 189 µg/L) were found in the Rockwater Well collected near the intersection of Highway 89 and Tenth Street;
- 141 to 180-foot Sample Depth: Highest PCE concentrations (67 µg/L) were found in LBWC #5 collected near the intersection of 12th Street and Anita Drive; and
- 125 to 312-foot Sample Depth: PCE concentrations in TKWC #1 were below MCLs (5 µg/L).

1.2.4.2.2 Off-Site Groundwater Investigation (EKI, 2017) Results

Figure 1-8 is a plot showing the analytical results from the Off-Site Investigation (EKI, 2017) completed for Seven Springs/Fox). As done for the water purveyor/LRWQCB results,these are presented as a cross-plot of log PCE Concentration (in micrograms/liter (µg/L)) in reference to the bottom of the screen sample depth interval (in ftbgs),from which the sample was collected to help identify where maximum PCE concentrations are found at varying depths through the South Y Plume.

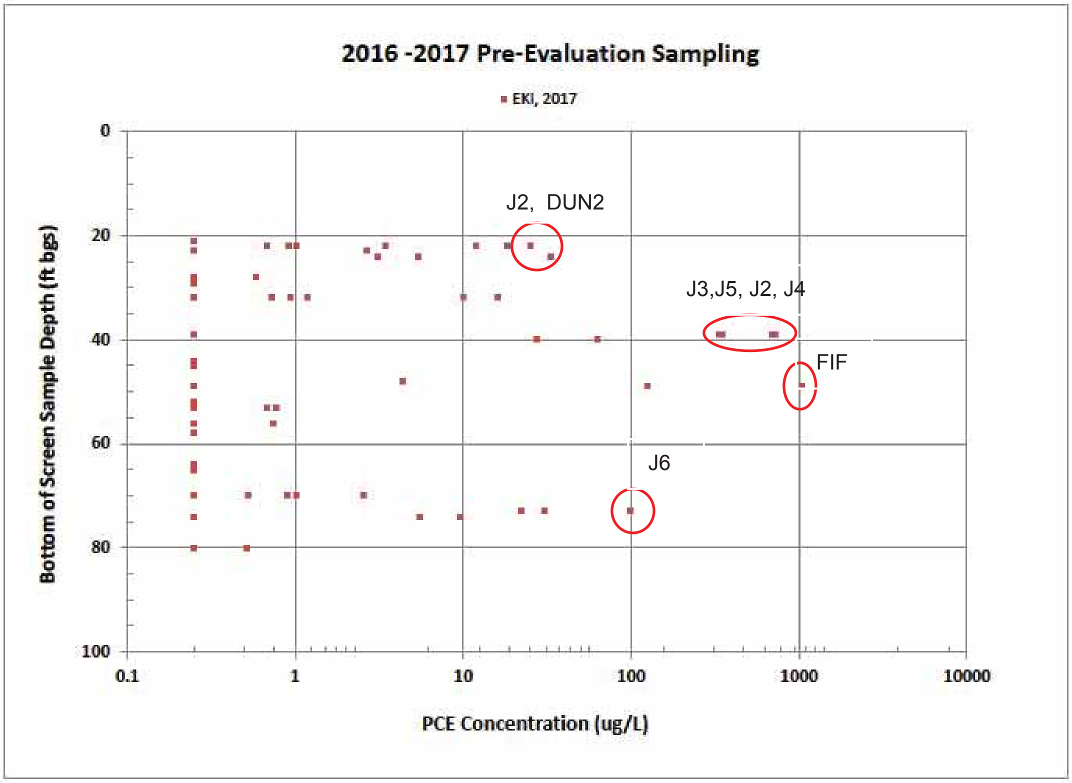


Figure 1-8: Cross plot of PCE concentration (µg/L) versus bottom of screen sample depth for groundwater samples collected during the Off-Site Groundwater Investigation (EKI, 2017).

Inspection of Figure 1-8 shows the following;

- 15 to 25-foot Sample Depth: Highest PCE concentrations (25 to 33 µg/L) were found in J2 (18 – 22') collected along James Street; and DUN2 (20 -24') collected near the intersection of Dunlap Drive and Eloise Avenue, respectively.
- 35 to 39-foot Sample Depth: Highest PCE concentrations (338 – 718 µg/L) were found in J3, J5, J2 and J4 collected along James Street between 5th Street and Dunlap;
- 45 to 49-foot Sample Depth: Highest PCE concentrations (1,040 µg/L) were found in FIF collected near the intersection of 5th Street and Eloise Avenue; and
- 69 to 73-foot Sample Depth: Highest PCE concentrations (99 µg/L) were found in J6 collected along Eloise Avenue between 7th Street and 10th Street.

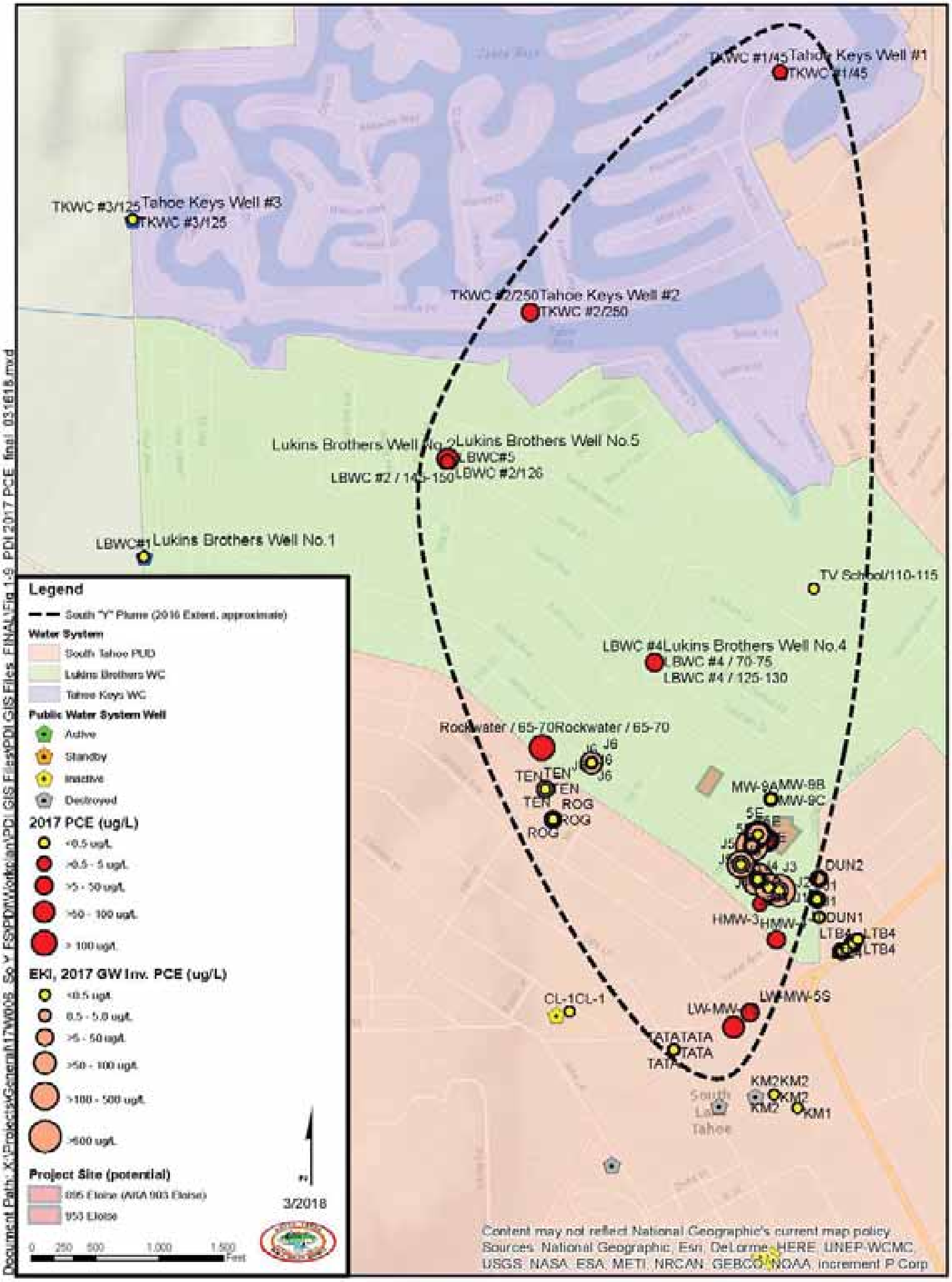


Figure 1-9: Recent PCE results, in micrograms per liter (µg/L), for groundwater samples collected within and neighboring the South "Y" Plume

1.3 Pre-Design Investigation Overview

In order to prepare a feasibility study of remediation strategies, aquifer characteristics information is necessary to define pumping and capture rates. This PDI is intended to also collect soil and groundwater data at the selected location and provide a new test well that when combined with existing South Y Area wells, can be used for obtaining aquifer characteristics.

Kennedy/Jenks will work with a California Licensed C57 drilling contractor to conduct a subsurface investigation and aquifer test evaluation at the selected location. This evaluation will identify vertical PCE concentrations in both soil and groundwater, establish aquifer properties needed to delineate capture zones(s), and the pilot test will provide water quality data required to complete a pre-design of a potential future extraction well and accompanying treatment system.

For the pilot test, Kennedy/Jenks will contract with vendors to provide the necessary treatment systems. The selected vendor will provide a granular activated carbon (GAC) filtration system that will be used to meet sanitary sewer discharge requirements throughout the project. Since the project schedule is relatively short, it is not anticipated that GAC breakthrough curves will be established through the flushing filter.

1.4 Project Organization and Responsibilities

The following list identifies the key Kennedy/Jenks project personnel and their responsibilities:

- Client and Technical Lead, Ivo Bergsohn, P.G., CHG, will provide technical expertise for designing the test well and remediation treatment oversight.
- Technical Advisory Committee have an ideal combination of qualifications, experience and local perspective that can benefit the overall project and represent the SWRCB-DOFA, the LRWQCB, the SWRCB – Division of Drinking Water, LBWC, TKPOA, and CSLT.
- Program Manager, Sachi Itagaki, will assume responsibility for all technical, financial, and administrative aspects of the project and the project team, including schedules and completion of all phases of field activities, data analysis, and report preparation.
- Project Hydrogeologist and Well Design Lead Mike McLeod, P.G., is responsible for technical aspects of the groundwater characterization, well drilling, soil and groundwater sampling, and aquifer testing.
- Additional technical resources including remediation, water treatment, water quality/chemistry, groundwater modeling, and infrastructure specialists are available from Kennedy-Jenks.

The Program Manager reports to the Technical Advisory Committee on this project and is responsible for monitoring and documenting the quality of all work produced within their area of technical expertise. The fundamental goal of their position is to perform field operations in a safe and efficient way, to acquire usable data, and to produce a quality work product.

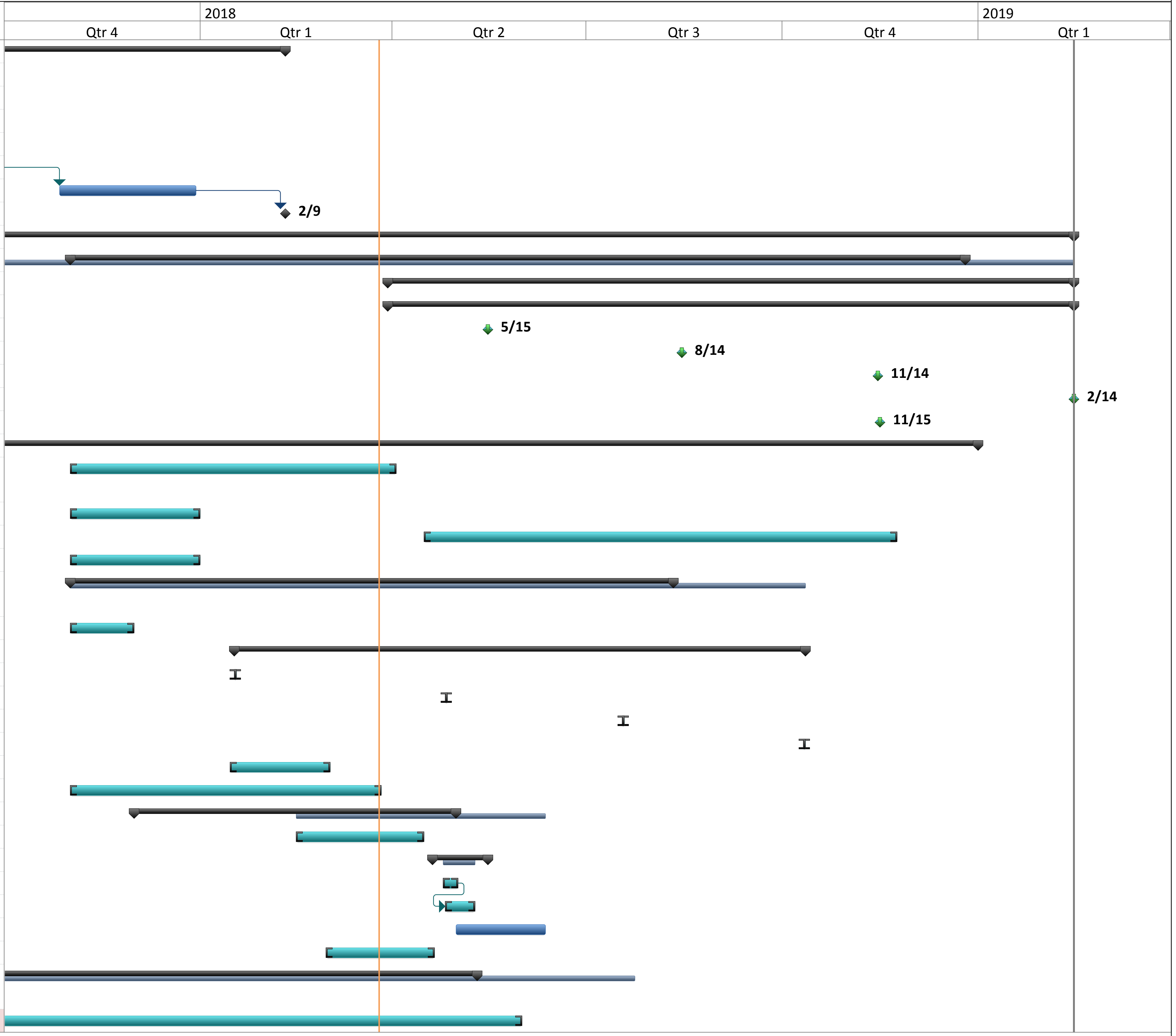
Kennedy/Jenks is responsible for the procurement and direct supervision of subcontractors used to implement the activities specified in this work plan.

1.5 Schedule

Based on our understanding of the overall project, we present the following proposed schedule, including major tasks, deadlines, duration, and projected start and finish dates for the project.

South Tahoe PUD
South Y Feasibility Study Schedule

ID	Task Name	Duration	Start	Finish
1	**Proposition 1 GWGP Program**	**433 days**	**Wed 6/15/16**	**Fri 2/9/18**
2	FS Planning Grant Pre-Application	40 days	Wed 6/15/16	Tue 8/9/16
3	**SWRCB Invitation Letter**	1 day	Thu 10/6/16	Thu 10/6/16
4	FS Planning Grant Full Proposal	80 days	Thu 8/4/16	Wed 11/23/16
5	**Preliminary Award**	1 day	Thu 3/30/17	Thu 3/30/17
6	***Board Meeting - Authorizing Resolution***	1 day	Thu 5/18/17	Thu 5/18/17
7	Negotiate Grant Agreement	46 days	Fri 10/27/17	Fri 12/29/17
8	**Final Agreement**	30 days	Mon 1/1/18	Fri 2/9/18
9	**RFP/Consultant Selection**	**490 days?**	**Fri 3/31/17**	**Thu 2/14/19**
26	**Task B - Project Management and Coordination**	**300 days**	**Wed 11/1/17**	**Tue 12/25/18**
27	**A-5 Reporting**	**230 days**	**Fri 3/30/18**	**Thu 2/14/19**
28	**Progress Reports**	**230 days**	**Fri 3/30/18**	**Thu 2/14/19**
29	PR 1 - 2018 Q1	33 days	Fri 3/30/18	Tue 5/15/18
30	PR 2 - 2018 Q2	33 days	Fri 6/29/18	Tue 8/14/18
31	PR 3 - 2018 Q3	34 days	Fri 9/28/18	Wed 11/14/18
32	PR 4 - 2018 Q4	35 days	Fri 12/28/18	Thu 2/14/19
33	2017/2018 Ann. Progress Summary	34 days	Mon 10/1/18	Thu 11/15/18
34	**Project Invoicing (KJC internal)**	**360 days**	**Tue 8/15/17**	**Mon 12/31/18**
48	**Task C - Submit GPS and Monitoring Plan (MP) and Monitoring and Reporting Plan (MRP)**	109 days	Wed 11/1/17	Mon 4/2/18
49	**Task D - Prepare Quality Assurance Project Plan**	44 days	Wed 11/1/17	Sun 12/31/17
50	**Task E - Upload Data to GeoTracker/GAMA system in EDF**	160 days	Mon 4/16/18	Fri 11/23/18
51	**Task F - Permitting for Field Work**	44 days	Wed 11/1/17	Sun 12/31/17
52	**Task G - Establish TAC, Kickoff Meeting and up to 3 TAC Meetings**	**203 days**	**Wed 11/1/17**	**Fri 8/10/18**
53	Subtask G.1: Establish TAC	22 days	Wed 11/1/17	Thu 11/30/17
54	**Subtask G.2: TAC Meetings**	**192 days**	**Wed 1/17/18**	**Thu 10/11/18**
55	TAC Meeting 1: Kick-Off	1 day	Wed 1/17/18	Wed 1/17/18
56	TAC Meeting 2	1 day	Thu 4/26/18	Thu 4/26/18
57	TAC Meeting 3	1 day	Wed 7/18/18	Wed 7/18/18
58	TAC Meeting 4	1 day	Thu 10/11/18	Thu 10/11/18
59	**Task H - MOU Preparation**	35 days	Mon 1/15/18	Fri 3/2/18
60	**Task I - Prepare Pre-Design Investigation Workplan**	104 days	Wed 11/1/17	Mon 3/26/18
61	**Task J - Conduct Pre-Design Investigation and Prepare Report**	**107 days**	**Fri 12/1/17**	**Mon 4/30/18**
62	Contract with Driller and Pumper	43 days	Thu 2/15/18	Sun 4/15/18
63	Field Work/Time	18 days	Fri 4/20/18	Tue 5/15/18
64	Drilling	5 days	Wed 4/25/18	Tue 5/1/18
65	Pump Test	10 days	Thu 4/26/18	Wed 5/9/18
66	Report Writing	30 days	Tue 5/1/18	Mon 6/11/18
67	**Task K - Feasibility Study Workplan**	37 days	Thu 3/1/18	Fri 4/20/18
68	**Task L.1-L.3 - Groundwater/Contaminant Transport Modeling (Formerly Task C)**	**406 days**	**Thu 10/20/16**	**Thu 5/10/18**
69	Subtask L.2: Fate & Transport Model (by DRI)	421 days	Thu 10/20/16	Thu 5/31/18

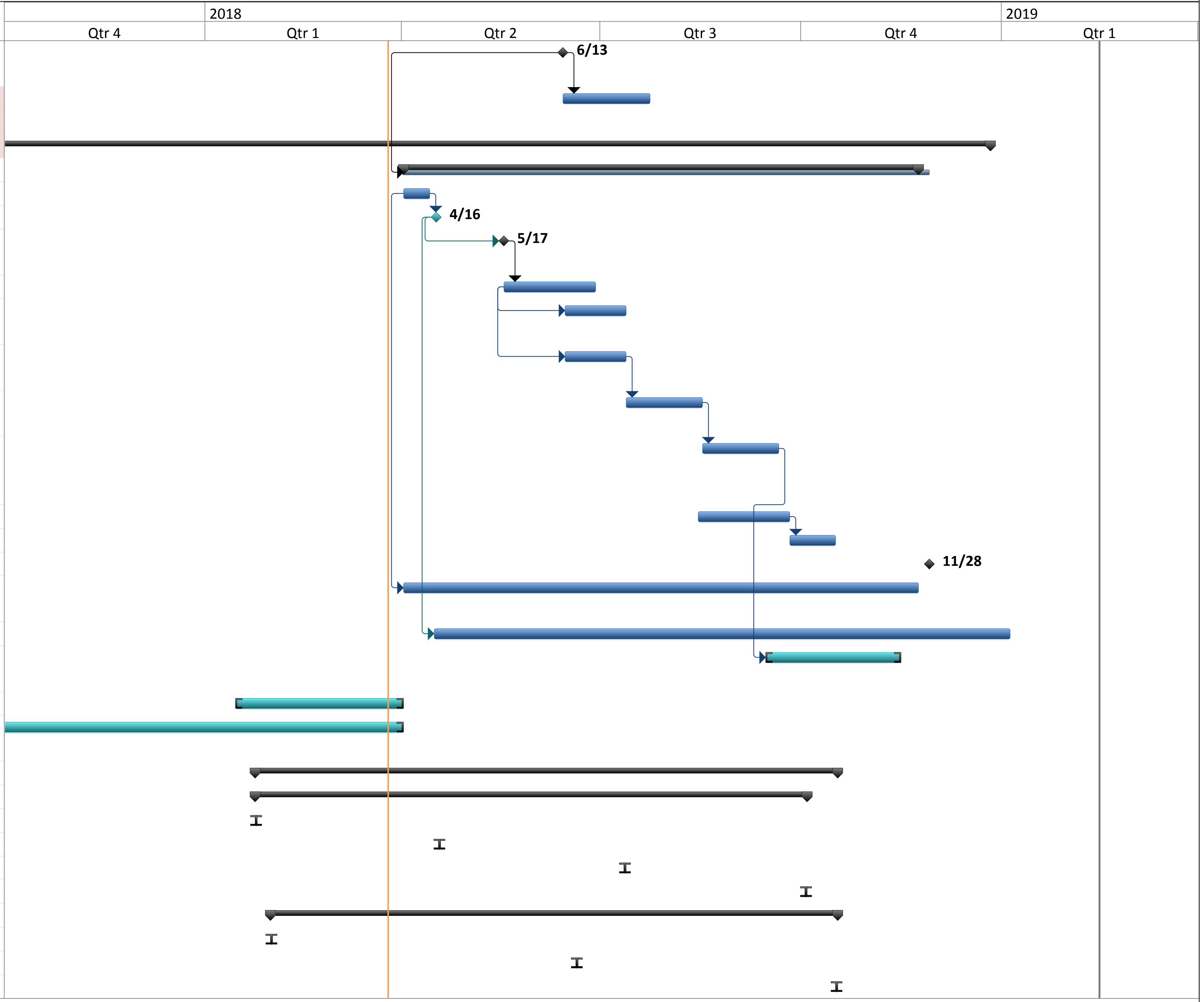


Project: SoY FS Sched_DRAFT v1_
Date: Mon 3/26/18

Task	▬	Summary	▬	External Milestone	◆	Inactive Summary	▭	Manual Summary Rollup	▬	Finish-only	]
Split	⋯	Project Summary	▬	Inactive Task	▭	Manual Task	▬	Manual Summary	▬	Deadline	↓
Milestone	◆	External Tasks	▬	Inactive Milestone	◇	Duration-only	▬	Start-only	[	Progress	▬

South Tahoe PUD
South Y Feasibility Study Schedule

ID	Task Name	Duration	Start	Finish
70	Subtask L.3.:Analysis of Pumping and PCE Containment Alternatives	65 days	Thu 3/15/18	Wed 6/13/18
71	Prepare FS Model Evaluation Technical Report (by DRI)	28 days	Thu 6/14/18	Mon 7/23/18
72	**Seven Springs/Fox So Y GW Investigation**	**62 days?**	**Fri 5/12/17**	**Mon 8/7/17**
78	**TKPOA Phase 1 Facilities Design**	**416 days**	**Wed 5/24/17**	**Wed 12/26/18**
86	**Task M.1-M.10 - Feasibility Study (Formerly Task D)**	**170 days**	**Mon 4/2/18**	**Fri 11/23/18**
87	SubTask M.1 - Data Review	10 days	Mon 4/2/18	Fri 4/13/18
88	SubTask M.1 - Kick-Off Meeting	1 day	Mon 4/16/18	Mon 4/16/18
89	Subtask M.2 - Screen Modeled Alternatives for Engineering Evaluation	20 days	Fri 4/20/18	Thu 5/17/18
90	Subtask M.3: Define Infrastructure Needs (3 Alternatives)	30 days	Fri 5/18/18	Thu 6/28/18
91	Subtask M.4 - Develop Life Cycle Cost Estimates (3 Alternatives)	20 days	Fri 6/15/18	Thu 7/12/18
92	Subtask M.5 - Develop Environmental Analysis Checklists (3 Alternatives)	20 days	Fri 6/15/18	Thu 7/12/18
93	Subtask M.6 - Select and Develop Recommended Alternative	25 days	Fri 7/13/18	Thu 8/16/18
94	SubTask M.7 - Implementation Plan for Recommended Alternative: Financial and Governance Plan (including drafting of report section)	25 days	Fri 8/17/18	Thu 9/20/18
95	Subtask M.8 - Prepare Draft Report	30 days	Wed 8/15/18	Tue 9/25/18
96	Subtask M.8 - Review Draft Report	15 days	Wed 9/26/18	Tue 10/16/18
97	Subtask M.9 - Prepare Final Report	20 days	Thu 11/1/18	Wed 11/28/18
98	Subtask M.10 - Project Management, Monthly Conference Calls, and QA/QC	170 days	Mon 4/2/18	Fri 11/23/18
99	**Task M.11 - As-Directed Services**	190 days	Mon 4/16/18	Fri 1/4/19
100	**Task N - Prepare Interim Remedial Action Plan (Based on FS Implementation Plan)**	45 days	Sat 9/15/18	Thu 11/15/18
101	**Task O - Prepare Environmental Compliance for Field Work**	56 days	Mon 1/15/18	Sun 4/1/18
102	**Task P - District Monitoring to Support Feasibility Study (Formerly Task E)**	348 days	Thu 12/1/16	Sun 4/1/18
103	**Task Q - Public Outreach (Formerly Task F)**	**191 days**	**Wed 1/24/18**	**Wed 10/17/18**
104	**Subtask Q.1 -So. Y SAG Meetings**	**181 days**	**Wed 1/24/18**	**Wed 10/3/18**
105	So Y SAG Meeting 1	1 day	Wed 1/24/18	Wed 1/24/18
106	So Y SAG Meeting 2	1 day	Wed 4/18/18	Wed 4/18/18
107	So Y SAG Meeting 3	1 day	Thu 7/12/18	Thu 7/12/18
108	So Y SAG Meeting 4	1 day	Wed 10/3/18	Wed 10/3/18
109	**Subtask Q.2 - DAC Outreach (3 Workshops)**	**186 days**	**Wed 1/31/18**	**Wed 10/17/18**
110	Public Workshop 1	1 day	Wed 1/31/18	Wed 1/31/18
111	Public Workshop 2	1 day	Wed 6/20/18	Wed 6/20/18
112	Public Workshop 3	1 day	Wed 10/17/18	Wed 10/17/18



Project: SoY FS Sched_DRAFT v1_
Date: Mon 3/26/18

Task	▬	Summary	▬	External Milestone	◆	Inactive Summary	▭	Manual Summary Rollup	▬	Finish-only	]
Split	┈	Project Summary	▬	Inactive Task	▭	Manual Task	▬	Manual Summary	▬	Deadline	↓
Milestone	◆	External Tasks	▬	Inactive Milestone	◇	Duration-only	▬	Start-only	[	Progress	▬

Section 2: Sampling, Analysis, and Monitoring Plan

2.1 Soil and Groundwater Sampling Plan

2.1.1 Objectives

The objective of soil and groundwater sampling is to characterize the range of contamination within the site; the baseline groundwater sampling will generate analytical documentation regarding the extent of contaminants in groundwater at the time of the field work. In addition, initial sampling will establish a baseline for new test well installation and remedial design decision making (reference section 2.2). South Y Area wells identified for baseline sampling (called observation wells) include the following wells (see Figure 2-1);

- EW-4D;
- MW-10B, -10C;
- MW-4A, -4B, and -4C;
- MW-7C and -7D.

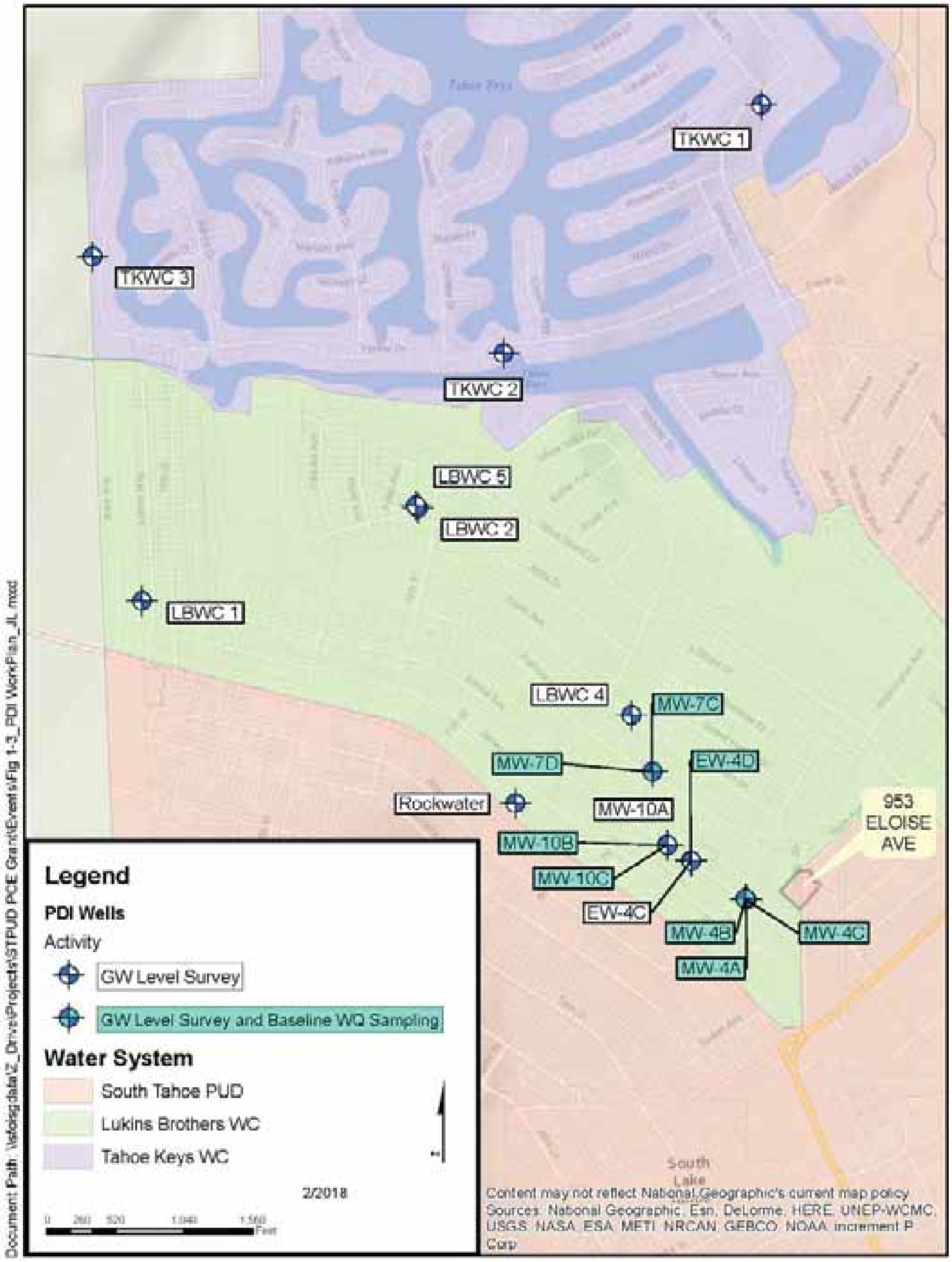


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Figure 2-1: PDI Wells

2.1.2 Rationale

Kennedy/Jenks proposes additional soil and groundwater sampling at the proposed site as well as groundwater sampling at the existing monitoring well sites to evaluate groundwater flow patterns and update current PCE contaminant concentration distributions within the contaminant plume. The soil and groundwater investigation will enable groundwater samples to be collected within the aquifer vertically to further define and delineate to non-detect concentrations the vertical extent of PCE contamination at the project site. Groundwater samples collected from PWS wells will be used to augment these data sets to show the extent of the PCE contamination along the lateral extents and near the leading edge of the groundwater plume.

2.1.3 Activities

The following subtasks will be completed during this portion of the field investigation.

- Baseline groundwater sampling at up to eight observation wells at the start of the field investigation (see Section 2.1.1)
- Prior to intrusive field work, the well site will be marked in white and Underground Service Alert will be notified. In addition, a subcontractor will sweep for underground utilities using non-invasive geophysical locating equipment. A well permit from El Dorado County will be obtained, and the necessary access and encroachment permits.
- One 12-inch-diameter boring will be drilled using sonic drilling methodology. This boring will be drilled to an approximate depth of 150 feet bgs.
- Soil and groundwater samples will be collected and analyzed
- Isolated aquifer zone groundwater sampling and aquifer testing will be completed in at least 5 zones in the boring

The exact boring location will be dependent upon the property evaluation discussed in Section 1. Of particular interest to this investigation is the vertical occurrence of low permeability zones that could affect the horizontal and vertical migration of the South “Y” Plume. In order to select appropriate depth intervals for sampling, aquifer testing and as a basis for Test Well design, pertinent lithologic information (Appendix B) and water quality data (Appendix C) were carefully reviewed and evaluated in order to minimize the potential for the vertical migration of contaminants deeper into the basin-fill aquifer. The proposed sample, test interval and test well design diagrams are provided in Appendix D.

The lithology in the borehole shall be logged. The log of drilling operations and lithologic log forms, (included in this appendix), shall be used for recording the lithologic logging information. Information on the forms includes the borehole location, drilling information and lithologic descriptions.

Core for lithologic description shall be obtained and logged on a continual basis as stated in the sampling and analysis plan (SAP). Soil types will be identified using the Unified Soil Classification System (USCS) group symbol and described in accordance with the 1990 American Society for Testing and Materials (ASTM) publication *D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

Descriptive information to be recorded in the field shall include: (1) identification of the predominant particles size and range of particle sizes, (2) percent of gravel, sand, fines, or all three, (3) description of grading and sorting of coarse particles, (4) particle angularity and shape, and (5) maximum particle size or dimension (6) moisture (dry, wet, or moist), (7) consistency, strength, and plasticity of fine-grained soils, (8) structure of consolidated materials, and (9) cementation (weak, moderate, or strong).

Additional information to be recorded includes the depth to the water table, caving or sloughing of the borehole, changes in drilling rate, presence of organic materials, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

During drilling, the borehole and work-area breathing zone shall be monitored with an organic vapor monitor (e.g., photoionization detector [PID], organic vapor analyzer [OVA]). Cuttings shall be also be screened with OVA. The OVA will be a RAE Systems MiniRae model 2000 or equivalent, with 10.6 eV lamp, calibrated at least once per day with isobutylene calibration gas. Three soil samples from depths with the highest contamination reading will be submitted for SW8260B VOC analysis. Soil samples will be collected by transferring soil from the core into stainless steel liners. Sample liner samples collected from the sonic core will be sealed using plastic end caps wrapped in Teflon tape, preserved and transported.

The sonic drilling method is used when drilling conditions are known to be difficult due to lithology. Sonic drilling is a soil penetration technique that fluidizes porous materials. Using a sonic head, drill casing and rods are brought to a vibration frequency of 100 to 200 Hertz. These waves are transmitted through the drill string to the end of the casing and reflected, causing the casing to stretch and thin, and to shorten and thicken. This vibration causes a very thin layer of soil directly around the drill rods to fluidize, which reduces the friction between the drill rod and the surrounding formation, allowing very rapid penetration. For continuous coring, the sonic drilling method uses a core barrel for the drill rods, which is encompassed by a larger diameter drill casing that enables the borehole to stay open and prevents collapse and cross-contamination. The core barrel is typically advanced 10 feet at a time. Upon completion of a core barrel run, the barrel is removed from the drill casing and the core sample is extruded from the barrel by means of vibration. The oversized casing is then advanced to seal off and support the borehole and prevent groundwater from shallow zones migrating into the deeper zones.

It is anticipated that a 7-inch diameter barrel will be used for coring. The 7-inch-diameter boring will be drilled to depths of up to 150 feet bgs and continuously cored to log lithology. After coring and casing to the borehole’s total depth, the well completion depth will be decided. The borehole below the completed well will be sealed with bentonite chips or pellets, and the remainder of the borehole will be reamed with 12-inch diameter casing to allow installation of the well casing, screen, and annular material.

The drilling contractor will make sound barriers available should they be required and will also be required to implement sediment and erosion control best management practices (BMPs).

Up to five groundwater samples will be collected within the existing borehole at approximate depths of 25, 35, 50, 65, 80, and 135 feet bgs based on the information contained in Section 1.2.4; exact depths will be determined in the field and will be dependent upon lithology. To collect discrete groundwater samples, the boring will be cored and cased to the designated depth. A temporary 4-inch stainless steel wire-wrapped well screen and blank casing and a temporary gravel pack will be installed in the casing, which will then be retracted approximately five feet to expose the temporary well to the aquifer. A small diameter submersible pump with dedicated tubing will be installed to develop and purge groundwater from the temporary well and then permit sampling of the groundwater within the newly-isolated aquifer zone. Following the completion of the testing activities, the entire temporary well screen will be pulled out and subsequent drilling activities will be implemented.

Groundwater samples will be analyzed for VOCs using EPA Method 8260B, according to the SAP.

The coring will be interrupted at four depths where nearby CPTs indicate the presence of finer grained layers: 22 feet bgs, 38 feet bgs, 55 feet bgs, 74 feet bgs. At these depths, the subcontractor will remove the core barrel, case the borehole, clear the casing of soil, and insert a split-spoon drive sampler to conduct a Standard Penetration Test (SPT). The drive sampler will be 1.5-inches inner diameter, 18-inches long, and advanced using a 140-pound hammer falling 30 inches. The hammer blows over each six-inch interval will be recorded on the boring log. Upon completion of the SPT, coring and zone water sampling will resume.

Subsequent to soil sampling and isolated aquifer zone testing, the borehole will be converted to a test well as detailed in Section 2.2 below.

2.1.4 Deliverables

1. Completed log of drilling operations and lithologic log forms with borehole location, drilling information and lithologic descriptions.

2. Groundwater and soil sampling analysis results

2.2 New Test Well

2.2.1 Objectives

The objective of the test well installation is to provide a means of estimating aquifer characteristics and provide a potential extraction well for remediation of PCE contaminated groundwater.

2.2.2 Rationale

As summarized in Section 1.0 above, recent groundwater sampling results collected show the lateral and vertical extent of groundwater contamination in a number of locations. Prior to evaluating the feasibility of remediation activities upgradient of PWS wells, one new test well be installed at the selected property location in order to evaluate both vertical extent of soil and groundwater contamination at the specific location in the plume but also to provide a test well for aquifer testing that can be used to derive aquifer characteristics for use in the feasibility study and/or pre-design.

2.2.3 Activities

The following subtasks will be completed during this portion of the field investigation.

- Upon completion of the test boring, a single-completion, 8-inch-diameter test well will be installed into the boring. The final depths will be based upon stratigraphic findings and the zone groundwater sample results, but two potential completion alternatives are shown in Appendix D - a shallow well and a deeper well.

  A shallow well would have 20 feet of well screen, between 30 and 50 feet bgs. A deeper well would have 15 feet of well screen between 60 and 75 feet bgs.

  Both wells would be constructed with 8-inch diameter, stainless steel louvered well screen, and Schedule (SCH) 80 PVC blank riser, blank sump, and bottom cap. Stainless steel or PVC centralizers will be placed at the top and bottom of the well screen and approximately every 40 feet above the well screen

  Final selection of slot size and filter pack will be made based upon gradation testing of aquifer material. The slot size and filter pack will be selected from amongst commonly available sizes.

- As described above, the boring will be cored to an estimated depth of 150 feet bgs. The borehole below the proposed well depth will be sealed using bentonite chips or pellets, which will effectively seal lower water-bearing zones. The upper section of the borehole will be reamed with 12-inch diameter sonic casing to allow the well construction.

- Annular material will include appropriate filter pack sand (along with the slot size, selected based upon gradation tests conducted on aquifer material), placed from the base of the reamed borehole to one to two feet above the top of the screen section.

- A 3-feet or greater transition seal of bentonite chips of pellets will be placed above the filter pack. This transition seal will be allowed to hydrate at least 30 minutes prior to installation of the sanitary seal.

- The sanitary cement seal will be composed of cement-bentonite grout. The mix will conform to the State of California well standards for sealing material and contain no more than 5% bentonite powder by weight. The sanitary seal will be pumped through tremie pipe, from the bottom to the ground surface. The seal will be placed under the observation of El Dorado County.

- Well development will begin no sooner than 48 hours after the well seal is made. Any water added during well installation will be removed before development. The development procedure will be accomplished by bailing and swabbing followed by pumping. A sand bailer will initially be used to remove fine-grained sediments and sand from the well. A surge block will then be used to gently swab the casing to increase flow from the formation into the well. Bailing and surging will continue until sediment collected is less than 1 teaspoon per bailer load before pumping begins. An air-isolation tool will then be used to remove water from the well via air displacement. The air-isolation tool will be fitted with rubber diaphragms that focus the water removal from 5-foot sections of the well screen. Well development with the air-isolation tool will continue until the discharged water is visually absent of sediments. Water then will be removed from the well using a submersible pump until turbidity, temperature, pH, and conductivity field parameters have stabilized. If the parameters do not stabilize within what the field geologist or technician considers a reasonable amount of time, the field geologist or technician will contact senior technical personnel for guidance.

- A coordinate survey will be completed to tie in the new groundwater test well with the observation wells. The observation wells will be used to evaluate groundwater level monitoring, determination of flow direction and gradient, and trend monitoring. A California-licensed surveyor will survey the well casings relative to an on-site benchmark. The survey will be completed to a horizontal accuracy of at least 0.1 foot and a vertical accuracy of at least 0.01 foot. These elevations will be referenced to the National Geodetic Vertical Datum of 1988.
- The static water level (SWL) will be measured in the observation wells and used to determine the direction of groundwater flow. Measurements in the observation wells will be performed within a single 12-hour period during each monitoring event. SWL measurements will be made using an electronic water-level measuring probe and tape accurate to approximately ± 0.01 feet.

Table 2-1: Test Well Construction Details

Test Well	Total Depth (feet bgs)[a]	Screened Interval (feet bgs)[a]	Filter Pack (feet bgs)[a]	Bentonite Seal (feet bgs)[a]
TW-1 Option A	150	30-50	28-55	25-28
TW-1 Option B	150	60-75	58-80	55-58

[a] All depths are approximate and will be determined in the field based on stratigraphy and/or zone groundwater sample results.

bgs = below ground surface

Deliverables

1. Test well as-builts
2. Coordinate survey of observation wells and test well
3. Static water level measurements of observation wells and test well

2.3 Aquifer Testing and Monitoring

2.3.1 Objectives

The objective of the aquifer testing is to estimate hydraulic characteristics of the aquifer, including specific capacity and the influence that nearby test well may have on drawdown on the aquifer. A second objective of the aquifer testing is to evaluate the aquifer characteristics to estimate well yield and long-term pumping suitability to achieve mass removal and PCE plume capture.

2.3.2 Rationale

Installation of the proposed test well will facilitate periodic sampling and tracking of the PCE concentration trends in the groundwater plume. In addition, the proposed location will help further define the vertical extent of the PCE plume. These data will be used to evaluate the effectiveness of the groundwater remedy to provide hydraulic control of the groundwater plume. Installation of the proposed test well will provide additional hydraulic control needed in the shallow aquifer to further limit the migration of the groundwater plume.

Step- and constant-rate pumping tests and water level recovery tests are proposed in the test well. The step-rate test data will be used to determine the optimum pumping rate the well for the constant-rate test. The constant-rate test data will be used to determine well efficiency, aquifer parameters, boundary conditions, and to evaluate the potential capture zone footprint. In addition, a final well video survey is proposed in the test well. The video will be used to document the final "as-built" construction of the well.

2.3.3 Activities

Prior to test pumping, a temporary on-site treatment and discharge system will be installed to remove chlorinated hydrocarbons from waste water generated during the aquifer tests. All treated water will be discharge to the Districts main sewer collection system (MH TK 388) and/or the Eloise Stormwater Retention Basin. All discharges of treated groundwater to the Retention Basin will comply with the terms and conditions of Lahontan's General NPDES Permit (Board Order No. R6T-2016-0011, General NPDES No. CAG91600) for surface water disposal of treated groundwater and the permit requirements of the City of South Lake Tahoe (CSLT) storm sewer system (MS4) NPDES Permit (Board Order No. R6T-2017-0010, NPDES No. CAG616001), as required under the CSLT Eloise Basin Stormwater Agreement with the District. Treated discharges to the District's sewer collection system will be in accordance with District standards.

Set-up for the aquifer tests will consist of the following:

- Place pressure transducers in test well and nearby observation wells MW-4A, MW-4B and MW-4C. STPUD owns Solinst Leveloggers (model 3001). Leveloggers will be deployed into the test well and observation wells and utilized during the pumping test. Each of the pressure transducers will be set to record water levels every five minutes. A picture of a pressure transducer and what they look like setup in the observation wells are shown in Figure 2.1. These transducers are capable of measuring water levels to within 0.001 feet and temperatures to 0.01 degree C. The logging capabilities and data storage allow for a variety of programmable solutions to observe subtleties necessary to accurately evaluate aquifer properties.

Figure 2-2: Picture of typical pressure Solinst transducer.

After the date has been set for startup of the aquifer test, field staff will be onsite at least one week before the date to begin set-up that will include installing flow meters and totalizer for the test well and programming the transducers for recording the pump test. During this period, water level measurement will be collected from the test well and observation wells using a hand held electric well sounder. These water levels will be recorded to the nearest 0.01 foot.

Table 2-2: Aquifer Testing Water Level Sampling Frequency

Frequency, One Measurement Every	Elapsed Time, For the First
1 second	0 – 5 minutes
30 seconds	5 – 15 minutes
1 minute	15 – 30 minutes
5 minutes	30 – 60 minutes (1 hour)
10 minutes	1 hour to 24 hours
30 minutes	24 hours

Kennedy/Jenks will coordinate and analyze an 8-hour step-rate pumping test and a 72-hour constant-rate pumping test at the new test well. Groundwater levels will also be monitored and recorded for a 12-hour recovery period immediately following completion of the constant-rate test. The pump contractor will provide the test engine, motor, and ancillary equipment for both tests.

The step-rate or step-drawdown test is used to evaluate head losses during operation of a test well. Traditionally, the step-drawdown test is used to evaluate the specific capacity (i.e., discharge rate/ drawdown) of a well at various discharge rates (Driscoll, 1986). In a step-drawdown test, a well is pumped at an initial discharge rate for a specific time interval, and then at successively higher discharge rates during additional time intervals or “steps.” Water levels are measured in the test well for the duration of each new time step.

The objective of step-drawdown testing for TW-01 is to establish the optimum pumping rate for an extraction well. The step-drawdown test will consist of a minimum of four steps, with each individual step estimated to last 1 to 2 hours. Electronic pressure transducers, data-loggers and hand-operated measuring devices will be used during the tests to collect water level data. The pumping steps are expected to range from 50 to 200 gpm. During the step-drawdown test, water level measurements and water quality field parameters, including electrical conductivity, sand content, pH, and temperature of the discharge water wil be recorded. Procedures for the monitoring of depth to groundwater information and groundwater sample collection are presented in detail in Appendix E. If, after proceeding with the test, it is apparent that these pumping rates will be insufficient to cause drawdown in a potential extraction well, the rate planned for each step may be increased accordingly. The necessity for changes to the proposed pumping rates is a function of the actual conditions encountered during the test, and represents a judgment call that will be made by the field geologist after consultation.

As mentioned, the step-drawdown test will be performed to assess drawdown in the test well at different discharge rates to determine well efficiencies. Results of the step-drawdown test will be plotted as drawdown-versus-time graphs for the various incremental discharges. Using the step-drawdown data, estimates of hydraulic transmissivity (T) will be made with the Theis & Jacob Recovery Test Method, applied by the AQTESOLV (Duffield, 2007) pumping test computer program. Well efficiency will also be estimated using methodology outlined by Clark (1977), utilizing the method of Hantush and Bierschenk (1964).

Following completion of the step-drawdown tests and recovery of TW-01, a 72-hour constant-rate pumping test will be performed on the test well. The time period of the constant-rate tests may be lengthened or shortened based on the results of the step-drawdown tests. In addition to monitoring water levels in TW-01, pressure transducers in will be installed in the observation wells to monitor the effects (i.e., water levels) on selected A, B, and C zone wells.

The basic principle of a constant-rate test is that if a well is pumped at a constant-rate and measurements of the drawdown in the test well and observation wells at known distances from the test well are made, then these measurements can be substituted into an appropriate well-flow equation to estimate the hydraulic properties of the aquifer penetrated by the test well. Depending on the test conditions and aquifer characteristics, results of the constant-rate test will allow estimates of aquifer hydraulic conductivity (K), T, and storativity (S).

The pumping rate used in the constant-rate test will be based on data obtained during step-drawdown testing. The rate will be based on the maximum rate that the pump is expected to sustain for the duration of the 72-hour pumping period or 200 gpm, whichever is less (i.e., limited by the on-site water treatment system capacity). If feasible, the rate will be set so that the water level in the test well does not draw down more than 10 percent of the aquifer thickness. However, the drawdown limitation in the test well may be sacrificed to produce an increase in the pumping rate, if necessary, to demonstrate an influence in the observation wells. Under no circumstances will the water level be lowered below the intake port of the submersible pump during the test.

Analysis of the pumping test data will be completed using the computer program AQTESOLV (Duffield, 2007), which provides automatic test computations of two commonly used mathematical test solutions: (1) the Theis type-curve method (Theis, 1935), and (2) Cooper-Jacob straight line method (Cooper and Jacob, 1946). Based on the geologic and hydraulic conditions of the test, the test data will be analyzed using mathematical models that represent the following aquifer systems: unconfined; confined; and confined, leaky. Results of the analysis will facilitate estimation of hydraulic properties (e.g., K, T, and S), boundary conditions (e.g., constant head, impermeable), aquifer type, optimum long-term extraction rate, and steady-state radius of pumping influence.

During the constant-rate test, groundwater elevations will be measured at 3 minute intervals for the first 30-minutes; at 5-minute intervals after 30-minutes to 90-minutes; at 10-minute intervals after 90-minutes to 240 minutes; at 30-minute intervals after 240-minutes to 1440 minutes and hourly after 1440 minutes.of pumping time. The optimum pumping rate of the test well (determined during the step-discharge test) will be maintained throughout the constant-rate test. In addition, groundwater levels at the observation wells will be manually monitored throughout the duration of the constant-rate test. Every 24 hours of pumping, a water sample will be collected and submitted to an analytical laboratory for analysis of VOCs using EPA Method 8260B.

After the cessation of pumping, a water level recovery test will be conducted for a period of twelve hours or until 95% water level recovery has been achieved (whichever occurs first).

Subsequent to the pumping tests, final well inspection will be conducted with a downhole video survey. The video survey will document the final well construction showing interior of the well casing and screened interval. A video survey log will be prepared that describes the content of the well video for each test well.

2.3.4 Deliverables

1. Results and analysis of data from 8-hour step-rate pumping test and a 72-hour constant-rate pumping test at the new test well.

2. Pressure transducer readings from observation wells during pump testing of test well.

2.4 Health and Safety

Kennedy/Jenks will provide a site-specific Health and Safety Plan (HASP) that will be followed by Kennedy/Jenks staff. The plan will indicate standard procedures for reacting to emergencies and will provide emergency contact information and directions to local occupational health clinic and emergency room. Kennedy/Jenks staff will have a hardcopy of the HASP in the field. Kennedy/Jenks requires that all contractors and subcontractors follow their own respective HASPs that will be reviewed prior to the commencement of field work.

Section 3: Decontamination Procedures

The purpose of decontamination and cleaning procedures during drilling, well installation, and soil sampling is to prevent foreign contamination of the samples and cross-contamination between observation wells and between sampling sites. Before use, all downhole drilling and groundwater sampling equipment will be decontaminated by steam cleaning or, alternatively, by washing with a nonphosphate detergent, such as Liquinox, or an equivalent. A tap water rinse and a deionized (DI) water rinse will follow the detergent washing. The following item-specific decontamination procedures will be observed.

- Drill rig: Steam clean prior to drilling at each new site.
- Drill stems and tools: Steam clean prior to drilling each borehole.
- Downhole abandonment equipment (e.g., tremie pipe): Pressure wash between each well.
- Reusable soil or groundwater samplers: Rinse with DI water, Liquinox and DI water mixture, and DI water (in that order) between each use.
- Water level sounder: Rinse with DI water, Liquinox and DI water mixture, and DI water (in that order) between each use.
- Development rig (submersible equipment): Steam clean between observation wells.
- Pumps: Steam clean exterior of pump and hose (or use disposable hose), and run detergent water and tap water through pump if there is no check ball installed on pump.
- In situ groundwater sampling equipment: Rinse with DI water, Liquinox and DI water mixture, and DI water (in that order) before installation in each well.

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Section 4: Investigation-Derived Waste

4.1 Sources of Waste

During the course of investigation activities, investigation-derived waste (IDW) will be generated, consisting of soil (soil cuttings) and water (decontamination, development and purged waters). The IDW will be containerized in 55-gallon drums or other appropriate storage containers (roll-off soil bins, Baker Tanks, etc.) as it is generated. To the extent possible, IDW that is anticipated to be contaminated will be segregated in separate containers from IDW that is anticipated to be uncontaminated. Waste containers will be labeled with appropriate “analysis pending” labels as the waste is generated.

4.2 Characterization

Treated water quality is expected to meet drinking water standards. The source water is expected to contain high concentrations of VOCs (PCE and potentially breakdown by-products, such as trichloroethene (TCE), dichloroethene (1,2-DCE) and vinyl chloride (VC)), which will be completely removed through the GAC filtration system. Based on review of the available water quality data provided by the District for the South Y Area wells; these chlorinated hydrocarbons are believed to be the primary contaminants of concern. Trace levels of total petroleum hydrocarbon (TPH) compounds and fuel oxygenates (Methyl tert-butyl ether) are also likely to occur at concentrations below applicable drinking water standards.

Samples of the waste will be collected immediately following containerization to the extent possible to expedite waste characterization of disposal. Samples will also be collected and analyzed to meet the profiling and acceptance criteria of the specific disposal facility(ies) that will eventually receive the waste. It is anticipated that soil will be disposed of at an appropriate Class II facility capable of receiving soil cuttings with moisture content in excess of 50%. To the extent possible, IDW that is anticipated to be contaminated will be segregated in separate containers from IDW that is anticipated to be uncontaminated. Waste containers will be labeled with appropriate “analysis pending” labels as the waste is generated.

4.3 Disposal

Mechanical well development will generate relatively small volumes of waste consisting debris and sediment removed from the well. This solid material can be added to the soil cuttings. Based on the results of the profiling activities, an appropriate disposal facility will be selected to receive the IDW material. It is anticipated that soil will be disposed of at an appropriate Class II facility capable of receiving soil cuttings with a moisture content in excess of 50 percent. A subcontractor licensed to haul hazardous waste will transport the waste to the disposal facility. Appropriate disposal and waste manifest documentation will be produced and maintained to document the disposal process.

During these aquifer tests the produced water will be filtered through a granular activated carbon (GAC) filtration system that will also be used for pilot testing. The water will be filtered prior to pumping into the sanitary sewer.

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Section 5: Quality Assurance Project Plan

This QAPP serves as the primary guide for the integration of QA/QC functions into groundwater characterization activities at the groundwater plume site. This QAPP presents the procedures, objectives, functional activities, and specific QA/QC activities designed to achieve established data quality goals. The QAPP provides for all quality-related field sampling and laboratory analysis activities that will be implemented during investigation activities, and is subject to DTSC approval.

Environmental measurements are made to produce data that are scientifically valid, of known and acceptable quality, meet established objectives, and are legally defensible. This QAPP recognizes the responsibility to implement minimum procedures that assure that the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters of all data generated meet the specified data quality objectives (DQOs). Throughout this section, specific procedural guidance is included. These procedures and their associated data collection and data tracking forms will be used to ensure the consistency and thoroughness of data generation and data integrity.

This QAPP was developed in accordance with the United States Environmental Protection Agency's (USEPAs) QAPP guidance documents (EPA QA/G-5 and EPA QA/R-5) and the District's Laboratory Quality Assurance Program (LQA Program), which is provided in wholes as Appendix E, and is referenced as appropriate throughout.

5.1 Project Design and Rationale

STPUD has initiated this investigation to conduct a baseline sampling in a new bore hole and South Y Area wells to determine the extent of contamination and to drill a new test well to provide the information necessary to design a remedy which is a cost-effective approach to groundwater contamination reduction and restoration. Once groundwater sampling is complete, the data will be used to effectively design a groundwater remedy with the objective of containing and limiting the migration of the contaminated groundwater plume, thereby limiting further damage to the aquifer. In order to gather information regarding aquifer characteristics one well in the C water bearing zone (which extends to approximately 190 feet bgs), shall be developed under this scope of work.

The scope of work for this pre-design investigation includes collection of groundwater samples in observation wells and a new test well located within the plume, test well construction and development, to support preparation of a remedial design for a groundwater remedy. Further groundwater assessment, contaminant migration modeling, and sampling to evaluate this system may be performed to determine what further groundwater remedial measures are necessary. Groundwater samples collected at the newly constructed test well will be analyzed for VOCs.

Because current South Y Area monitoring wells are not equipped with permanent pumps, a temporary pump will be installed at each selected monitoring well. Parameters (pH, temperature, conductivity, and turbidity) will be collected and recorded on the sample data sheet. Water parameters will be measured using a flow cell connected to the sample port, prior to collecting the water sample. Samples will be collected directly from the end of the Teflon tubing subsequent to purging at least three well volumes from the well. Water quality parameter meter(s) will be calibrated at the interval recommended by the manufacturer. Purging will be considered complete when pH, temperature, conductivity and turbidity have stabilized. The pH, temperature, conductivity and turbidity are considered stable when the variations in three successive readings does not exceed:

pH:	Difference between three or more consecutive readings is within ±0.2 units
Temperature:	±1° Celsius
Conductivity:	±3% micromhos per centimeter (µmho/cm) or microSiemens per centimeter (µS/cm)
Turbidity:	±10% or three readings below 10 nephelometric turbidity units (NTU) (whichever is greater)

Samples for VOC analysis will be collected in laboratory-supplied, 40-ml VOA vials with Teflon-lined septum and HCl preservative. Sample containers, preservation, and holding times for liquid samples are described in the QAPP. The vials will be filled to form a convex meniscus above the upper rim of the vial. Overfilling will be avoided to maintain levels of preservative in the vials. The cap, with septum, will then be applied to the vial and tightened. The vials will be inverted, gently tapped, and checked to determine whether bubbles are present in the vials. Any vials with visible bubbles will be discarded, and replacement vials will be filled.

The parameters in Table 5-1 below are proposed for analysis. Baseline groundwater analysis in the observation wells will be limited to VOCs and field parameters while the broader suite of analytes (e.g. general mineral and inorganics) will occur in the test well sufficient to gather information for treatment pre-design.

Table 5-1: Chemical Analysis Parameters for Groundwater and Soil

Analyte	Method	Units	Volumes/Bottles/Preservatives
Field Tests			
pH	Field	Units	STPUD supplied Handheld Meter and HACH DR 5000
Conductivity	Field	µmhos/cm	
Temperature	Field	Deg. Celsius	
Turbidity	Field	NTU	
Total chlorine	Field	mg/L	

Analyte	Method	Units	Volumes/Bottles/Preservatives
General Mineral			
pH	4500-H B	units	
Total alkalinity (as $CaC0_3$)	2320B	mg/l	250 mL unpreserved plastic
Hydroxide as OH			
Carbonate as CO_3			
Bicarbonate as HCO_3			
Total Hardness as $CaCO_3$	200.7	mg/l mg/kg (soil)	250 mL Nitric acid preserved plastic 4 oz. glass jar (soil)
Calcium			
Magnesium			
Potassium			
Sodium			
Total Cations		meq/l	
Sulfate	300.0	mg/l mg/kg (soil)	1 L unpreserved plastic 4 oz. glass jar (soil)
Chloride			
Nitrate as NO_3			
Nitrite as N			
Nitrate + Nitrite as N			
Fluoride			
Total Suspended Solids	160.4	mg/l	1 L unpreserved plastic
Specific Conductance	2510B	µmhos/cm	
Total Dissolved Solids	2540CE	mg/l	
Total Organic Carbon	SM 5310C/EPA 415.3	mg/l mg/kg (soil)	3x40 ml preserved VOA vials 4 oz. glass jar (soil)
Inorganic Chemical			
Aluminum	200.8	µg/l	500 ml unpreserved plastic 4 oz. glass jar (soil)
Antimony			
Arsenic			
Barium			
Beryllium			
Boron			
Cadmium			
Chromium			
Copper			
Iron			
Lead			
Manganese			
Nickel			
Selenium			
Silver			
Thallium			
Vanadium			
Zinc			
Mercury			

Analyte	Method	Units	Volumes/Bottles/Preservatives
Volatile Organics			
1,1,1-Trichloroethane	VOC524.2 (water) 8260B (soil)	µg/l µg/kg (soil)	3x40 ml preserved VOA vials Soil: Either 1) 4 oz. glass jar with Teflon lid, or 2) 5 grams with Encore or equivalent sampler for preservation by EPA Method 5035
1,1,2-Trichloro-1,2,2-trifluoroethane			
1,1,2-Trichloroethane			
1,1-Dichloroethane			
1,1-Dichloroethene			
1,1-Dichloropropene			
1,2,3-Trichlorobenzene			
1,2,4-Trichlorobenzene			
1,2,4-Trimethylbenzene			
1,2-Dichloroethane			
1,2-Dichloropropane			
2-Butanone			
Acetone			
Benzene			
Bromodichloromethane			
Bromoform			
Carbon tetrachloride			
Carbon Disulfide			
Chloroethane			
Chloroform			
Chloromethane			
cis-1,2-Dichloroethene			
Dichlorodifluoromethane			
Ethylbenzene			
m,p-Xylene			
Methyl tert butyl ether (MTBE)			
Methylene chloride			
o-Xylene			
Tetrachloroethene			
Toluene			
trans-1,2-Dichloroethene			
Trichloroethene (PCE)			
Trichlorofluoro-methane			
Vinyl chloride			
Total Petroleum Hydrocarbon - diesel	EPA 8015M	mg/l	500 ml unpreserved glass amber

5.2 Sample Collection and Quality Control

The quality of data collected in an environmental study is critically dependent upon the quality and thoroughness of field sampling activities. Considering the sensitivity of analytical methods and the levels of detection specified for contaminant analyses, the sampling process becomes integral to the quality of data generated. As a result, general field operations and practices and specific sample collection and inventory will be well planned and carefully implemented.

Section 2 provides detailed descriptions of the soil and groundwater sampling program. The following topics are described in this QAPP relating to sampling:

- Techniques used to select sampling locations;
- Requirements for sample collection, preservation, containers, holding times, and transport;
- Types of analyses to be performed;
- Sample collection by matrix, parameter, location, and frequency;
- Use of control samples (e.g., field duplicates and field blanks);
- Analytical methods to be performed;
- Sample documentation and tracking; and
- Requirements for waste and contaminated material disposal.

5.2.1 Sampling Design

5.2.1.1 Water Sampling

To complete the groundwater plume characterization, semi-annual groundwater samples will be collected for a period of up to two years (for a total of four sampling events). As a part of the sampling, location information, physical parameters, groundwater level measurements, groundwater quality parameters, and baseline groundwater samples will be collected from up to 8 existing monitoring wells which will be pumped to purge 3- 5 well casing volumes prior to sample collection. To minimize the cost of purge water disposal, low-flow sampling methods may also be used. Groundwater sampling from the new test well will also occur. The information will be used to design a groundwater remedy for the plume that emanates from the site. In addition, IDW samples will be analyzed for VOCs and total metals, for disposal purposes.

5.2.1.2 Soil Sampling

Soil core will be screened for VOCs using a PID, and three soil samples will be retained at depths of the maximum PID readings. This data will also be used for IDW disposal. One soil sample from the aquifer zone will also be analyzed for ions and metals concentrations that may inform remedial options that may be considered for the plume source area in the future.

5.2.2 Sample Containers, Volumes, and Preservation

The sample container, preservation method, and holding time requirements are summarized in Table 5-2: , Table 5-3 and the District LQA Program, Section III and Section V. The District staff will provide sample containers and pick up samples once collected.

Table 5-2: Sample Container and Holding Time Requirements for Water Samples (Groundwater Sampling, Trip Blanks)

Methods	Parameter	Sample Container	Volume	Preservative	Holding Time
EPA 353.2	Nitrate	Plastic	250 ml	H_2SO_4 , pH<2, 4°C	28 Days
EPA 200.8/ EPA 7470A	Total Metals	Plastic	500 ml	HNO_3, pH<2, 4°C	180 Days Hg 28 days
SM2320B	Alkalinity	Plastic	250 ml	4°C	14 days
EPA 200.7	Hardness and ions	Plastic	250 ml	HNO_3, pH<2, 4°C	180 Days
EPA 300 series	Anions and nitrate	Plastic	125 ml	4°C	28 days
EPA 160.4	TSS	Plastic	1 liter	4°C	7 days
SM 2540 CE	TDS	Plastic	1 liter	4°C	7 days
SM 5310C/ EPA 415.3	TOC	Glass	250 ml	H_2SO_4 , pH<2, 4°C	28 Days
SW8260B	VOCs	Amber Glass, Teflon Lined	(3) 40 ml VOA Vials	HCL, pH<2, 4°C	14 Days

Notes:

Analyses with similar container and preservation requirements may be combined into one container.
The holding time is from the time/date of sample collection.

H_2SO_4 = sulfuric acid
HCl = hydrochloric acid
HNO_3 = nitric acid
ml = milliliter
VOA = volatile organics analysis
VOC = volatile organic compound
°C = degrees Celsius

Table 5-3: Sample Container and Holding Time Requirements for IDW Samples

Matrix	Method	Sample Container	Volume	Preservative	Holding Time
Soil	EPA 8260B	Encore Sampler	5 grams	4°C	48 hours unpreserved, 14 days from preservation to analysis
Soil	EPA 6010	6-inch metal liner with Teflon caps	50 grams	4°C	180 days

Soil	EPA 8015M	6-inch metal liner with Teflon caps	50 grams	4°C	14 days
Water	EPA 8260B	Amber Glass, Teflon Lined	(2) 40 ml VOA Vials	HCl, pH<2, 4°C	14 Days
Water	EPA 6010	Plastic	250 ml	HNO_3 pH<2,	180 days
Water	EPA 8015M	Glass amber	500 ml	4°C	14 days

HCl = hydrochloric acid
Hg = mercury
HNO_3 = nitric acid
IDW = investigative-derived waste
ml = milliliter
oz = ounce
VOA = volatile organics analysis
°C = degrees Celsius

5.2.3 Field Data and Sample Collection Procedures

Field data collection forms and sample collection procedures are included in Appendix E as part of the District LQA Program. The purpose of these procedures is to obtain samples that represent the environment under investigation. Procedures that will be used for field and sampling activities are discussed in District LQA Program, Section III. Sample preservation methods are shown in Tables 6-3 and 6-4.

Field personnel are responsible for the use and maintenance of field notebooks when conducting project-related fieldwork. Field notebooks provide a means for recording all data collection activities performed at a site. Field notebooks are intended to provide sufficient data and observation notes to enable participants to reconstruct events that occur during site activities. All entries should be as factual, detailed, and descriptive as possible so that a particular situation can be reconstructed without reliance on the collector's memory. Field notebooks are not to be used as a sole source of project or sampling information, nor should they be used for recording personal feelings or opinions or any other inappropriate terminology. Field notebooks will be completed with consecutively numbered pages. Notebooks will be permanently assigned to field personnel.

The cover of each notebook will contain the following information:

- Person or organization to whom the book is assigned;
- Book number;
- Project number (if different from site number);
- Site name and number; and
- Start date of notebook entries.

Entries into the notebook may contain a variety of information. At a minimum, notebook entries must include the following information at the beginning of each day:

- Date;

- Start time;
- Weather;
- County, state, and site address;
- All field personnel present and directly involved; and
- Level of personal protection being used on site.

In addition, information recorded in the field notebook should include (but is not limited to) the following:

- A detailed description of sampling locations, physical parameters, and groundwater level measurements.
- Information on field QC samples (i.e., duplicates and trip blanks).
- Observations about site and samples (odors, appearance, etc.).
- Information about any activities, extraneous to sampling activities, that may affect the integrity of the samples (e.g., low-flying aircraft nearby, fossil-fueled motors being used nearby, painting operations being carried out upwind of sampling sites, etc.).
- Equipment used on site, including time and date of calibration. Equipment calibration also will be recorded in the calibration log book.
- Maps or photographs acquired or taken at the sampling site.
- Forms used during sampling.

All notebook entries will be made in indelible black or blue ink. No erasures are permitted. If an incorrect entry is made, the data will be crossed out with a single strike mark and dated and initialed by the originator. Entries will be organized into easily understandable tables, if possible. The PM or PM-designee will review field notebooks that result from field operations for completeness and accuracy upon completion of the project.

5.3 Chain-Of-Custody Procedures

Proper chain-of-custody and sample tracking methods will be used during sample collection as described in the District LQA Program, Section IV. These methods include maintaining the documentation necessary to trace sample possession and the proper completion of standardized chain-of-custody forms used to accompany samples picked up by District staff and shipped to the District’s contract laboratory.

Field personnel (samplers) are responsible for performing sample custody, documentation, and tracking tasks when collecting environmental samples meant for laboratory analysis or archiving. The personnel are responsible for the care and custody of the collected samples and the proper and complete preparation of all sample labels and chain-of-custody forms related to the samples until the samples are transferred or dispatched properly.

During an investigation, custody is maintained if an environmental sample is:

- In one's actual physical possession or view;

- In one's physical possession, and has not been tampered with (i.e., under lock or official seal);
- Retained in a secure area with restricted access; or
- Placed in a container and secured with an official seal so that the sample cannot be accessed without breaking the seal.

A chain-of-custody form will be used as the sample custody and analyses specification document for all samples from the time of collection to laboratory analysis.

5.3.1 Field Procedures for Custody Documentation

The following chain-of-custody procedures will be implemented to maintain and document sample possession:

- Samples will be collected as described in District LQA.
- The sampler (or person in possession of samples) is responsible for the care and custody of the samples collected until they are properly transferred or dispatched to the analytical laboratory.
- Sample labels will be completed for each sample container using block printed text and indelible ink.
- When possible, all samples pertaining to one physical sampling location will be recorded on the same chain-of-custody form.

5.3.2 Transfer of Custody and Shipment

Section IV of the District LQA Program describe the procedures for sample chain of custody. Samples must always be accompanied by chain-of-custody paperwork. When transferring the possession of samples from the Contractor to the District, the individual(s) relinquishing and receiving will sign, date, and note the time in the appropriate space on the custody paperwork. If the transfer occurs among the sampling team, the individual receiving the samples must document the range of sample numbers transferred to their possession in the “Received By” field. This act documents the physical transfer of the sample or group of samples from the sampler to other field personnel. When shipping samples by overnight courier, the individual in possession of the samples relinquishes the samples by signing, dating, and noting the time and completing the “Received By” box with the courier name and air bill number.

All shipments will be accompanied by the appropriate custody and analyses specification document(s) identifying the shipment container's contents and analyses needed for each sample. The original documents will be sealed in a plastic bag and placed in the ice chest.

If sent by common carrier or air freight, the air bill will be maintained. The method of shipment, courier name(s), and other pertinent information will be entered on the chain-of-custody form.

The following information will be conveyed to the scheduled laboratory when samples are shipped:

- Date shipped;
- Number of samples by concentration (high, medium, low), if known, and sample matrix; and
- Carrier and air bill number.

Field personnel will notify the laboratory representative of Saturday sample deliveries, if necessary.

5.4 Analytical Quality Control Procedures

The procedures and methods used for analytical quality control procedures is described in the following sections as well as Section IX and Section X of the District LQA Program.

5.4.1 Quality Control Checks

The QC checks of both field screening and laboratory sample analysis will be used to assess and document data quality and to identify discrepancies in the measurement process that need correction. The collection and analysis of field duplicates, laboratory duplicates, trip blanks, and matrix spike/matrix spike duplicate (MS/MSD) samples will be used, as appropriate, for QC checks on the representativeness of the environmental samples, the precision of sample collection and handling procedures, and the accuracy of laboratory analysis. The analytical laboratory shall also report any QC failures, such as calibration check samples that exceed control limits.

5.4.2 Sample Preservation

Sample preservation is instrumental in maintaining the integrity of the samples from the time of collection until the analyses are performed. Therefore, the samples will be preserved during collection and storage to prevent or retard degradation or modification of the chemicals in the samples. Preservation requirements are summarized in Tables 5-3 and 5-4 and the District LQA Program, Section V.

5.5 Data Quality Management

5.5.1 Data Handling Systems

The following sections describe the process for handling data in terms of data generation, review, and routing for field sampling data. The procedures identified in previous sections describe the recording of measurements onto data collection forms. This section discusses the monitoring and controls established to track field data through the following events:

- Field form completion; and
- Field review and correction.

5.5.2 Data Validation

Data validation will be performed on every work order. This will include the review of analytical results, associated laboratory internal QC data and field QC data reported by the analytical laboratory. All data generated will be assessed for PARCC parameters. The data assessment criteria for each of these parameters are described in Table 5-2.

5.5.3 Data Assessment

Data quality may be assessed in terms of precision, accuracy, representativeness, comparability (fitting ongoing trends), and completeness. The first two are assessed in quantitative terms, while the latter three are generally expressed as qualitative characteristics. The methods for data assessment are described in Section XI of the District LQA Program.

5.5.4 Data Reporting

Laboratory measurements will be recorded in standard formats that specify site location, sample identification, date, matrix parameter, parameter value, and detection limit. Laboratory and field data will be combined and summarized in final tables and graphs that are appropriate to the type of data and convey information to support the findings of the data collection program. In all cases, data will be clearly tabulated and presented in a consistent way to facilitate the comparison of common sets of data.

5.5.5 Data Reporting Package Archiving and Retrieval

The analytical laboratory will archive data reporting documents for a minimum of three years, in accordance with the District procedures. The District also maintains data in its own databases in perpetuity.

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Section 6: Pre-Design Investigation Report

Subsequent to field activities, laboratory analysis, and data evaluation, an investigation field summary report will be prepared and submitted to STPUD for review prior to submittal to the TAC. The report will include the following:

- A historical summary of the site background;
- A record of activities completed including soil and groundwater sampling and pump test results;
- An evaluation of the quality of the data collected;
- A report of the data findings and design assumptions for the feasibility study;
- Conclusions and recommendations;
- All laboratory reports; and
- All daily field notes, drilling logs, subcontractor reports, and photographs.

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Terra Vac, 2001. Pump Test Results, Computer Modeling and System Expansion Conceptual Design, Swiss Mart, 913 Emerald Bay Road, South Lake Tahoe, California, August 8, 2001.

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William F. Pilsbury, Inc., 1987. Improvement Plans for Tahoe Valley Erosion Control Project Phase 1, PWC 1986-06, Bid No. 1991-21, Sheet 8, October 1987.

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Appendix A: 903 and 953 Eloise Site Photos

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PRE-DESIGN INVESTIGATION SITE AREA

PRE-DESIGN INVESTIGATION

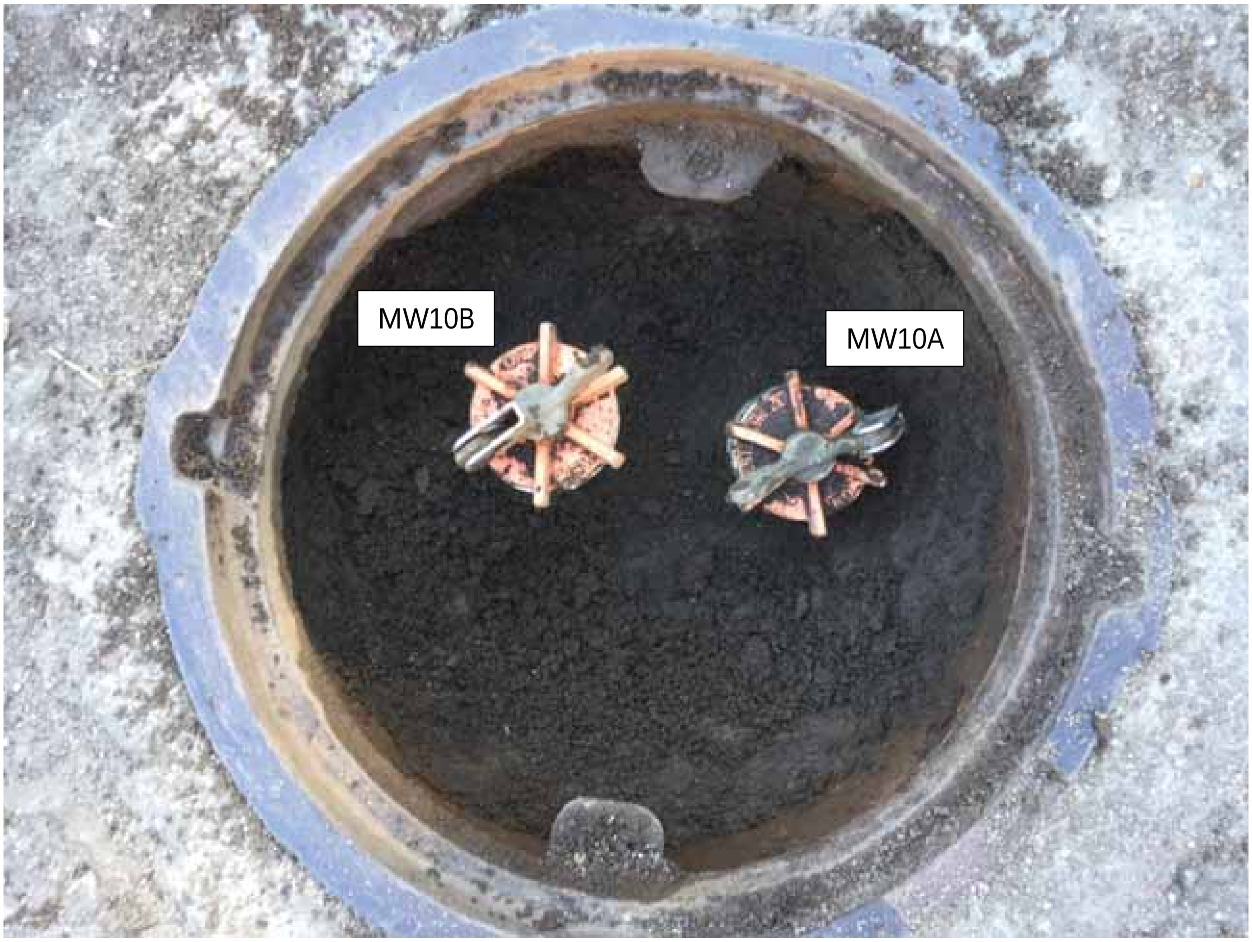
Stanford Alumni Association (SAA) Property,
903 Eloise Avenue (AKA 895 Eloise Avenue)
(APN 023-29-109)

Well House, 903 Eloise Avenue is located in southwest corner of property (APN 023-29-109). The wellhead is located in the southwest corner of the well house (wood frame/stucco); power to the well house has been disconnected. The property address is identified as 895 Eloise Avenue on the El Dorado County Parcel Layer.

Wellhead, 903 Eloise Avenue has an 8-inch cover plate with 1-inch discharge line. Water Well Drillers Report 49374 shows this well to be constructed of 6-inch welded steel casing to a total depth of 76 feet. Well perforations are from 56 to 76 feet and consist of 5-inch x 0.25-inch torch cut slots. This well is abandoned and is proposed to be used as a possible observation well during the field test.

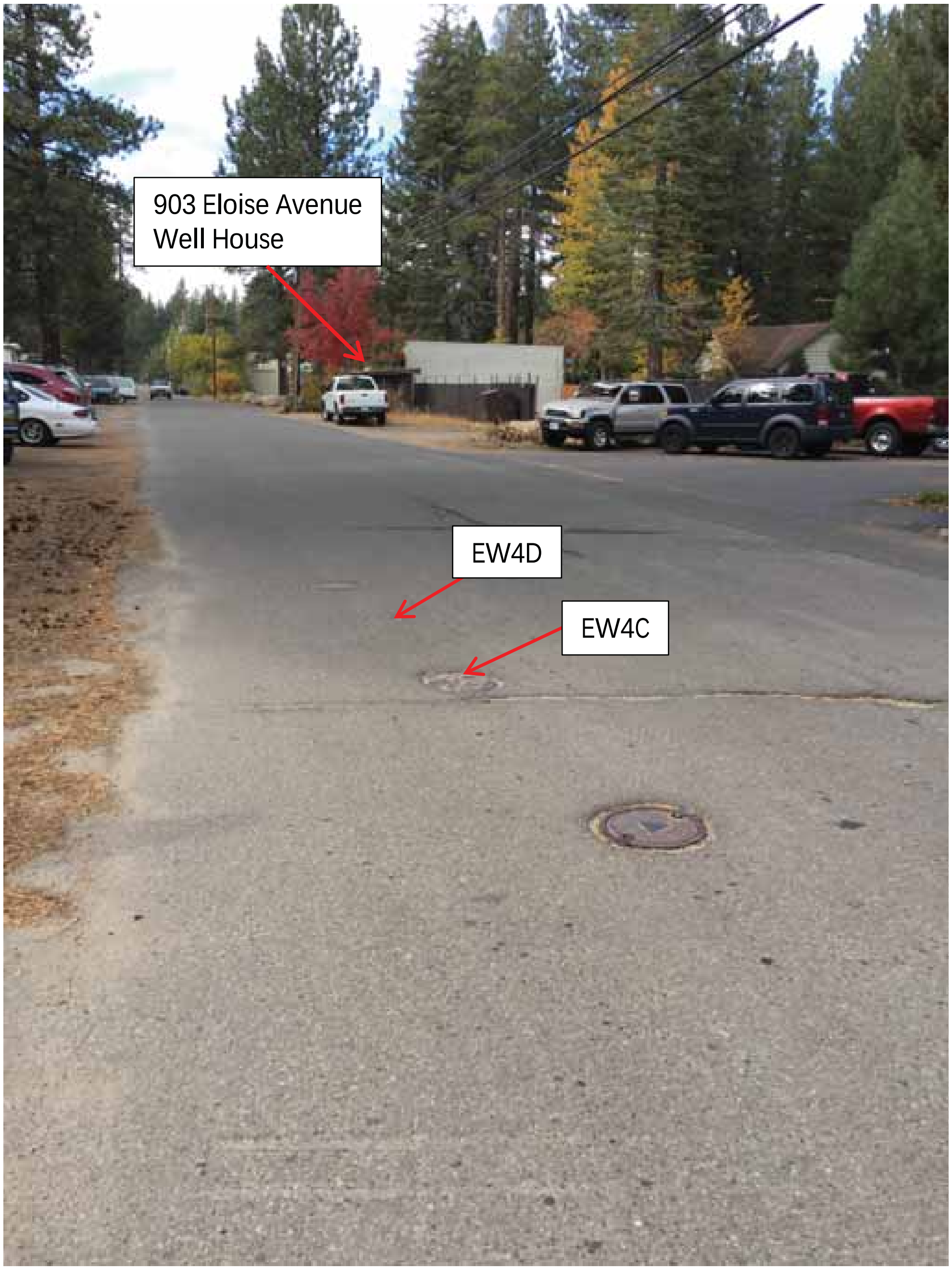
Swiss Mart Monitoring Wells 10A, 10B and 10C are located about 50 to 60 feet southwest of the 903 Eloise Avenue Well House. MW10A and 10B share a 12-inch well cover. MW10C is located west of MW10A/10B and is completed within an 8-inch well cover.

MW10C; 2-inch PVC Well; TD = 80 ft btoc;



Monitoring Wells MW10A and MW10B; MW10A is situated east of MW10B.

MW10A; 2-inch PVC Well; TD = 24.60 ft btoc;
MW10B 2-inch PVC Well; TD = 49.80 ft btoc.



Swiss Mart Monitoring Wells EW4C and EW4D are located across from Hatch Electric (921 Eloise Avenue) approximately 150 feet east of the 903 Eloise Avenue Well House. EW4C is situated within a 12-inch well cover; EW4D is completed within a 6-inch well cover.

EW4C; 2-inch Well; TD = 74.78 ft btoc;
EW4D; 4-inch Well; TD = 134 ft btoc.

903 Eloise Avenue, the fenced yard includes an open area of about 70’ x 120’.

View from the southeast corner within the fenced portion of the property.

PRE-DESIGN INVESTIGATION

Eloise Stormwater Retention Basin,
953 Eloise Avenue (APN 023-30-109)

Proposed Work Site Area includes parking area in southeast corner of the Liberty Utilities property (933 Eloise Ave.) and adjoining southwest corner of the CSLT property (953 Eloise Ave.).

Proposed work site area, southwest corner of CSLT property at 953 Eloise Avenue (APN 023-30-109). View north from Eloise Avenue (Top); View south from north edge of parking area (Bottom).

Proposed Test Well Location bordering the east side of the Liberty Utilities parking area in the southwest corner of the CSLT property at 953 Eloise Avenue.

Alternate Test Well location along the west side of 953 Eloise Avenue. The Eloise Stormwater Retention Basin lies immediately to the east. View to North (Top); View to South (Bottom).

Monitoring Well cluster MW-4, situated along north shoulder of Eloise Avenue, neighboring the proposed Test Well location, view to North. MW-4A and -4B are completed in a 12-inch flush-grade well cover; MW-4C is completed in an 8-inch flush-grade well cover.

MW4A; 2-inch PVC Well; TD = 25.10 ft btoc;
MW4B; 2-inch PVC Well; TD = 48.80 ft btoc;
MW4C; 2-inch PVC Well; TD = 78.50 ft btoc;

Monitoring Wells MW4A and MW4B; MW4A is situated west of MW-4B.

MW-4C

Eloise Stormwater Retention Basin, view north from inlet.

Eloise Stormwater Retention Basin, view south from outlet.

Appendix B: Lithologic and Well Construction Logs

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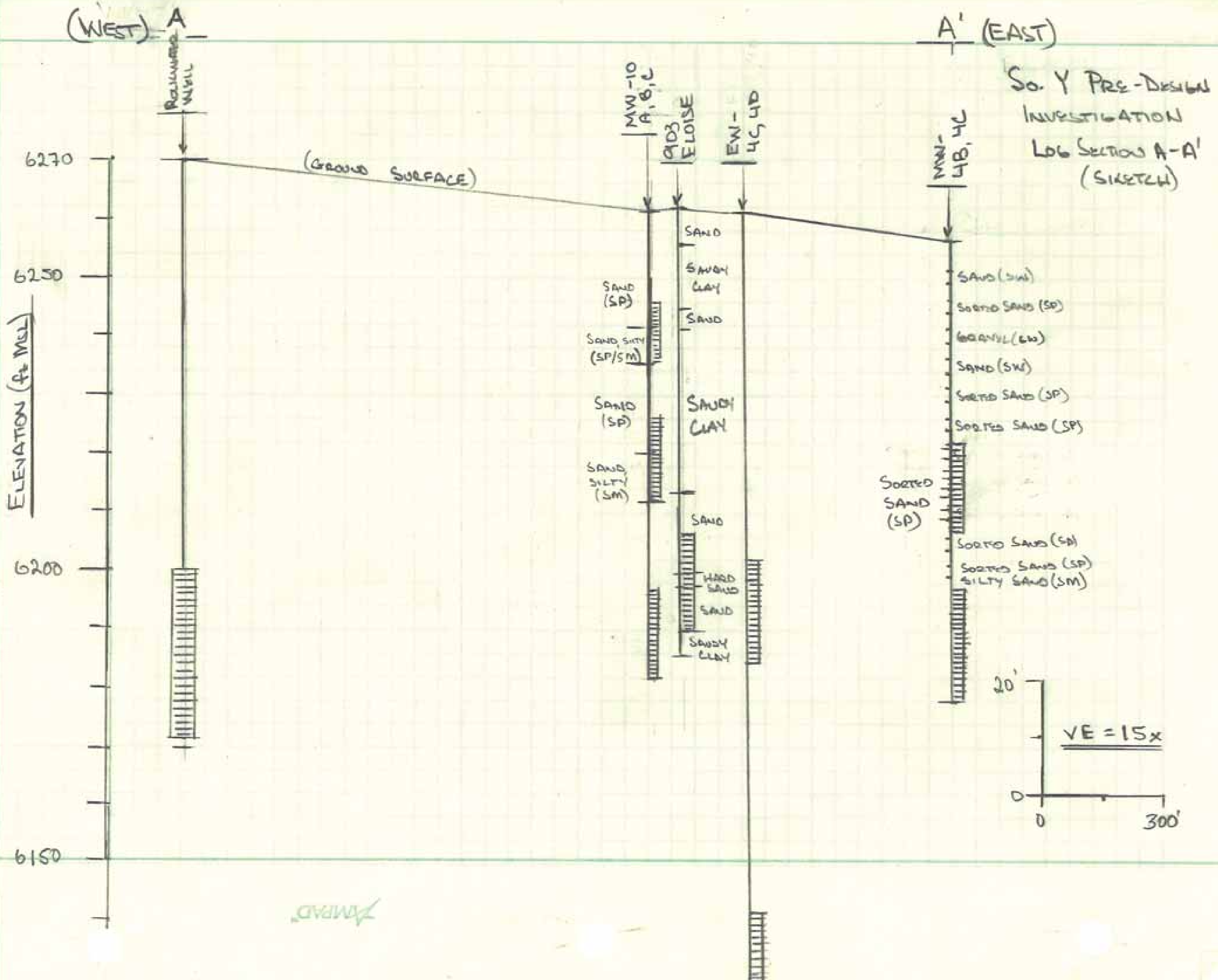
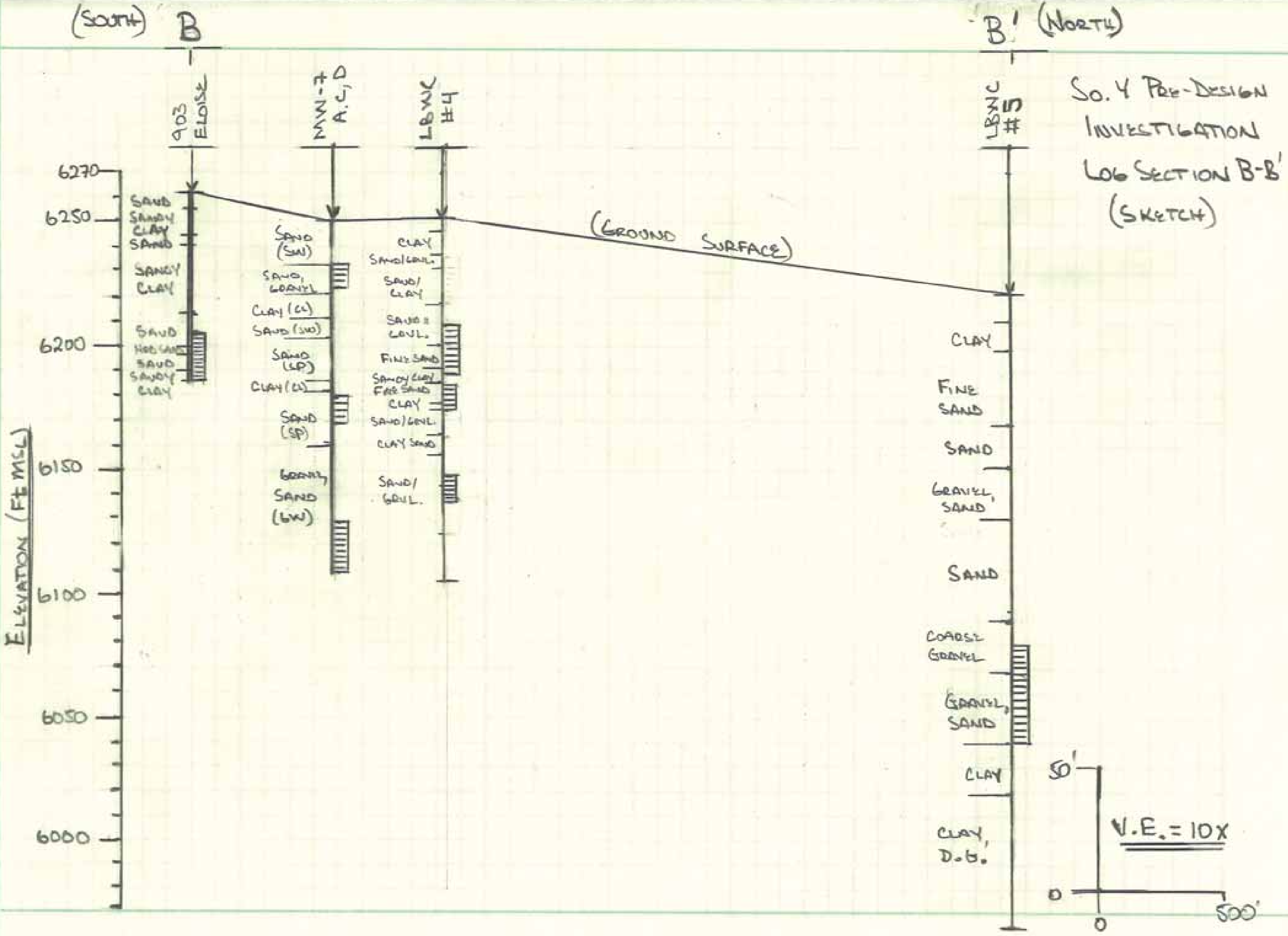


So. Y Pre-Design
Investigation
Log Section A-A'
(Sketch)



So. Y Pre-Design Investigation Log Section B-B' (Sketch)

PDI WORKPLAN

LINE OF SECTION (SKETCH)

SECTION A - A' (NW - SE)

WELL	SEGMENT	TOTAL	ESTIMATED ELEVATION	TD
1) ROCKWATER WELL	0	—	6270	
2) MW-10 (A, B, C)	1,200'	1,200'	6261.41	100'
3) 903 ELOISE	70'	1,270'	6262	76'
4) EW-4C	170'	1,440'	6261.31	77.5
5) MW-4C	530'	1,970'	6256.32	79.0'

SECTION B - B' (S - NNE)

			ELEV	TD
1) 903 ELOISE	0	-	6262	76'
2) MW-7A, C	580'	580'	6251.61	80'
3) LBWC #4	460'	1,040'	6242	132
4) LBWC #5	2,280'	3,320'	6223	255

D.B.
1/9/18

ORIGINAL
File Original, Duplicate and Triplicate with the
REGIONAL WATER POLLUTION
CONTROL BOARD No. 6
(Insert appropriate number)

JUN 3 8 1958

VATER WELL DRILLERS REP ?T
(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA

Do Not Fill In
Nº 49374
State Well No. 12N/18E
Other Well No.........

(1) OWNER:
Name Verne Pearsold
Address 3804 - 32nd ave
Sacramento, Calif

(2) LOCATION OF WELL:
County El Dorado Owner's number, if any—
R. F. D. or Street No. Eloise ave
265 ft South of 7th St on Eloise ave
6 ft East of Eloise, Tahoe
Valley, Calif

(3) TYPE OF WORK (*check*):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (*check*):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED:
SINGLE ☒ DOUBLE ☐
From 0 ft. to 76 ft. 6" Diam. 12 Gage or Wall

If gravel packed
Diameter of Bore from ft. to ft.

Type and size of shoe or well ring 5/8 X 3 X 6 Steel Size of gravel:
Describe joint Welded

(7) PERFORATIONS:
Type of perforator used Torch
Size of perforations 5 in., length, by 1/4 in.
From 56 ft. to 76 ft. 4 Perf. per row 5 Rows per ft.

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☒ Yes ☐ No To what depth 6 ft.
Were any strata sealed against pollution? ☒ Yes ☒ No If yes, note depth of strata 5 ft
From 0 ft. to 6 ft.
Method of Sealing Cement

(9) WATER LEVELS:
Depth at which water was first found 5 ft.
Standing level before perforating 18 ft.
Standing level after perforating 18 ft.

(10) WELL TESTS:
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No
Was electric log made of well? ☐ Yes ☒ No

(11) WELL LOG:
Total depth 76 ft. Depth of completed well 76 ft.
Formation: *Describe by color, character, size of material, and structure.*

ft.	to ft.	Formation
0	3	Sandy Soil
3	6	Sand
6	17	Sandy Clay
17	20	Sand
20	48	Sandy Clay
48	62	Sand
62	64	Hard Sand
64	72	Sand
72	76	Sandy Clay

CONFIDENTIAL
Section 7076.1, Water Code

Work started 5-27 1958. Completed 5-28 19

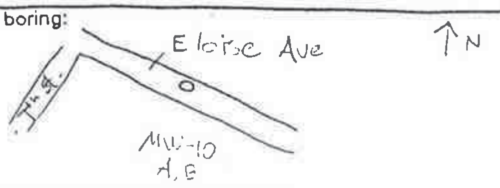
WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME BLAIN + IMBACH WELL DRILLING
(Person, firm, or corporation) (Typed or printed)
Address P. O. Box 286
Tahoe Valley, Calif
[SIGNED] W E Blain
Well Driller
License No. 149189 Dated 6-9 19

95689 3-54 50M QUIN ® SPO
DWR FORM NO. 246

FIELD EXPLORATORY BORING LOG

Field location of boring:



Drilling method: HSA

Hole diameter: 10"

Project No.: 50-0344

Date: 6/20/01

Boring No: 10A,B

Client: [illegible] Co.

Location: Swiss/[illegible]

City: S. Lake Tahoe

Sheet 1 of 2

Logged by: GTK

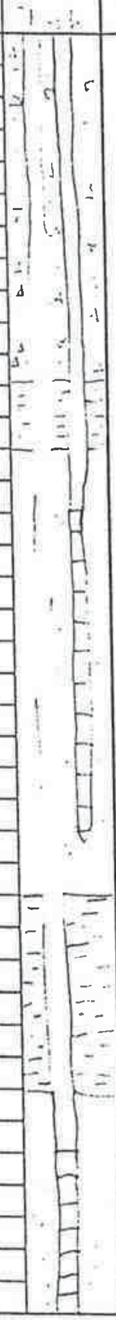
Driller: [illegible]

Casing installation data: 2" Sch 40 PVC:
10A - 25' deep 10' screen   10B - 50' deep 15' screen

Top of Box Elevation:

Datum:

Water Level				
Time				
Date				



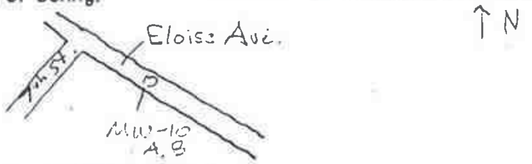
PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				0				4" Asphalt Hand Cleared ~5' ↓
				2				
				4				
				6				
				8			SP	drill cuttings: yellow brown fine grained SAND, dry - damp
				10				
				12				
				14				Same as above damp to wet
				16				
				18			SP/SM	drill cuttings: yellowish brown fine to coarse SAND with silt (80% sand 20% silt), damp to wet.
				20				drill cuttings: grades to coarse SAND with some gravel & silt moist. (75% Sand 1[illegible]% silt 5% gravel)
				22				
				24				
				26				drill cuttings grades to brown SAND w/ trace [illegible] damp to wet. (85% Sand [illegible] 5% gravel)
				28			SP	
				30				
				32				
				34				
				36				
				38				
				40				

Remarks:

▤ - well Screen   ☐ - blank casing   ▨ - #3 Sand   ⊟ - 3/8 bentonite   ▦ - grout mix

FIELD EXPLORATORY BORING LOG

Field location of boring:



Project No.: 30-0344
Date: 6/20/01
Boring No: 10 A,B
Client: [illegible] Oil Co.
Location: Swiss Mart
City: S. Lake Tahoe
Sheet 2 of 2
Logged by: GTK
Driller: S[illegible]
Casing installation data: 2" Sch 40 PVC
10A - 25' deep, 10' Screen 10B - 50' deep, 15' screen
Drilling method: HSA
Hole diameter: 10"
Top of Box Elevation:
Datum:

Water Level				
Time				
Date				

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				40				drilled [illegible]
				42			SM	Y[illegible] [illegible] [illegible] [illegible], S[illegible]
								[illegible] Sa[illegible]
				44				(10 YR 5/4) [illegible]
				46				
				48				Saturated
				50				end [illegible] @ 50'

Remarks: ★ Saturated soil encountered approx. 41' bgs.

▤ Well Screen ░ #3 Sand

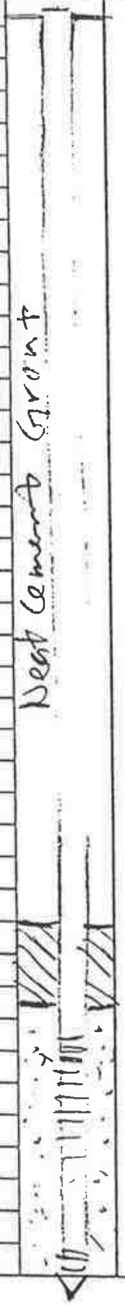
FIELD EXPLORATORY BORING LOG

Field location of boring: See Site Plan

Project No.: 20-0342
Date: 6-25-01
Boring No: MW-10C
Client: Arco Oil
Location: 913 Emerald Bay Rd
City: SLT, CA
Sheet 1 of 1
Logged by: CMG
Driller: Gregg
Casing installation data: 2"ϕ Flush-thread Sched 40 PVC casing + 0.020" well screen
Drilling method: Mud Rotary
Hole diameter: 6"
Top of Box Elevation:
Datum:

Water Level				
Time				
Date				

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				4				
				8				
				12				
				16				
				20				Not
				24				Sampled
				28				
				32				Logged
				36				o
				40				
				44				
				48				
				52				
				56				
				60				
				64				
				68				
				72				
				76				
				80				TD @ 80' 6-25-01



Remarks:

▦ #3 Sand ▨ 3/8" Bentonite

FIELD BOREHOLE LOG

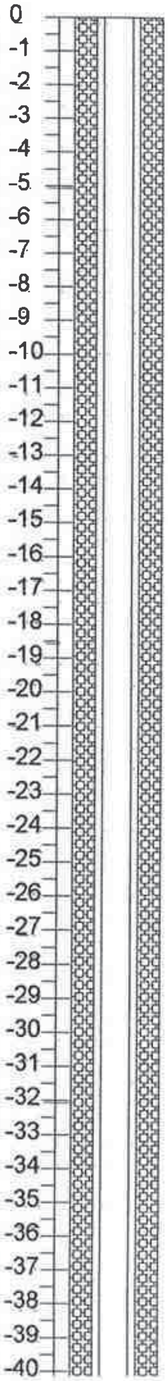
BOREHOLE NUMBER
MW-4C

PROJECT NUMBER: 300344
CLIENT: Swiss Mart
LOCATION: South Lake Tahoe, CA
DRILLING CO: BAEi, Inc.
DRILLING METHOD: Hollow Stem Auger
FIELD PARTY: Terra Vac, BAEi
GEOLOGIST: Roman Bober
DATE BEGUN: 10/28/99 DATE COMPLETED: 10/28/99

BORING LOCATION: Off-site, down NE
TOTAL DEPTH: 79'
GROUND SURFACE ELEVATION: na
DEPTH TO WATER: na
DEPTH TO PRODUCT: na
CASING SIZE: 2"
SCREEN LENGTH 20'
STICKUP 0'
RISER LENGTH 59'
SLOT SIZE 0.01"

DEPTH IN FEET	LITHOLOGY	USCS	OVA PPM	LITHOLOGY DESCRIPTION
0				NO SAMPLE
-5	░	SW	3	SAND: coarse to fine, poorly sorted, loose, grey to light brown, some brown to grey rock fragments, sw=0.4, 2-3-3
-7				NO SAMPLE
-10	░	SP	2	SORTED SAND: white grey to light brown, coarse to medium, loose, well sorted, with light brown silt, sw=1.0, 6-12-13
-12				NO SAMPLE
-15	▨	GW	8	GRAVEL: white to black, subangular to angular, coarse, loose rock fragments and sand and silt, sw=1.0, 10-12-22
-17				NO SAMPLE
-20	░	SW	6	SAND: grey to light brown, medium to fine, loose, poorly sorted, some white rock fragments, sw=1.0, 12-17-20
-22				NO SAMPLE
-25	░	SP	5	SORTED SAND: white to grey, loose, fine to medium, well sorted, with reddish brown streaks, sw=1.0, 11-12-14
-27				NO SAMPLE
-30	░	SP	7	SORTED SAND: grey to brown, fine, compact, well sorted, some clay, sw=1.0, 11-13-19
-32				NO SAMPLE
-35	░	SP	4	SORTED SAND: brown to grey, fine to medium, well sorted, some silt, sw=1.0, 14-18-19
-37				NO SAMPLE
-40	░	SP	5	SORTED SAND: brown to grey, fine to medium, well

WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER
MW-4C

PROJECT NUMBER:	**300344**	BORING LOCATION:	**Off-site, down NE**
CLIENT:	**Swiss Mart**	TOTAL DEPTH:	**79'**
LOCATION:	**South Lake Tahoe, CA**	GROUND SURFACE ELEVATION:	**na**
DRILLING CO:	**BAEi, Inc.**	DEPTH TO WATER:	**na**
DRILLING METHOD:	**Hollow Stem Auger**	DEPTH TO PRODUCT:	**na**
FIELD PARTY:	**Terra Vac, BAEi**	CASING SIZE:	**2"**
GEOLOGIST:	**Roman Bober**	SCREEN LENGTH	**20'**
DATE BEGUN: **10/28/99**	DATE COMPLETED: **10/28/99**	STICKUP	**0'**
		RISER LENGTH	**59'**
		SLOT SIZE	**0.01"**

DEPTH IN FEET	LITHOLOGY USCS	OVA PPM	LITHOLOGY DESCRIPTION
-41	SP	5	SORTED SAND: brown to grey, fine to medium, well sorted, some silt, sw=1.0, 17-21-23
-42			NO SAMPLE
-43			
-44			
-45	SP	4	SORTED SAND: light grey to brown, fine to medium, loose, well sorted, some silt, sw=1.0, 10-26-35
-46			
-47			NO SAMPLE
-48			
-49			
-50	SP	3	SORTED SAND: same as above, sw=1.0, 3-7-17
-51			
-52			NO SAMPLE
-53			
-54			
-55	SP	4	SORTED SAND: same as above, sw=1.0, 17-33-50
-56	SM		SILTY SAND: brown, compact
-57			NO SAMPLE
-58			
-59			
-60			
-61			
-62			
-63			
-64			
-65			
-66			
-67			
-68			
-69			
-70			
-71			
-72			
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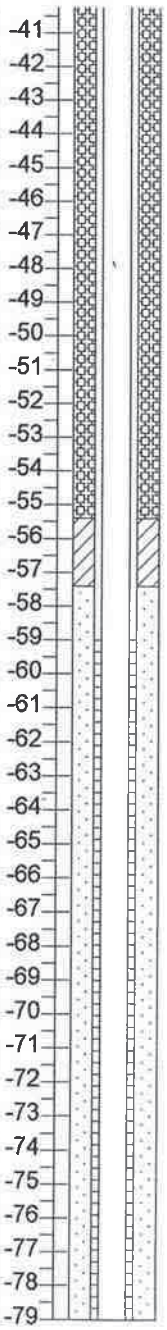
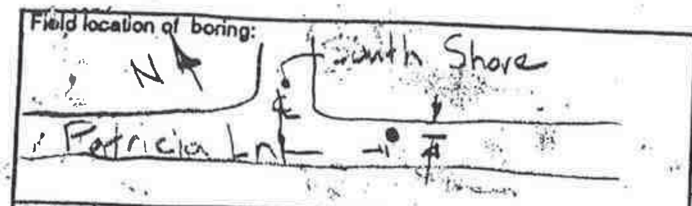
-74			
-75			
-76			
-77			
-78			
-79			

WELL INSTALLATION



FIELD EXPLORATORY BORING LOG

Field location of boring:



Project No.: 30-0344
Date: 11-27-00
Boring No: MW-7D
Client: Ameri Oil
Location: 913 Emerald Bay Rd
City: SLT
Sheet 1 of 1
Logged by: CMG
Driller: Spectrum
Casing installation data: 2" ¢ sch 40 120' blank 20' 0.020" machine slot well screen.
Drilling method:
Hole diameter:
Top of Box Elevation:
Datum:

Water Level				
Time				
Date				

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				10			SW	SAND - fine - coarse (DG)
				20				±17' SAND med - coarse well
								rounded pebbles
				30				Smoother drilling @ 20'-23' back to
								SAND w/ fine to coarse gravels
				40			CL	(well rounded) - interbeds of
								~~harder~~ coarser [illegible]
				50			SW	CLAY, trace silt trace fine sand.
							SP	SAND w/ fine to med [illegible]
				60				(well rounded)
						65		No gravels @ 45,
				70			GP?	SAND, med to fine, some fines
							SP	~~[illegible]~~ - clay & silt
				80				
								GRAVEL to 68' back to Sand @
				100			GW	68 trace fines
								GRAVEL med to fine, ~~poorly~~ well sorted
				110				sand, gravels well rounded.
				120				As above, maybe change to
								SAND w gravel.
				130				
				140				
								TDB 143

Remarks: Calls from grab samples in drilling mud. No moist, density
or color calls. No percentage of fine calls.

WELL LOG WELL # 4

Drilled July and August 1966

0 - 32 ft.	Top soil
32 - 43 ft.	Rock embedded clay
43 - 49 ft.	Coarse sand pea gravel *
49 - 63 ft.	Coarse sand and clay in short straits *
63 - 68 ft.	Fine sand and pea Gravel
68 - 78 ft.	Coarse sand and pea Gravel *
78 - 88 ft.	Fine sand (Red coloring, probably Iron)
88 - 96 ft.	Sandy clay
96 - 104 ft.	Find sand
104 - 105 ft.	Clay layer
105 - 115 ft.	Coarse sand and pea gravel *
115 - 118 ft.	Hard shale and heavy rocks (End casing)

In 1970 installed 10" liner

118 - 123 ft.	Clay sand
123 - 128 ft.	1/8 sand
128 - 132 ft.	1/8 sand
132 - 150 ft.	3/8 water gravel *
150 - 155 ft.	3/8 water gravel *
155 - 162 ft.	Gravel with light sand
162 - 174 ft.	light sand.

174 ft. Total depth of well

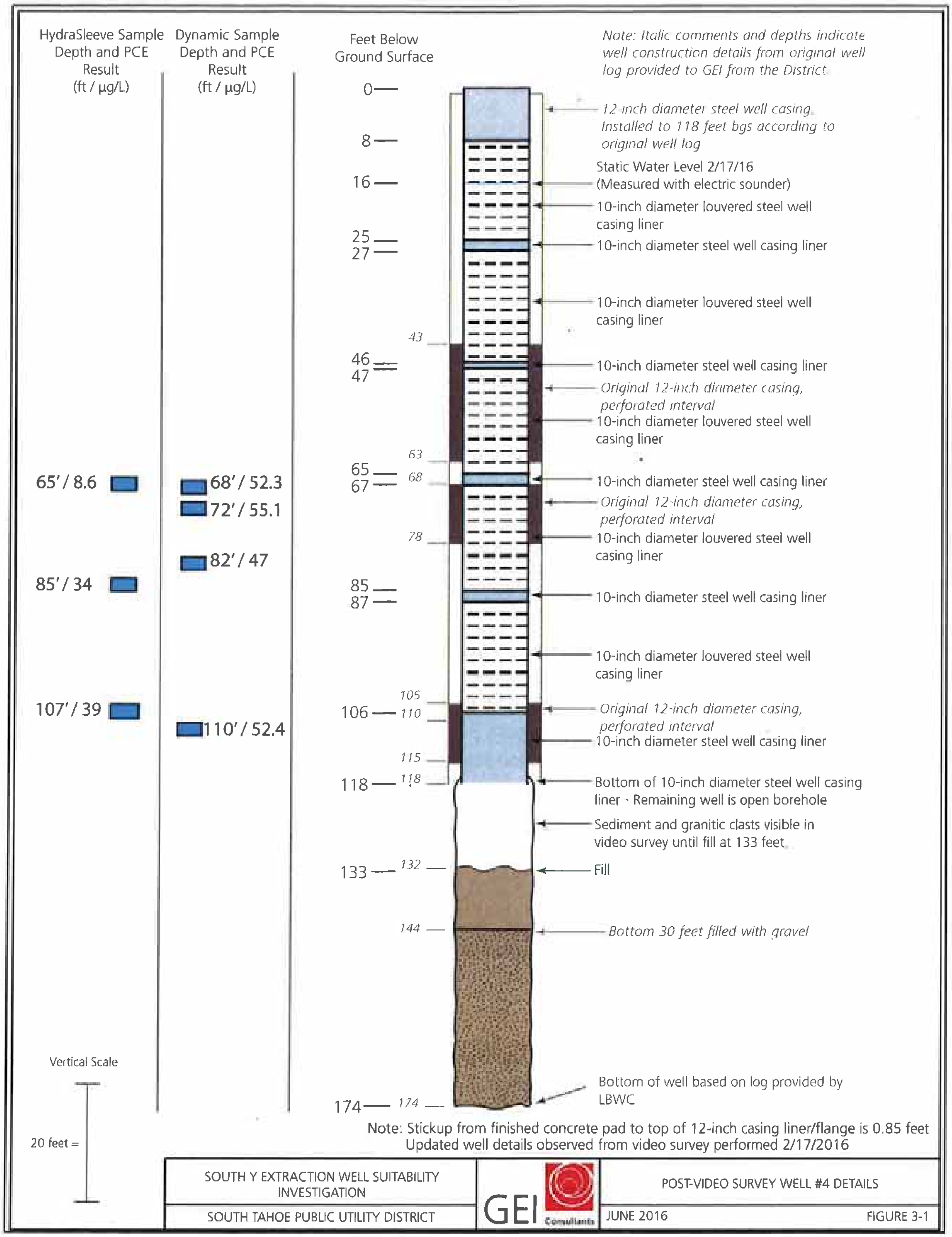
Steel well casing

14 inch dia. casing from 0' to 118'

10 inch dia. liner from 110' to 174'
The last 30 feet where Graveled back to stop sand.

* Areas with Perforation.

Figure 3-1. Post-Video Survey Well #4 Details



Note: Italic comments and depths indicate well construction details from original well log provided to GEI from the District.

Note: Stickup from finished concrete pad to top of 12-inch casing liner/flange is 0.85 feet
Updated well details observed from video survey performed 2/17/2016

LUKINS BROTHERS WATER COMPANY INC.

WELL LOG Pump Station #5

0-8'	Top soil.
8-20'	Clay
20-35'	Fine sand.
36-50'	Find sand.
50-68'	D.G. sand.
68-70'	cores sand.
70-92'	Gravel with light sand.
92-128'	Light sand.
128-132'	1/8 sand.
132-150'	3/8 water gravel
150-153'	3/8 water gravel
153-164'	Gravel with light sand.
154-180'	Gravel with light sand.
180-202'	Clay
202-224'	Clay with D.G.
224-255'	Clay with D.G.
255 ft.	**Total depth of well**

STEEL WELL CASING

53 feet of 24" conducter casing for gravel pack.
255 feet of 16" casing
Perferation from 141 to 180' using 7 cuts ¼ by 3 inch.
140 yard of gravel were placed during drilling.

Appendix C: Analytical Results Summary

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Sampling Event	Affiliation	# of Sites / # of Samples	Sampling Method(s)	Source
9/26/2016- 10/12/2016	LRWQCB	7/14	Not specified	L. Dernbach, 12/21/2016
12/7/2016 – 12/29/2016	STPUD/LBWC	4/5	HydraSleeve Sampler	STPUD Lab
3/16/2017 – 7/6/2017	STPUD/LBWC	5/6	HydraSleeve Sampler	STPUD Lab
10/25/2017 – 10/26/2017	STPUD/LBWC	5/5	Pump	STPUD Lab
12/6/2016 – 10/24/2017	TKWC	3/10	Pump	TKPOA
6/26/2017-7/20/2017	Seven Springs LLP/ Fox Capital Mngmnt. Corp.	19/80	Cone Penetrometer Test/Membrane Interface Probe (CPT/MIP)	Off-Site GW Inv. Rpt (EKI, 8/30/2017)
6/26/2017- 6/20/2017	LRWQCB	5/9	Snap Sampler /Low Flow Purging	L. Dernbach, 8/24/2017
12/20/2016; 5/8/2017	Seven Springs LLP/ Fox Capital Mngmnt. Corp.	3/6	Low Flow Purging/Hand Bailing	Geotracker (SL0601754315)

South Y PCE
Feasibility Study
Pre-Evaluation
PCE Water Quality Data

WELL	PCE	DCE	TCE	Perf_Interval	Date	ID#	DTW_ft
LBWC #2 / 145-150	0.6	0.0	0.0	132-156	12/07/16	AG54023	20.02
LBWC #4 / 70-75	**12.9**	0.0	0.0	43-78	12/07/16	AG54024	16.43
LBWC #4 / 125-130	**39.8**	0.5	0.8	105-132	12/07/16	AG54025	16.43
CL-1	0.0	0.0	0.0	105-115	12/28/16	AG54319	32.52
TV School/110-115	0.0	0.0	0.0	86-146	12/29/16	AG54331	7.25
LBWC #2 / 145-150	0.8	0.0	0.0	132-156	03/16/17	AG55264	15.49
LBWC #4 / 70-75	**9.0**	0.0	0.0	43-78	03/16/17	AG55265	11.42
LBWC #4 / 125-130	**26.7**	0.5	0.8	105-132	03/16/17	AG55266	11.42
CL-1	0.0	0.0	0.0	105-115	05/17/17	AG55694	77.51
Rockwater / 65-70	**189.0**	3.3	3.3	70 - 99	07/06/17	AG55695	35.50
TV School/110-115	0.0	0.0	0.0	86-146	04/28/17	AG55696	2.90
CL-1	0.0	0.0	0.0	105-115	10/25/17	AG58505	28.70
LBWC #2/126	3.6	0.0	0.0	132-156	10/26/17	AG58506	
LBWC #4	**42.5**	0.6	1.1	43-78	10/26/17	AG58507	
LBWC#5	**67.0**	2.5	2.0	141-180	10/26/17	AG58508	
Rockwater / 65-70	**147.0**	4.0	4.0	70 - 99	10/26/17	AG58509	
LW-MW-1S	**56.0**			15 - 25	12/20/2016	GEOTRACKER	12.23
LW-MW-5S	**51.0**			19 - 29	12/20/2016	GEOTRACKER	11.05
OS-1	**9.6**			10 - 25	12/20/2016	GEOTRACKER	12.63
LW-MW-1S	**72.0**			15 - 25	5/8/2017	GEOTRACKER	3.08
LW-MW-5S	**13.0**			19 - 29	5/8/2017	GEOTRACKER	2.12
OS-1	1.1			10 - 25	5/8/2017	GEOTRACKER	4.09
LBWC#1	0.0	0.0	0.0	132 - 182	04/11/17	LBWC	
MW-7A	0.0	0.0	0.0	15 - 25	09/26/16	LRWQCB	13.42
MW-7C	**5.2**	0.0	0.0	70 - 80	09/26/16	LRWQCB	25.00
MW-8A	0.0	0.0	0.0	15 - 25	09/26/16	LRWQCB	22.08
MW-8B	0.3	0.0	0.0	35 - 50	09/26/16	LRWQCB	25.00
MW-8C	1.9	0.0	0.0	65 - 80	09/26/16	LRWQCB	31.42
HMW-5	**9.5**	0.0	0.0	9 - 24	09/28/16	LRWQCB	12.75
MW-9A	0.0	0.0	0.0	15 - 25	09/28/16	LRWQCB	15.67
MW-9B	**9.2**	0.0	0.0	35 - 50	09/28/16	LRWQCB	20.58
MW-9C	1.8	0.0	0.0	65 - 80	09/28/16	LRWQCB	24.75
HMW-3	2.3	0.0	0.0	9 - 24	10/12/16	LRWQCB	13.02
HMW-4	**11.0**	0.0	0.0	9 - 24	10/12/16	LRWQCB	12.67
MW-4A	**15.0**	0.0	0.3	15 - 25	10/12/16	LRWQCB	12.42
MW-4B	**110.0**	1.4	4.2	35 - 50	10/12/16	LRWQCB	17.08
MW-4C	1.8	0.0	0.0	59 - 79	10/12/16	LRWQCB	19.58
HMW-5	4.2	0.0	0.0	9 - 24	06/26/17	LRWQCB	4.20
MW-4C	1.0	0.0	0.0	59 - 79	06/26/17	LRWQCB	12.70
HMW-3	1.0	0.0	0.0	9 - 24	06/27/17	LRWQCB	5.42
MW-4A	**6.9**	0.0	0.0	15 - 25	06/27/17	LRWQCB	5.42
MW-4B	**86.0**	0.0	3.5	35 - 50	06/27/17	LRWQCB	10.20
HMW-4	**9.1**	0.0	0.0	9 - 24	06/28/17	LRWQCB	4.90

South Y PCE
Feasibility Study
Pre-Evaluation
PCE Water Quality Data

WELL	PCE	DCE	TCE	Perf_Interval	Date	ID#	DTW_ft
MW-9C	2.0	0.0	0.0	120 - 140	06/28/17	LRWQCB	18.50
MW-9A	0.0	0.0	0.0	15 - 25	06/29/17	LRWQCB	7.80
MW-9B	4.6	0.0	0.0	35 - 50	06/29/17	LRWQCB	13.60
TKWC #2/250	**17.0**			138-188	12/06/16	TKWC	
TKWC #1/45	2.3			125-312	12/13/16	TKWC	
TKWC #2/250	**20.0**			138-188	12/13/16	TKWC	
TKWC #2/250	**16.0**			138-188	12/20/16	TKWC	
TKWC #1/45	1.8			125-312	03/28/17	TKWC	
TKWC #2/250	**18.0**			138-188	03/28/17	TKWC	
TKWC #3/125	0.0			175-300	05/20/17	TKWC	
TKWC #3/125	0.0			175-300	08/15/17	TKWC	
TKWC #1/45	2.1			125-312	09/24/17	TKWC	
TKWC #2/250	**16.0**			138-188	10/24/17	TKWC	

LTLW Off-Site Investigation (EKI, 2017)

Groundwater Sample Location	Grab Groundwater Sample ID	GW Sample Depth Interval (ft bgs)	Sample Date	PCE (μg/L)	PCE numeric (μg/L)	TCE (μg/L)	cis-1,2-DCE (μg/L)
KM1	KM1GW21	17-21	6/26/2017	<0.5	0.25	<0.5	<0.5
KM1	KM1GW32	28-32	6/26/2017	<0.5	0.25	<0.5	<0.5
KM1	KM1GW44	40-44	6/26/2017	<0.5	0.25	<0.5	<0.5
KM1	KM1GW70	66-70	6/26/2017	<0.5	0.25	<0.5	<0.5
KM2	KM2GW21	17-21	6/26/2017	<0.5	0.25	<0.5	<0.5
KM2	KM2GW32	28-32	6/26/2017	<0.5	0.25	<0.5	<0.5
KM2	KM2GW44	40-44	6/26/2017	<0.5	0.25	<0.5	<0.5
KM2	KM2GW70	66-70	6/27/2017	<0.5	0.25	<0.5	<0.5
TATA	TATAGW28	24-28	7/6/2017	<0.5	0.25	<0.5	<0.5
TATA	TATAGW48	44-48	7/6/2017	4.34	4.34	<0.5	<0.5
TATA	TATAGW64	60-64	7/6/2017	<0.5	0.25	<0.5	<0.5
TATA	TATAGW74	70-74	7/6/2017	<0.5	0.25	<0.5	<0.5
TATA	TATADUP	70-74	7/6/2017	<0.5	0.25	<0.5	<0.5
LTB1	LTB1GW22	18-22	7/20/2017	1.01	1.01	<0.5	<0.5
LTB1	LTB1GW32	28-32	7/20/2017	<0.5	0.25	<0.5	<0.5
LTB1	LTB1GW45	41-45	7/20/2017	<0.5	0.25	<0.5	<0.5
LTB1	LTB1GW52	48-52	7/20/2017	<0.5	0.25	<0.5	<0.5
LTB1	LTB1GW74	70-74	7/20/2017	**9.57**	**9.57**	<0.5	<0.5
LTB2	LTB2GW22	18-22	7/19/2017	0.68	0.68	<0.5	<0.5
LTB2	LTB2GW32	28-32	7/19/2017	0.72	0.72	<0.5	<0.5
LTB2	LTB2GW39	35-39	7/19/2017	<0.5	0.25	<0.5	<0.5
LTB2	LTB2DUP	35-39	7/19/2017	<0.5	0.25	<0.5	<0.5
LTB2	LTB2GW49	45-49	7/19/2017	<0.5	0.25	<0.5	<0.5
LTB2	LTB2GW58	54-58	7/19/2017	<0.5	0.25	<0.5	<0.5
LTB3	LTB3GW22	18-22	7/19/2017	0.91	0.91	<0.5	<0.5
LTB3	LTB3GW32	28-32	7/19/2017	1.18	1.18	<0.5	<0.5
LTB3	LTB3GW45	41-45	7/19/2017	<0.5	0.25	<0.5	<0.5
LTB3	LTB3GW52	48-52	7/20/2017	<0.5	0.25	<0.5	<0.5
LTB3	LTB3GW74	70-74	7/20/2017	**5.48**	**5.48**	<0.5	<0.5
LTB4	LTB4GW22	18-22	7/18/2017	1.03	1.03	<0.5	<0.5
LTB4	LTB4DUP	18-22	7/18/2017	1.02	1.02	<0.5	<0.5
LTB4	LTB4GW28	24-28	7/18/2017	0.58	0.58	<0.5	<0.5
LTB4	LTB4GW39	35-39	7/18/2017	<0.5	0.25	<0.5	<0.5
LTB4	LTB4GW49	45-49	7/18/2017	<0.5	0.25	<0.5	<0.5
LTB4	LTB4GW58	54-58	7/19/2017	<0.5	0.25	<0.5	<0.5
DUN1	DUN1GW24	20-24	6/23/2017	3.11	3.11	<0.5	<0.5
DUN1	DUN1GW32	28-32	6/23/2017	0.93	0.93	<0.5	<0.5
DUN1	DUN1GW56	52-56	6/23/2017	<0.5	0.25	<0.5	<0.5
DUN1	DUN1GW70	66-70	6/23/2017	2.58	2.58	<0.5	<0.5
DUN2	DUN2GW24	20-24	6/27/2017	**33.1**	**33.1**	0.59	<0.5
DUN2	DUN2GW32	28-32	6/27/2017	**16**	**16**	<0.5	<0.5
DUN2	DUN2GW56	52-56	6/27/2017	0.74	0.74	<0.5	<0.5
DUN2	DUN2GW70	66-70	6/27/2017	1.03	1.03	<0.5	<0.5
J1	J1GW24	20-24	6/27/2017	**5.35**	**5.35**	<0.5	<0.5
J1	J1GW32	28-32	6/27/2017	**9.95**	**9.95**	<0.5	<0.5
J1	J1GW56	52-56	6/27/2017	<0.5	0.25	<0.5	<0.5

J1	J1GW70	66-70	6/27/2017	0.9	0.9	<0.5	<0.5
J2	J2GW22	18-22	6/28/2017	**25**	**25**	<0.5	<0.5
J2	J2GW39	35-39	6/28/2017	**694**	**694**	**14.3**	**6.18**
J2	J2GW65	61-65	6/28/2017	<0.5	0.25	<0.5	<0.5
J2	J2GW70	66-70	6/28/2017	<0.5	0.25	<0.5	<0.5
J3	J3GW22	18-22	6/28/2017	3.46	3.46	<0.5	<0.5
J3	J3GW39	35-39	6/28/2017	**351**	**351**	**11.6**	5.19
J3	J3GW65	61-65	6/28/2017	<0.5	0.25	<0.5	<0.5
J3	J3GW70	66-70	6/29/2017	<0.5	0.25	<0.5	<0.5
J4	J4GW22	18-22	6/29/2017	**12**	**12**	<0.5	<0.5
J4	J4GW39	35-39	6/29/2017	**718**	**718**	**14.4**	**10.4**
J4	J4GW65	61-65	6/29/2017	<0.5	0.25	<0.5	<0.5
J4	J4GW70	66-70	6/29/2017	0.53	0.53	<0.5	<0.5
J5	J5GW22	18-22	6/29/2017	**18.5**	**18.5**	<0.5	<0.5
J5	J5GW39	35-39	6/29/2017	**338**	**338**	**8.64**	3.65
J5	J5GW65	61-65	6/29/2017	<0.5	0.25	<0.5	<0.5
J5	J5GW70	66-70	6/30/2017	<0.5	0.25	<0.5	<0.5
FIF	FIFGW23	19-23	6/30/2017	2.7	2.7	<0.5	<0.5
FIF	FIFGW40	36-40	6/30/2017	**27.3**	**27.3**	0.73	<0.5
FIF	FIFGW49	45-49	6/30/2017	**1040**	**1040**	**20.8**	**11.8**
FIF	FIFGW80	76-80	6/30/2017	0.51	0.51	<0.5	<0.5
5E	5EGW23	19-23	7/5/2017	<0.5	0.25	<0.5	<0.5
5E	5EGW40	36-40	7/5/2017	**63.3**	**63.3**	2.05	<0.5
5E	5EGW49	45-49	7/5/2017	**124**	**124**	4.53	1.21
5E	5EGW80	76-80	7/5/2017	<0.5	0.25	<0.5	<0.5
ROG	ROGGW29	25-29	7/7/2017	<0.5	0.25	<0.5	<0.5
ROG	ROGDUP	25-29	7/7/2017	<0.5	0.25	<0.5	<0.5
ROG	ROGGW45	41-45	7/7/2017	<0.5	0.25	<0.5	<0.5
ROG	ROGGW53	49-53	7/7/2017	0.78	0.78	<0.5	<0.5
ROG	ROGGW73	69-73	7/7/2017	**30.5**	**30.5**	0.61	0.93
TEN	TENGW29	25-29	6/23/2017	<0.5	0.25	<0.5	<0.5
TEN	TENGW45	41-45	6/23/2017	<0.5	0.25	<0.5	<0.5
TEN	TENGW53	49-53	6/23/2017	<0.5	0.25	<0.5	<0.5
TEN	TENGW73	69-73	6/23/2017	**22**	**22**	<0.5	<0.5
J6	J6GW29	25-29	7/6/2017	<0.5	0.25	<0.5	<0.5
J6	J6DUP	25-29	7/6/2017	<0.5	0.25	<0.5	<0.5
J6	J6GW45	41-45	7/6/2017	<0.5	0.25	<0.5	<0.5
J6	J6GW53	49-53	7/6/2017	0.68	0.68	<0.5	<0.5
J6	J6GW73	69-73	7/6/2017	**99.1**	**99.1**	1.45	1.16

1,1-DCE (µg/L)	Other VOCs (µg/L)	TOS (ft bgs)	BOS (ft bgs)
<0.5	ND	17	21
<0.5	ND	28	32
<0.5	ND	40	44
<0.5	ND	66	70
<0.5	ND	17	21
<0.5	ND	28	32
<0.5	ND	40	44
<0.5	ND	66	70
<0.5	ND	24	28
<0.5	ND	44	48
<0.5	ND	60	64
<0.5	ND	70	74
<0.5	ND	70	74
<0.5	ND	18	22
<0.5	ND	28	32
<0.5	ND	41	45
<0.5	ND	48	52
<0.5	ND	70	74
<0.5	ND	18	22
<0.5	ND	28	32
<0.5	ND	35	39
<0.5	ND	35	39
<0.5	ND	45	49
<0.5	ND	54	58
<0.5	ND	18	22
<0.5	ND	28	32
<0.5	ND	41	45
<0.5	ND	48	52
<0.5	ND	70	74
<0.5	ND	18	22
<0.5	ND	18	22
<0.5	ND	24	28
<0.5	ND	35	39
<0.5	ND	45	49
<0.5	ND	54	58
<0.5	(b)	20	24
<0.5	(b)	28	32
<0.5	ND	52	56
<0.5	ND	66	70
<0.5	ND	20	24
<0.5	ND	28	32
<0.5	ND	52	56
<0.5	ND	66	70
<0.5	(b)	20	24
<0.5	ND	28	32
<0.5	ND	52	56

<0.5	ND	66	70
<0.5	ND	18	22
<5	ND	35	39
<0.5	ND	61	65
<0.5	ND	66	70
<0.5	ND	18	22
<5	ND	35	39
<0.5	ND	61	65
<0.5	ND	66	70
<0.5	ND	18	22
<5	ND	35	39
<0.5	ND	61	65
<0.5	ND	66	70
<0.5	ND	18	22
<2.5	ND	35	39
<0.5	ND	61	65
<0.5	ND	66	70
<0.5	ND	19	23
<0.5	ND	36	40
<5	ND	45	49
<0.5	ND	76	80
<0.5	ND	19	23
<0.5	ND	36	40
<1	ND	45	49
<0.5	ND	76	80
<0.5	ND	25	29
<0.5	ND	25	29
<0.5	ND	41	45
<0.5	ND	49	53
<0.5	ND	69	73
<0.5	ND	25	29
<0.5	ND	41	45
<0.5	ND	49	53
<0.5	ND	69	73
<0.5	ND	25	29
<0.5	(c)	25	29
<0.5	ND	41	45
<0.5	ND	49	53
<0.5	ND	69	73

Appendix D: Sample/Test Intervals and Test Well Design (proposed)

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South Y Feasibility Study
Pre-Design Investigation
Test Well Drilling and Design- Preliminary

SAMPLE/TEST INTERVALS (Preliminary)	
Soil Sample Collection Depth (ft bgs)	35’ – 60’; 65’ – 70’
Groundwater Sample Depth Interval (ft bgs)	20- 25’; 30’ – 35’; 45’ – 50’; 60 – 65’; 75’-80 and 130 – 135’
Zone Test Depth Intervals (ft bgs)	Type A (30’ – 50’); or Type B (60’ – 75’)
Total Test Boring Depth (ft bgs)	150’

TEST WELL DESIGN (Preliminary)	**Type A**	**Type B**
Total Well Depth (ft bgs)	55’	80’
Well Screen Interval (ft bgs)	30’ – 50’	60’ – 75’
Slot Size (inches)	(0.020)	(0.020)
Filter Pack Interval (ft bgs)	28’ – 55’	58’ – 80’
Filter Pack Material	16 x 30 Graded Sand	16 x 30 Graded Sand
Transition Seal Interval (ft bgs)	25’ – 28’; 55’ – 58’	55’ – 58’; 80’ – 83’
Transition Seal Material	Bentonite Pellet	Bentonite Pellet
Annular Seal Interval (ft bgs)	0’ – 25’	0’ – 55’
Annular Seal Material	Type II Neat Cement Grout	Type II Neat Cement Grout
Abandoned Borehole Interval (ft bgs)	55’ – 150’	80’ – 150’
Test Borehole Sealing Material	Type II Neat Cement Grout	Type II Neat Cement Grout

Notes;

1) All proposed sample/test interval and well design depth intervals are based on careful review of available lithologic, geotechnical and water quality data from the following sources;
    a) Field Borehole Log Borehole MW-4C, 10/28/1999;
    b) Sounding 5ECPT CPT and MHP logs, EKI, 2017;
    c)LRWQCB PCE Monitoring Well Data, 2017;
    d) Off Groundwater Investigation Data Report, EKI 2017.
Final depth intervals may be adjusted based on subsurface conditions encountered in the field.

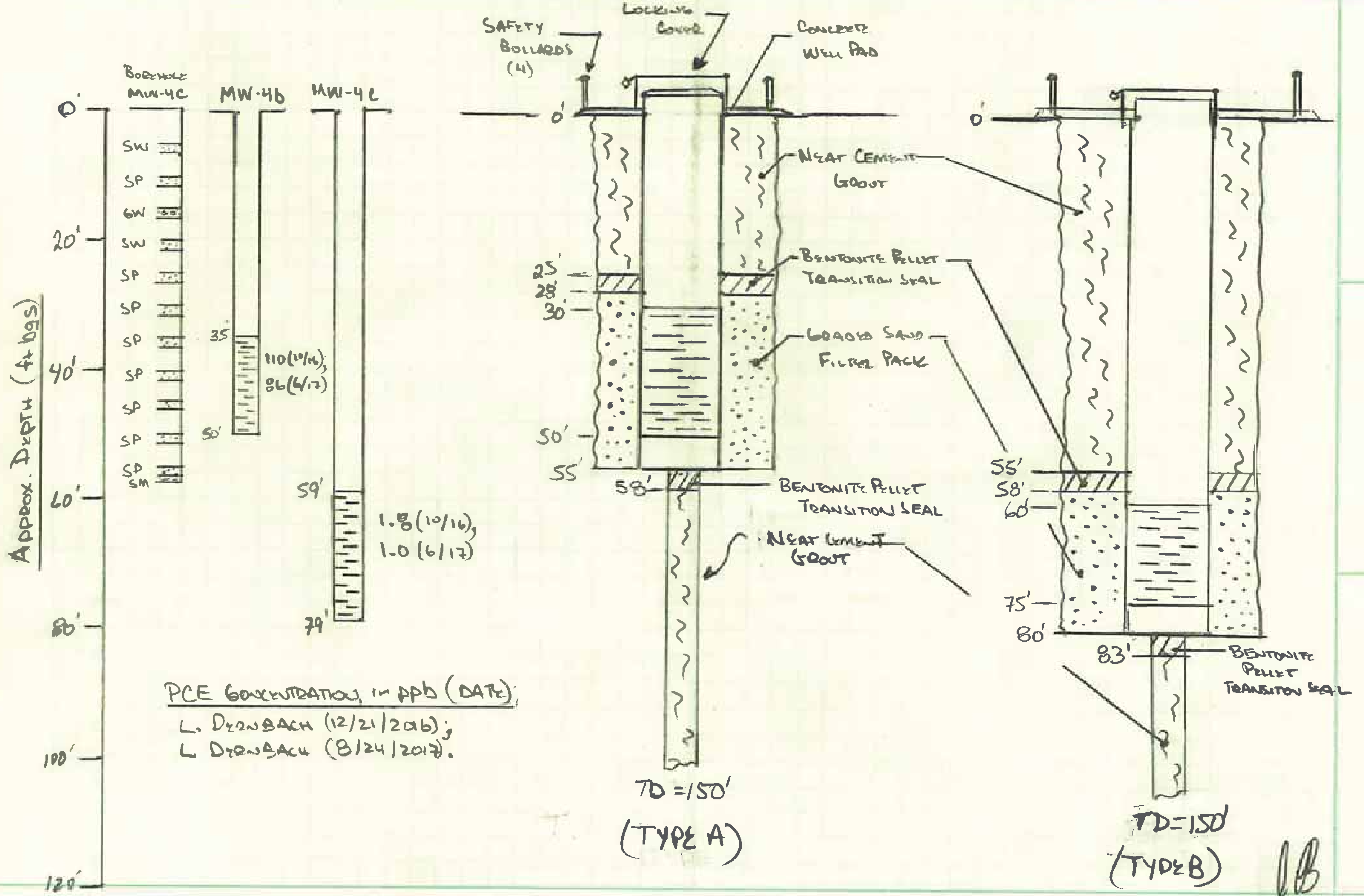
2) Selection of well screen slot size and graded sand filter pack are based on encountering medium sand through the well screen interval. Final filter pack and well screen design will be based on grain size analysis of the actual material encountered through the final depth interval selected for the well screen.

3) All sealing material for sealing of the test borehole and Test Well annular seal will be placed using the Tremie Method.

4) The test well construction will be completed with a locking well cover and a 3’ x 3’ x 4” concrete surface pad, with a 3-ft stick-up above ground surface.

5) Additional groundwater samples will be collected during aquifer testing, following Test Well construction.

PRELIMINARY DESIGN INVESTIGATION - TEST WELL GENERAL ARRANGEMENT DIAGRAM



PCE CONCENTRATION IN ppb (DATE);
L. DORNBACH (12/21/2016);
L. DORNBACH (8/24/2017).

JB
3/01/18

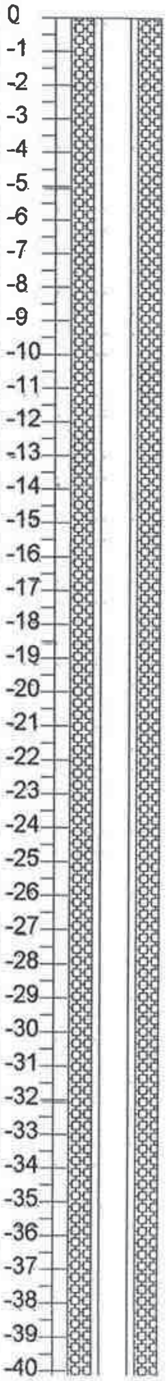
FIELD BOREHOLE LOG

BOREHOLE NUMBER
MW-4C

PROJECT NUMBER:	300344	BORING LOCATION:	Off-site, down NE
CLIENT:	Swiss Mart	TOTAL DEPTH:	79'
LOCATION:	South Lake Tahoe, CA	GROUND SURFACE ELEVATION:	na
DRILLING CO:	BAEi, Inc.	DEPTH TO WATER:	na
DRILLING METHOD:	Hollow Stem Auger	DEPTH TO PRODUCT:	na
FIELD PARTY:	Terra Vac, BAEi	CASING SIZE:	2"
GEOLOGIST:	Roman Bober	SCREEN LENGTH	20'
DATE BEGUN:	10/28/99	STICKUP	0'
DATE COMPLETED:	10/28/99	RISER LENGTH	59'
		SLOT SIZE	0.01"

DEPTH IN FEET	USCS	OVA PPM	LITHOLOGY DESCRIPTION
0			NO SAMPLE
-5	SW	3	SAND: coarse to fine, poorly sorted, loose, grey to light brown, some brown to grey rock fragments, sw=0.4, 2-3-3
-7			NO SAMPLE
-10	SP	2	SORTED SAND: white grey to light brown, coarse to medium, loose, well sorted, with light brown silt, sw=1.0, 6-12-13
-12			NO SAMPLE
-15	GW	8	GRAVEL: white to black, subangular to angular, coarse, loose rock fragments and sand and silt, sw=1.0, 10-12-22
-17			NO SAMPLE
-20	SW	6	SAND: grey to light brown, medium to fine, loose, poorly sorted, some white rock fragments, sw=1.0, 12-17-20
-22			NO SAMPLE
-25	SP	5	SORTED SAND: white to grey, loose, fine to medium, well sorted, with reddish brown streaks, sw=1.0, 11-12-14
-27			NO SAMPLE
-30	SP	7	SORTED SAND: grey to brown, fine, compact, well sorted, some clay, sw=1.0, 11-13-19
-32			NO SAMPLE
-35	SP	4	SORTED SAND: brown to grey, fine to medium, well sorted, some silt, sw=1.0, 14-18-19
-37			NO SAMPLE
-40	SP	5	SORTED SAND: brown to grey, fine to medium, well

WELL INSTALLATION



FIELD BOREHOLE LOG

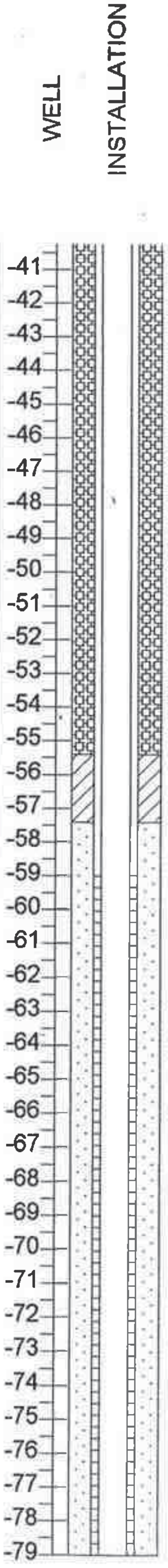
BOREHOLE NUMBER
MW-4C

PROJECT NUMBER: **300344**
CLIENT: **Swiss Mart**
LOCATION: **South Lake Tahoe, CA**
DRILLING CO: **BAEi, Inc.**
DRILLING METHOD: **Hollow Stem Auger**
FIELD PARTY: **Terra Vac, BAEi**
GEOLOGIST: **Roman Bober**
DATE BEGUN: **10/28/99** DATE COMPLETED: **10/28/99**

BORING LOCATION: **Off-site, down NE**
TOTAL DEPTH: **79'**
GROUND SURFACE ELEVATION: **na**
DEPTH TO WATER: **na**
DEPTH TO PRODUCT: **na**
CASING SIZE: **2"**
SCREEN LENGTH **20'**
STICKUP **0'**
RISER LENGTH **59'**
SLOT SIZE **0.01"**

DEPTH IN FEET

LITHOLOGY USCS	OVA PPM	LITHOLOGY DESCRIPTION
SP	5	SORTED SAND: brown to grey, fine to medium, well sorted, some silt, sw=1.0, 17-21-23
		NO SAMPLE
SP	4	SORTED SAND: light grey to brown, fine to medium, loose, well sorted, some silt, sw=1.0, 10-26-35
		NO SAMPLE
SP	3	SORTED SAND: same as above, sw=1.0, 3-7-17
		NO SAMPLE
SP	4	SORTED SAND: same as above, sw=1.0, 17-33-50
SM		SILTY SAND: brown, compact
		NO SAMPLE



OFF-SITE INVESTIGATION, ATTACHMENT B (EKI, 2017)

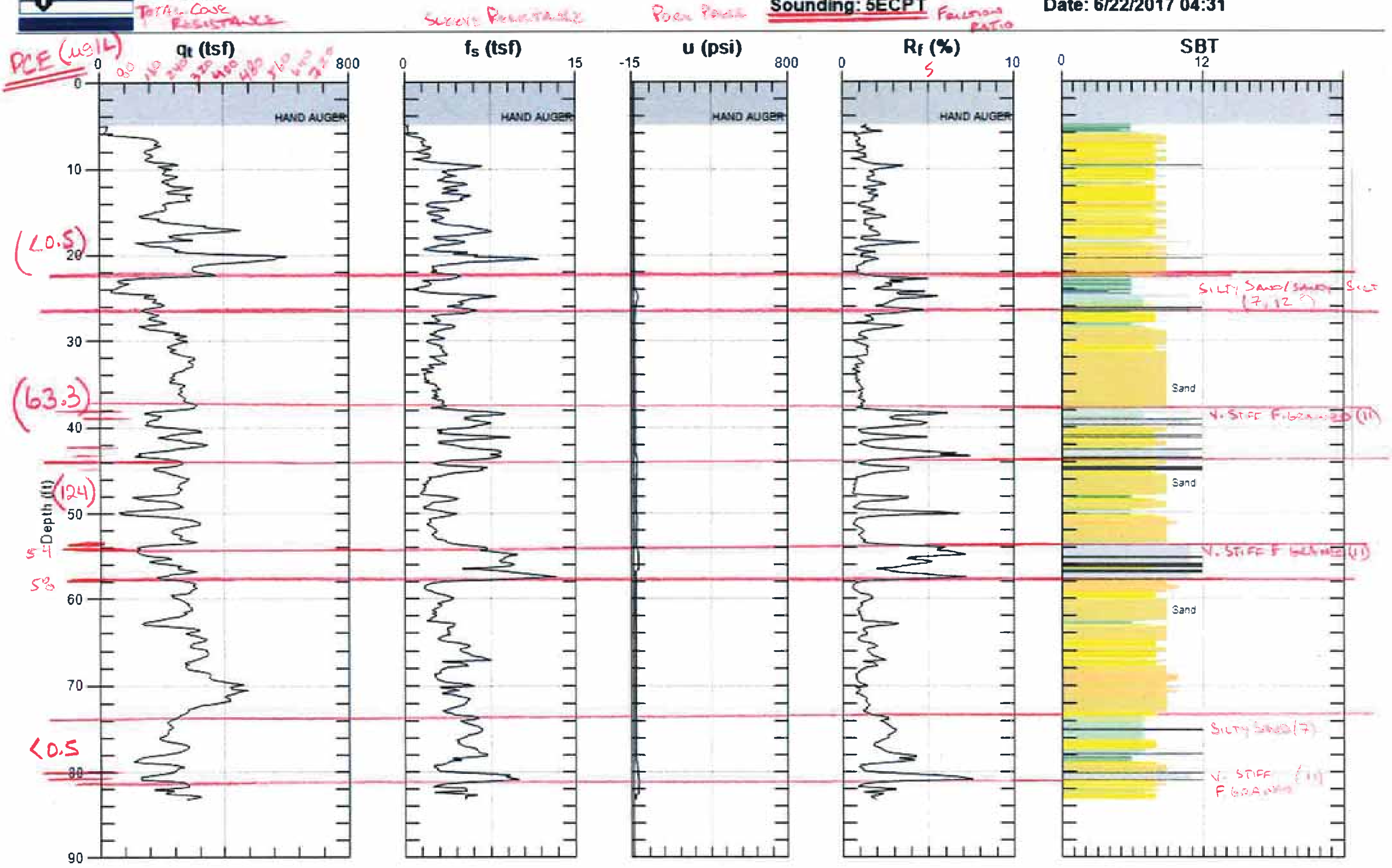
GREGG **EKI**

Site: S. LAKE TAHOE

Sounding: 5ECPT

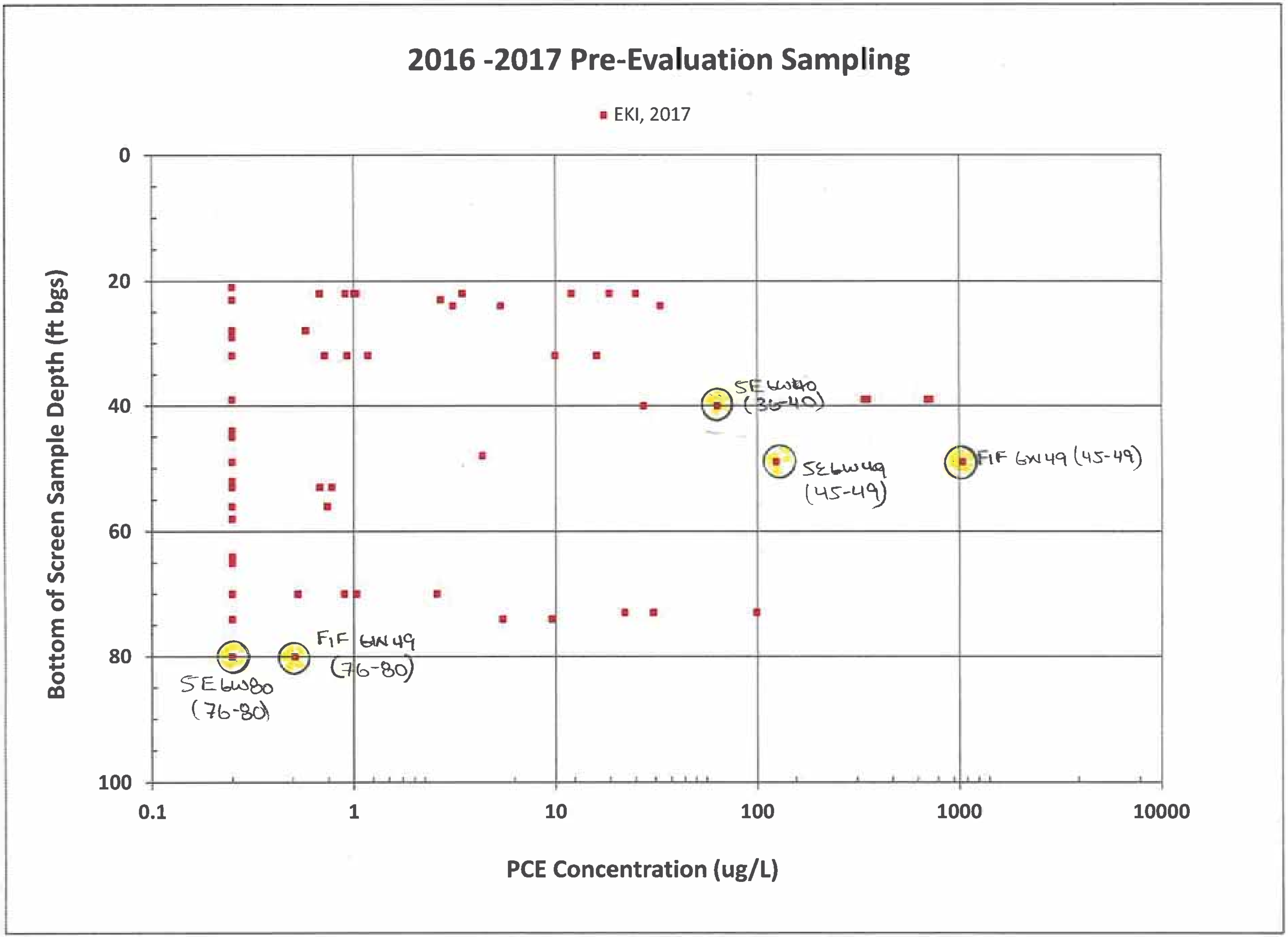
Engineer: S.CRONIN

Date: 6/22/2017 04:31



Max. Depth: 83.169 (ft)
Avg. Interval: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)


2016 -2017 Pre-Evaluation Sampling
■ EKI, 2017
Bottom of Screen Sample Depth (ft bgs)
0
20
40
60
80
100
0.1
1
10
100
1000
10000
PCE Concentration (ug/L)
SE6W40 (36-40)
SE6W49 (45-49)
FIF 6W49 (45-49)
FIF 6W49 (76-80)
SE6W80 (76-80)

Appendix E: Standard Operating Guidelines (SOGs) and Field Forms

Borehole Logging SOG

Boring Well Construction Log

Groundwater Level SOG

Groundwater Depth Log

Groundwater Sample SOG

Groundwater Purge and Sample Form

Equipment Decontamination SOG

Surface and Shallow Soil Sampling SOG

Well Construction Development SOG

Groundwater Pump Test SOG

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Standard Operating Guideline
Borehole Logging

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy/Jenks Consultants personnel for classifying soils and preparing boring logs and other types of soil reports. The purpose of this SOG is to facilitate the acquisition of uniform descriptions of soils encountered during borehole programs and to promote consistency in the logging practices used by Kennedy/Jenks Consultants personnel. This SOG provides guidance on procedures that are generally consistent with standard practices used to classify soils. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of subsurface exploration activities.

Borehole logging is the systematic observation and recording of geologic and hydrogeologic information from subsurface borings and excavations. The Unified Soil Classification System (USCS) (ASTM D2487-00) is used to identify, classify, and describe soils principally for engineering purposes, and is based on laboratory tests.

For field applications, ASTM D2488-06 (Visual-Manual Procedure) is used as the general guide adopted under this SOG.

Both ASTM D2487 and ASTM D2488 utilize the same group names and symbols. However, soil reports should state that boring logs are not formal USCS laboratory determinations, but are based on the visual-manual procedures described in ASTM D2488.

This SOG contains the following sections:

- Field Equipment/Materials
- Typical Procedures
    - Soil Classification
    - Classification of Coarse-Grained Soil
    - Classification of Fine-Grained Soil including Organic Soils
- Other Logging Parameters
- Logging Refuse
- References.

Field Equipment/Materials

Material/equipment typically required for classifying soils and preparing boring logs may include:

- Pens, pencils, waterproof pens, and field logbook or other appropriate field forms (e.g., boring log forms), water-tight field case.

- Daily inspection report forms

- USCS (ASTM D 2488-06) table and classification chart
- Soil color chart (i.e., Munsell) If used, the edition of the Munsell chart should be specified on each borehole log as the color descriptions and hue, color values and chromas have changed between editions. Also, whenever possible, the newest version of Munsell's color charts should be used due to fading of color chips over time.
- American Geological Institute (AGI) Data Sheets
- Graph paper
- Engineer's scale
- Previous project reports and boring logs (if available)
- Pocket knife or putty knife
- Hand lens
- Supply of clean water
- Dilute hydrochloric acid (HCl) (make sure and MSDS for HCl is included in the project HASP)
- Aluminum foil, Teflon® sheets, and paper towels
- Sample containers (brass, stainless steel or aluminum liners, plastic or glass jars)
- Clean rags or paper towels
- Sample shipping and packaging supplies
- Personnel and equipment decontamination supplies
- Personal protective equipment as described in the Health and Safety Plan (HASP).

Typical Procedures

Soil classification and borehole logging should be conducted by a qualified geologist, engineer or other personnel trained and experienced in the classification of soils.

Soils are typically logged in conjunction with advancing boreholes and sampling subsurface soils. Although the guideline focuses on classifying soil samples obtained from boreholes, this particular procedure also applies to soils and sediments collected using other techniques (e.g., post hole digger, scoop, Ekman, Ponar, or Van Veen grab samplers, and backhoe).

The USCS as described in ASTM D2488-06 categorizes soils into 15 basic group names, each with distinct geologic and engineering properties. The following steps are required to classify a soil sample:

1. Observe basic properties and characteristics of the soil. These include grain-size grading and distribution and influence of moisture on fine-grained soil.

2. Assign the soil a USCS classification and denote it by the standard group name and symbol.

3. Provide a written description to differentiate between soils in the same group, if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on either grain-size grading and distribution, or plasticity characteristics. In this case, assigning dual group names and symbols might be appropriate (e.g., GW-GC or ML-CL).

The two basic soil groups are:

1. **Coarse-Grained Soils –** For soils in this group, more than half of the material is larger than No. 200 sieve (0.074 mm).

2. **Fine-Grained Soils (including Organic Soils) –** For soils in this group, one half or more of the material is smaller than No. 200 sieve (0.074 mm).

Note: No. 200 sieve is the smallest size that can be seen with the naked eye.

Classification of Coarse-Grained Soils

Coarse-grained soils are classified on the basis of:

4. Grain size and distribution

5. Quantity of fine-grained material (i.e., silt and clay)

6. Character of fine-grained material

Classification uses the following symbols:

Basic Symbols	Modifying Symbols
G - gravel	W - well graded
S - sand	P - poorly graded
	M - with silt fines
	C - with clay fines

The following are basic facts about coarse-grained soil classification:

- The basic symbol G is used if the estimated volume percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated volume percentage of sand is greater than the percentage of gravel.

- Gravels include material in the size range from 3 inches to 0.2 inches (i.e., retained on No. 4 sieve). Sand includes material in the size range from 0.2 inches to 0.003 inches. Use the grain size scale used by engineers (ASTM Standards D422-63 and D643-78) to further classify grain size as specified by the USCS.

- Although not specifically treated in ASTM D2488-06, cobbles range in size from 3 inches to 10 inches and boulders refer to particles with a single dimension greater than 10 inches. They are included here for the purpose of completeness and for their hydrogeologic significance.

  Note: The ASTM grain size scale differs from the Modified Wentworth Scale used in teaching most geologists. Also, it introduces a distinction between sorting and grading (i.e., well graded equals poorly sorted and poorly graded equals well sorted.)

- The modifying symbol W indicates good representation of a range of particle sizes in a soil.

- The modifying symbol P indicates that there is a predominant excess or absence of particle sizes.

- The symbol W or P is only used when a sample contains less than 15 percent fines.

- Modifying symbol M is used if fines have little or no plasticity.

- Modifying symbol C is used if fines have low to high plasticity (clayey)

The following rules apply for the written description of the soil group name:

Types of Soil	**Rule**
Sands and gravels (clean)	Less than 5 percent fines
Sands (or gravels) with fines	5 to 15 percent fines
Silty (or clayey) sands or gravels	Greater than 15 percent fines

- Other descriptive information may include:
  - Color (e.g., Munsell Soil Color chart, specify edition). Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “dk brn (7.5 YR, 3/4).”
  - Relative Density/Penetration Resistance. For cohesionless materials use very loose, loose, medium, dense, or very dense estimated from drive sample hammer blows or other field tests. Blow counts may be used, if reliable.
  - Maximum grain size (fine, medium, coarse, as described in AGI data sheets or USCS). Note the largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
  - Composition of grains (mineralogy)
  - Approximate percentage of gravel, sand, and fines (use a percentage estimation chart as provided in the AGI data sheets)

Modifiers	**Description**
Trace	Less than 5 percent
Few	5 to 10 percent
Little	15 to 25 percent
Some	30 to 45 percent
Mostly	50 to 100 percent

- Angularity (round, subround, angular, subangular)
- Shape (flat or elongated)
- Moisture Condition (dry, moist, wet)
  - Dry - Absence of moisture to the touch.
  - Damp - Contains enough water to keep the sample from being brittle, dusty or cohesionless; is darker in color than the same material in the dry state.
  - Moist - Leaves moisture on your hand, but displays no visible free water.
  - Wet - Displays visible free water.
- HCl Reaction (none, weak, strong)
- Cementation (Crumbles under finger pressure: weak, moderate, or strong)
- Range of Particle Sizes (sand, gravel, cobble, boulder)
- Maximum Particle Size (fine, medium, coarse)
- Cementation (weak, moderate, or strong)
- Hardness (breaks with hammer blow)
- Structure (stratified, laminated, fissured, slickensided, blocky, lensed, homogeneous)
- Organic material
- Odor
- Iridescent sheen (based on sheen test)
- Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
- Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, contact and/or bedding dip, bedding features, sorting, structures, fossils, cementation, geologic origin, formation name, minerals, oxidation, etc.

Classification of Fine-Grained Soils

Fine-grained soils are classified on the basis of:

1. Liquid limit
2. Plasticity

Classification uses the following symbols:

Basic Symbols	**Modifying Symbols**
M - silt	L - low liquid limit
C - clay	H - high liquid limit
O - organic	
Pt - peat	

The following rules apply for the written description of the soil group name:

Types of Soil	**Rule**
Silts and clays with sand and/or gravel	5 to 15 percent sand and/or gravel
Sandy or gravelly silts or clays	Greater than 15 percent sand and/or gravel

The following are basic facts about fine-grained soil classification:

- The basic symbol M is used if the soil is mostly silt, while symbol C applies if it consists mostly of clay. Use of symbol O indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.

- Modifying symbols are based on the following hand tests conducted on a soil sample:

  - Dry strength (crushing resistance : none, low, medium, high, very high)
  - Dilatancy (molded ball reaction to shaking: none, slow, rapid)
  - Toughness (resistance to rolling or kneading near plastic limit : low, medium, high)
  - Plasticity (nonplastic, low, medium, high).

- Soil designated ML has little or no plasticity and can be recognized by none to low dry strength, slow to rapid dilatency, and low toughness.

- CL (lean clay) indicates soil with medium plasticity, which can be recognized by medium to high dry strength, no or slow dilatency, and medium toughness.

- OL is used to describe an organic, fine-grained soil that is less plastic than CL soil and can be recognized by low to medium dry strength, medium to slow dilatency, and low toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.

- MH soil has low to medium plasticity and can be recognized by low to medium dry strength, no to slow dilatency, and low to medium toughness.

- Soil designated CH (fat clay) has high plasticity and is recognizable by its high to very high dry strength, no dilatency, and high toughness.

- OH is used to describe an organic fine-grained soil that is less plastic than CH soil and can be recognized by medium to high dry strength, slow dilatency, and low to medium toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.

Note: PT (peat) is used to describe a highly organic soil composed primarily of vegetable tissue with a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor.

- Other descriptive information includes:
    - Color (e.g., Munsell) Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “reddish brn (5YR, 4/4).”
        - Moisture condition,
    - Omit moisture terms below the regional water table and when drilling with mud or air-mist rotary systems.
    - Consistency (thumb penetration test: very soft, soft, firm, hard, very hard . For fine sediments use very soft, soft, medium, stiff, very stiff, and hard.) These are estimated from drive sample hammer blows or other field tests. Blow counts may also be used, if reliable.
        - Structure (same descriptors as coarse grain)
        - Compactness (loose, dense) for silts
        - Odor
        - Iridescent sheen (based on sheen test)
        - Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
        - HCl Reaction (none, weak, strong).
    - Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, , contact and/or bedding dip, bedding features, cementation, structures, fractures, fracture fillings, fossils, formation name, minerals, oxidation).

Fine-Grained Rock Description

- Textural Classification
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “gry grn (5G, 5/2).”
- Hardness. Very hard, hard, medium, soft, very soft..
- Moisture Content. Dry, damp, moist, wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).
- Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and cementation. Estimate secondary permeability due to natural rock fractures when applicable.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.

- Fractures are identified by depth, angle, width, and associated mineralization if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]) should be stated. For example, “NF @90.8', 25 deg to axis, 0.1” wide, minor calcite.”

- Coarse-Grained Rock Description

- Textural Classification.

- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding also is recorded. For example, “gry olive grn (5GY, 3/2).”Hardness. Very hard, hard, medium, soft, very soft.

- Moisture Content. Dry, damp, moist, and wet (saturated).

- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).

- Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.

- Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.

- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.

- Fractures are identified by depth, angle, width, and associated mineralization, if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]), should be stated. For example, “NF @126.1', 35 deg to axis, 0.1” wide, minor calcite.”

Other Logging Parameters

Rock Quality Designation

This designation generally follows ASTM D6032-08 Standard Test Method for Determining Rock (RQD) of Rock Core.

The RQD denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. This method is generally applied to core barrel samples.

Standard Penetration Tests

This method generally follows ASTM D1586-08A Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. This method provides a means of assigning a relative density to the soil by counting the number of hammer blows (blow counts) required to advance a split-barrel sampler a specified distance into the undisturbed soil ahead of the lead auger. This method is not applicable to boreholes advanced with direct-push sampling equipment. It is used primarily in conjunction with hollow stem auger drilling apparatus as the test can be performed through the auger string without removal of the augers thereby allowing the borehole to remain open to the bottom of the drill string without risk of caving. As the sampler is advanced by the repeated drop of a hammer of known weight, the blow counts are recorded on the log and used to provide a relative density descriptor to the soil penetrated during the test.

The number of blows required to drive the sampler 6 in. by a 140-lb hammer falling 30 in. Fifty blow counts per 6-in drive is considered "refusal," and sampling at this depth is usually terminated. In addition, a total of 100 blow counts per 18-in. drive, or no observed advance of the sampler during ten successive hammer blows, is also considered "refusal." During coring, leave this section blank. Normally, the second and third 6-in. intervals are recorded and added as the number of blows per feet.

Sampler Type/Depth. Give sampler type by the letter code listed below and identify the depth at the top of the sampling interval in feet below ground surface (bgs).

Sampler type	Inside diameter(in.)	Code
Standard penetrometer	1.38	SP
Split-barrel (small)	2.0	SBS
Split-barrel (large)	2.5	SBL
HQ wireline core	2.3	PC

Those descriptors are as follows for coarse grained soils:

Very Loose	0 to 3 SPT Sampler	0 to 4 Mod CA Sampler
Loose	4 to 7 SPT Sampler	5 to 10 Mod CA Sampler
Medium Dense	8 to 23 SPT Sampler	11 to 30 Mod CA Sampler
Dense	24 to 38 SPT Sampler	31 to 50 Mod CA Sampler
Very Dense	> 38 SPT Sampler	>50 Mod CA Sampler

Relative Density Descriptors for fine grained soils are as follows:

Very Soft	<1 SPT Sampler	0 to 1 Mod CA Sampler
Soft	1 to 3 SPT Sampler	2 to 4 Mod CA Sampler
Firm	4 to 6 SPT Sampler	4 to 8 Mod CA Sampler
Stiff	7 to 12 SPT Sampler	8 to 15 Mod CA Sampler
Very Stiff	13 to 23 SPT Sampler	15 to 30 Mod CA Sampler
Hard	> 23 SPT Sampler	>30 Mod CA Sampler

Regardless of the degree of adherence to the ASTM Standard Method, split barrel samplers are used as the preferred method of undisturbed sample acquisition in a hollow stem auger drilling. Upon retrieval of the sampler from the borehole, the sampler should be opened without making contact with its interior contents and the logging personnel should record the percent recovery or length of the sample recovered. Sample containers should be removed with a clean gloved (gloves may not be needed, depending upon requirements of HASP) hand and placed in a clean, dry area for examination and logging. The sample will be described per the above. Any lithologic changes that may be observable in the exposed ends of the intact core over the sampled interval should be recorded on the log before any disturbance thereof. The depth of the lithologic changes should be estimated and recorded on the boring log. The least disturbed sample container of the two deeper six-inch sample increments should be secured with Teflon® or aluminum end sheets and snug fitting plastic end caps, sealed with silicon tape, depending upon testing, sampler may be filled with one inch rings instead of 6 inch. Sealing material should also be compatible with subsequent testing requirements.

Ambient Temperature Head-Space:

Organic vapor analyzers such as photoionization detectors (PIDs) or flame ionization detectors (FIDs) are generally used to assess the relative concentration of volatile hydrocarbons in the soil as the borehole is advanced and recorded as a value in parts per million on the boring log. This can be done by placing a uniform amount of soil in a Ziploc® bag, glass jar or other clean container, allowing the soil in the container to equilibrate to the ambient temperature, then inserting the probe of the PID or FID into the sealed container and recording the maximum PID or FID reading.

Non-Aqueous Phase Liquid (NAPL) Containing Soil

Appropriate observations of NAPL containing soil should include the following:

Appearance: If a separate phase liquid appears to be present, it might be described as “dark brown viscous fluid or liquid observed in the soil matrix.” This remark should follow the lithologic description in the borehole log. Observations of color should be made such as “black streaks” or “mottled gray to “olive brown”, however, it should not be inferred or remarked that the color is a necessary consequence of petroleum staining.

Odor: If the soil smells like petroleum it might be remarked that it has a “petroleum like” or “solvent like” odor. The use of terms like “strong” or “slight” should be avoided because there is no way to ensure that these terms can be applied uniformly in the field between various persons performing the logging (i.e. ,each persons olfactory sense is different). The use of terms like “chemical odor” should also be avoided as there is no common reference point. Notations regarding the type of petroleum distillate present (e.g., “diesel-like odor” or “gasoline odor”) are inappropriate as these are determination s that can only be accurately made by laboratory analysis.

Logging Refuse

This procedure applies to the logging of subsurface samples collected from a landfill or other waste disposal sites:

1. Observe refuse as it is brought up by the hollow stem auger, bucket auger, or backhoe.

2. If necessary, place the refuse in a plastic bag to examine the sample.

3. Record observations according to the following:

    a. Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, construction debris. Use such terms as "mostly" or "at least half." Do not use percentages.

    b. Moisture content: dry, damp, moist, wet.

    c. State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.

    d. Color: obvious mottling included.

    e. Texture: spongy, plastic (cohesive), friable.

    f. Odor.

    g. Combustible gas indicator readings (measure downhole).

    h. Miscellaneous: dates of periodicals and newspapers, degree of drilling effort (easy, difficult, very difficult).

References

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. ASTM D1586-08A

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). ASTM D2488-06.

Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System. ASTM D2487-00

Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core. ASTM D6032-08.

Grain Size Scale Used by Engineers. ASTM D422-63 and ASTM D643-78.

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U.S. Department of the Interior. 1989. *Earth Manual*. Washington, D.C.: Water and Power Resources Service.

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Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION			
DRILLING COMPANY	DRILLER		
DRILLING METHOD (S)	DRILL BIT (S) SIZE:		
ISOLATION CASING	FROM	TO	FT.
BLANK CASING	FROM	TO	FT.
PERFORATED CASING	FROM	TO	FT.
SIZE AND TYPE OF FILTER PACK	FROM	TO	FT.
SEAL	FROM	TO	FT.
GROUT	FROM	TO	FT.

Boring/Well Name ____________________

Project Name ____________________

Project Number ____________________

ELEVATION AND DATUM	TOTAL DEPTH
DATE STARTED	DATE COMPLETED
STATIC WATER ELEVATION	
LOGGED BY	
SAMPLING METHODS	WELL COMPLETION ☐ SURFACE HOUSING ☐ STAND PIPE ______ FT.

SAMPLES			Depth (Feet)	WELL CONSTRUCTION	USCS Log	Lithology	Color	SAMPLE DESCRIPTION and DRILLING REMARKS
Type No.	Recovery (Feet)	Penetration Resist (Blows/6 in.)						

F-40.1
(6-87) (3-88)

SHEET________ OF________

Boring & Well Construction Log **Kennedy/Jenks Consultants**

Project Name ____________________ **Project Number** ________ . ____ **Boring/Well Name** __________

SAMPLES			Depth (Feet)	WELL CONSTRUCTION	USCS Log	Lithology	Color	SAMPLE DESCRIPTION and DRILLING REMARKS
Type No.	Recovery (Feet)	Penetration Resist (Blows/6 in.)						

F-40.2
(6-87) (3-88)

SHEET________ OF________

Standard Operating Guideline
Measuring Groundwater Levels

A.1 Introduction

This guideline describes the field procedure typically followed by Kennedy/Jenks Consultants when measuring groundwater levels. Groundwater levels in wells will be measured prior to commencing developing, purging, sampling, and pumping tests.

A.2 Equipment

- Electronic water level monitoring probe or other measuring device
- Decontamination supplies (e.g., buckets, Alconox, distilled water, squirt bottle)
- Field notebook
- Groundwater purge-and-sample form(s) if in conjunction with groundwater sampling
- Keys for locks (if necessary)
- Tools to open well covers (e.g., socket wrench, spanner wrench)
- Disposable gloves (as a minimum), and other protective clothing (as necessary).

A.3 Typical Procedure

1. If more than one well will be measured, begin depth measurement in the order in terms of lowest to highest chemical concentrations in the monitoring wells.

2. Remove well caps from all wells prior to initiation of water level measurement activities. This will allow wells to equilibrate, if necessary.

3. If the potential exists for floating product (LNAPL) to be present, use an electric oil-water interface probe or oil-sensitive paper to measure depth of the floating product and the electronic depth probe to measure the depth-to-water. Record both depths in field notebook and note the water depth as the "depth with oil layer present." Unless otherwise instructed, always measure depths to floating product layer and groundwater from the top of the north side of the well casing.

4. When floating product is not present, measure depth-to-water using a pre-cleaned water level probe from the top of the north side of the well casing, unless otherwise instructed.

5. Repeat measurements a minimum of three times or have field partner confirm measurement.

6. Record time of day the measurement was taken using military time (e.g., 16:00).

7. Decontaminate water level and/or oil-water interface probe and line prior to reuse (refer to SOG-2, Equipment Decontamination).

Groundwater Depth Measurement Log

Kennedy/Jenks Consultants

Project Name: ______________________________

Project Number: ______________________________

Project Manager: ______________________________

Date: ____________________

Time Start: ____________________

Time End: ____________________

Page 1 of 1

Well Number	Time	Groundwater Depth	Total Well Depth	Measuring Point Description	Comments

Standard Operating Guideline
Groundwater Sampling

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy/Jenks Consultants personnel during the collection of groundwater samples from monitoring wells. Groundwater sampling from temporary boreholes (e.g., grab groundwater samples collected from direct push borings) is not addressed by this SOG. This SOG provides guidance on procedures that are generally consistent with standard practices used in environmental sampling. Federal, state and/or local regulatory agencies may require groundwater sampling procedures that differ from those described in this SOG and/or may require additional procedures. As guidance, this SOG does not constitute a specification of requirements for groundwater sampling. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific sampling objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of groundwater sampling activities.

This SOG does not address Quality Assurance/Quality Control (QA/QC) procedures for groundwater sampling in detail. While some general QA/QC procedures are addressed, project-specific QA/QC procedures should be developed and presented in a Quality Assurance Project Plan (QAPP), field sampling and analysis work plan, or other project- or activity-specific document.

This SOG contains the following sections:

- Field Equipment/Material
- Typical Procedures for Monitoring Well purging and Groundwater Sampling
- Stabilization Criteria for Adequacy of Monitoring Well Purging
- Typical Procedures for Groundwater Sampling using Passive Diffusion Bags (PDBs)
- Quality Control Guidance
- Investigation-Derived Waste (IDW) Management
- References

Field Equipment/Materials

Material/equipment typically required for the collection of groundwater samples from monitoring wells may include:

- Electric water-level monitoring probe
- Multi-phase interface monitoring probe
- Bladder pump, peristaltic pump, pre-cleaned, disposable, 2- or 4-inch bailers with disposable cord, inertial pump, submersible pump, passive diffusion bags or other suitable apparatus for purging the well and sampling
- Flexible discharge tubing [polyethylene (PE), Teflon™, or similar]
- Purge water collection container
- Multi-parameter water quality meter (temperature, pH, specific conductance, redox potential)
- Turbidity meter
- Flow-through cell
- Nitrocellulose filters (if conducting field filtering)
- Sample containers (laboratory-supplied) with appropriate preservatives
- Additional chemical preservatives (if necessary)
- Watch or stopwatch
- Sample labels, pens, field logbook, or other appropriate field forms (e.g., groundwater purge and sample forms, chain-of-custody forms), and access agreements and third-party sample receipts (if warranted)
- Previous purging and sampling data for monitoring wells to be sampled, including water levels, purging parameters, and laboratory analysis results.
- Monitoring well boring and construction log (including wellhead elevation survey and reference point information)
- Personnel and equipment decontamination supplies
- Sample shipping and packaging supplies
- Personal protective equipment as specified in the Health and Safety Plan (HASP).

Typical Procedures for Monitoring Well Purging and Groundwater Sampling

1. **Pre-Purging Data Collection and Purging Equipment Placement.** Record the data and information collected during this procedure on a groundwater purge and sample form. Perform the following prior to groundwater sampling:
    a. Calibrate the multi-parameter water quality meter, prior to beginning sampling and as necessary based on field conditions, in accordance with the instructions in the manufacturer's operation manual. Note that it may be appropriate to keep a written log of the calibration procedures and an instrument maintenance with the instrument.

b. Examine the monitoring well to be sampled and associated protective surface enclosure for any structural damage, poorly fitting caps, and leaks into the inner casing. If notable conditions exist, they should be recorded on the sampling log for the well so that any necessary follow-up corrective actions can be planned and implemented.

c. Record an initial measurement of the depth to water. Calculate the volume of water in the well casing if wetted-casing-volume-based purging is to be used to remove the so-called “stagnant water” from the well prior to sampling. The volume of water in the wetted well casing should be calculated using the formula: $V = (\pi r^2) \times L$ where r is one half of the inner diameter of the well casing/screen and L is the length of wetted casing/screen (calculated by subtracting the depth to water from the total well depth). Total well depth should not be measured at the start of a sampling event (due to the potential to cause turbidity). Measure the total well depth after sample collection. Note that some regulatory agencies require that the calculated “stagnant water” volume include the water contained in the pores space of the wetted portion of the monitoring well filter pack in addition to the casing/screen. If this is a requirement, it should be defined in the project-specific sampling requirements.

d. If light non-aqueous phase liquid (LNAPL) is potentially present, measure the depth and thickness of the LNAPL and the static water level using a multiphase interface monitoring probe. Use one of the following devices for purging:

a. Bladder pump: adjust the pump intake at a depth approximately equal to the middle or just slightly below the middle of the well screen interval or water column unless another position is justified based on site-specific conditions.

b. Peristaltic pump: place the pump intake at a depth equal to the approximate middle or just slightly above the middle of the well screen interval or water column unless another position is justified based on site-specific conditions. Note: If degassing of water is occurring when sampling with a peristaltic pump, alternative types of sampling equipment should be used for volatile organic compound (VOC) or volatile petroleum hydrocarbon (VPH) sample collection.

c. Inertial pump: place the pump intake at a depth approximate to the middle or just slightly below the middle of the well screen interval or water column unless another position is justified based on site-specific conditions. Note: Some studies suggest that the use of inertial pumps for purging and/or sampling may produce a low bias when collecting samples for VOC and VPH analyses. This should be considered along with regulatory requirements when selecting an inertial pump for purging and/or sampling.

d. Submersible pump: place the pump intake at a depth approximate to the middle or just slightly below the middle of the well screen interval unless another position is justified based on site-specific conditions.

e. Pre-cleaned or disposable bailers. Note: The use of bailers for low-flow purging/sampling is not appropriate.

f. Another suitable purging/sampling device may be selected for use depending upon project requirements.

2. **Monitoring Well Purging and Sampling.** When purging of a monitoring well prior to sampling is appropriate and/or required, purge the well using either (a) wetted-casing-volume-based purging or (b) low-flow purging as described in the following sections. If a well exhibits evidence of slow recharge, or produces excessively silty water, etc., the well may need to be redeveloped.

   a. Wetted-casing-volume-based purging.

      (1) Establish a purging rate to pump or bail approximately three wetted-casing volumes of groundwater without dewatering the well.

      (2) If using a pump, set-up the discharge tubing, flow-through cell, water quality meter, and purge water collection container. If turbidity is measured, collect the sample for turbidity measurement after groundwater passes through the flow-through cell in the vial provided with the turbidity meter. If using a bailer, maintain a clean plastic container next to the well for collecting observation samples. Begin purging the well.

      (3) At the beginning of purging and periodically thereafter, record the following information and water quality parameters/observations on the groundwater purge and sample form: As guidance, field parameters may be measured after one purge volume is removed and every ½ purge volume thereafter.

         - Date and time
         - Purge volume and/or flow rate
         - Water depth
         - Temperature
         - pH
         - Specific conductance
         - Dissolved oxygen
         - Oxidation-reduction potential (ORP)
         - Other observations as appropriate (turbidity, color, presence of odors, sheen, etc).

      (4) Continue purging until water quality parameters have stabilized (refer to "Stabilization Criteria for Adequacy of Monitoring Well Purging" below) and/or a minimum of three wetted-casing volumes of water have been removed from the well. If a well purges dry, let it recover to 80 percent of original water column, then sample. If the well takes a very long time to recover (i.e., longer than 2 hours), try to sample the well at the end of day or first thing the next day.

      (5) Collect the sample in pre-cleaned sample containers suitable for the laboratory analyses to be performed.

    (6) If sampling using a bailer, use a bottom-emptying device or other technique to avoid sample agitation. If the collected water is very turbid, or a bottom-emptying bailer is not used, properly transfer the water from the bailer into the appropriate sample containers. Be careful to avoid agitating the sample. When sampling for VOCs, turn the bottle upside down after filling the container to identify possible headspace. If bubbles are present, top off the sample container or resample.

  b. Low-flow purging and sampling.

    (1) Place the pump intake at a depth equal to the approximate middle or just slightly above the middle of the well screen interval or water column or otherwise as dictated by well-specific soil stratigraphy and project-specific requirements**.** For example, it may be appropriate that the pump intake be set opposite to any preferential flow pathways (i.e., zones of higher permeability).

    (2) Place an electronic water-level indicator probe in the well, approximately 0.5 to 3 inches below the piezometric surface. If available, a transducer of sufficient accuracy can also be used to measure depth to water when purging.

    (3) Connect the pump discharge tube to a flow-through cell housing a water quality parameter probe.

    (4) Activate the pump for purging at a flow rate ranging from approximately 0.1 to 0.5 liters per minute (L/min) or other flow rate as dictated by project-specific and/or site-specific requirements. (Note: Some regulatory agencies may require specific flow rates). Determine the flow rate by timing the rate at which the flow-through cell is filled.

    (5) During purging, monitor the water level in the well to evaluate potential drawdown. The goal is to minimize drawdown to less than approximately 4 inches. If drawdown is observed (especially rapid drawdown at the beginning of purging), decrease the pumping rate.

    (6) Measure water quality parameters at approximately 3- to 5-minute intervals during purging. Continue purging until water quality parameters have stabilized (refer to "Stabilization Criteria for Adequacy of Monitoring Well Purging" below)

    (7) Immediately after purging, collect the sample in pre-cleaned sampled containers suitable for the laboratory analyses to be performed using the same flow rate that was used during purging unless it is necessary to decrease the rate to minimize aeration or turbulent filling of sample containers. If sampling for VOCs or VPH reduce the flow rate to 0.1 L/min or less.

3. **<u>Sampling with LNAPL Present in a Monitoring Well.</u>** Wells containing LNAPL are typically not sampled for dissolved phase constituents in groundwater due to the potential for entrainment of LNAPL in the aqueous sample matrix. If such sampling is required, and purging is not required, make sure the pump intake is placed in the upper 2 feet of water column and collect the samples without purging in a manner

that reduces the potential for mixing of the groundwater sample with air or LNAPL. If groundwater sampling is required from wells containing LNAPL for the purposes of characterizing VOCs, and purging is required, purge the well prior to sampling unless or until LNAPL becomes entrained in the sampling apparatus. If LNAPL will likely become entrained in the groundwater, the sample should be collected without purging. If LNAPL becomes entrained in the sampling apparatus then the sampling effort for VOCs should be aborted.

4. **Field Filtering Groundwater Samples.** Groundwater sample filtering and/or preservation should be performed in accordance with the requirements of the analytical method being specified and any other project-specific requirements. For example, samples collected for dissolved metals are typically filtered using a 0.45 μm filter.
5. **Sample Collection Considerations.** When multiple analyses will be performed, collect the samples in order of decreasing sensitivity to volatilization (i.e., VOC samples first and metals last). When sampling for VOCs, turn the sample container upside down after filling to identify possible headspace. If bubbles are present, top off the sample bottle or resample (do not reuse bottles, especially if they have been pre-preserved by the vendor or laboratory). If possible, the pump should not be moved or turned off between purging and sampling; however, the pump may need to be turned off for a very brief period (as a practical matter) so field personnel can handle samples and minimize the potential for water to splash on the ground surface. The ground surface should be protected from incidental splashing, especially if water from the well would be considered a hazardous waste for disposal purposes.
6. **Monitoring Wells with Slow Recharge.** If a well purges dry, let it recover to 80 percent of original water column, then sample. If the well takes a very long time to recover (i.e., longer than 2 hours), try to sample the well at the end of day or first thing the next day.
7. **Sample Container Filling and Shipping.** Fill the appropriate containers for the analyses to be requested and ensure that the required label information is completely and accurately filled in. Follow sampling packaging, shipping, and chain-of-custody procedures (see applicable SOG).
8. **Decontamination.** Follow personnel and equipment decontamination procedures (see applicable SOG).

Stabilization Criteria for Adequacy of Monitoring Well Purging

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EPA 2001) states that “with respect to groundwater chemistry, an adequate purge is achieved when pH, specific conductance, and temperature of groundwater have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). Wells should be considered stable when the criteria listed in the following table have been met for pH, specific conductance, temperature, and turbidity. Attempts should also be made to stabilize ORP and dissolved oxygen.

Field Parameters	Stabilization Criteria for Three or More Consecutive Readings	Notes
pH	Difference between three or more consecutive readings is within ±0.2 units	–
Temperature	Difference between three or more consecutive readings is constant	–
Specific Conductance	Difference between three or more consecutive readings is within ±3%	–
Turbidity	Difference between three or more consecutive readings is within ±10% or three consecutive readings below 10 NTUs	Generally, turbidity is the last parameter to stabilize. Attempts should be made to achieve stabilization; however, this may not be possible. It should be noted that natural turbidity in groundwater may exceed 10 NTUs. If turbidity is greater than 50 NTU, redevelopment of the well may be warranted.
ORP	Difference between three or more consecutive readings is within ±20mV	Very sensitive. Attempts should be made to achieve stabilization; however, due to parameter sensitivity this may not be possible.
Dissolved Oxygen	Difference between three or more consecutive readings is within ±10% or ±0.2 milligrams per liter (mg/L), whichever is greater	Very sensitive. Attempts should be made to achieve stabilization, especially when collecting samples of VOC analysis; however, due to parameter sensitivity this may not be possible.

Attempts should be made to achieve the stabilization criteria. Because of geochemical heterogeneities in the subsurface environment, stabilization of field parameters during purging may not always be achievable. If field parameter measurements do not indicate stabilization, continued conventional purging may be required until a minimum of three wetted-casing volumes have been removed. During low-flow purging of a well containing a large volume of casing water, it may be practical to discontinue low-flow purging and proceed with sampling if field parameters have not stabilized within a reasonable period. This judgment must be made on a site-specific/project-specific basis.

Typical Procedures for Groundwater Sampling Using Passive Diffusion Bags (PDBs)

Groundwater sampling using water-filled passive diffusion bag (PDB) samplers may be suitable for obtaining samples for VOC analysis. The suggested application of the method is for long-term monitoring of VOCs in groundwater wells at well characterized sites. (Note: The use of PDBs may not be suitable for the assessment of Tertiary Amyl Methyl Ether, methyl tert-butly ether, methyl-isobutyl ketone, styrene, and acetone).The effectiveness of the use of a single PDB sampler in a well is dependent on the assumption that there is horizontal flow through the well screen and that the quality of the water in the well screen is representative of the groundwater in the aquifer directly adjacent to the screen. If there are vertical components of intrabore-hole flow, multiple intervals of the formation contributing to flow, or varying concentrations of VOCs vertically within the screened or open interval, then a multiple deployment of PDB samplers within a well may be more appropriate for sampling the well.

Typically PDB samplers should not be used in wells having screened or open intervals longer than10 feet. If PDB samplers are to be used in wells with screened intervals of greater than 10 feet, then they are generally used in conjunction with borehole flow meters or other techniques to characterize vertical variability in hydraulic conductivity and contaminant distribution or used strictly for qualitative reconnaissance purposes. In larger well screens or in wells that may have vertical flow, the use of baffles should be considered.

Following are the procedures for deploying a PDB sampler.

1. **Acquire PDBs.** Obtain the pre-filled PDB samplers from the analytical laboratory. (The PDB samplers are prefilled at the laboratory with laboratory-grade deionized water. Unfilled PDB samplers can be obtained and filled in the field but this is not recommended.)
2. **Deploy PDBs in Monitoring Wells.** To deploy the PDB sampler in the well:
    a. Measure the well depth and compare the measured depth with the reported depth to the bottom of the well screen from well-construction records. This is to check whether sediment has accumulated in the bottom of the well, whether there is a non-screened section of pipe (sediment sump) below the well screen, and the accuracy of well-construction records.
    b. Attach the PDB sampler to a weighted line. (Sufficient weight should be added to counterbalance the buoyancy of the PDB sampler.) (Note: Stainless-steel or Teflon-coated stainless-steel wire is preferable, but rope can be used if it is of sufficient strength, non-buoyant, and subject to minimal stretching. However, the rope should not be reused due to the potential for cross contamination.) Additionally, to prevent cross-contamination, the weighted lines should not be reused in different wells.
    c. To prevent cross-contamination, he PDB samplers should not contact non-aqueous phase liquid (NAPL) during deployment or retrieval.
    d. Calculate the distance from the bottom of the well, or top of the sediment in the well, up to the point where the PDB sampler is to be placed.
    e. Attach the PDB sampler to the weight or weighted line at the target depth.
        1) For the field-fillable type of PDB sampler, the sampler is equipped with a hanger assembly and weight that can be slid over the sampler body until it rests securely near the bottom of the sampler.
        2) If using a coated stainless-steel wire as a weighted line, make loops at appropriate points to attach the upper and lower ends of PDB sampler.
        3) Where the PDB sampler position varies between sampling events, movable clamps with rings can be used.

        4) When using rope as a weighted line, tie knots or attach clasps at the appropriate depths. Nylon cable ties or stainless-steel clips inserted through the knots can be used to attach the PDB samplers.

    f. Lower the weight and weighted line down the well until the weight rests on the bottom of the well and the line above the weight is taut. The PDB samplers should now be positioned at the expected depth. (The depth can be checked by placing a knot or mark on the line at the correct distance from the top knot/loop of the PDB sampler to the top of the well casing and checking to make sure that the mark aligns with the lip of the casing after deployment.)

    g. Secure the assembly. (A suggested method is to attach the weighted line to a hook on the inside of the well cap.)

    h. Reattach the well cap. The well should be sealed in such a way as to prevent surface-water in-flow into the well.

    i. Allow the system to remain undisturbed until the PDB sampler equilibrates. Laboratory and field data suggest that a 2-week equilibration time is probably adequate for most applications. Note: In less-permeable formations, longer equilibration times may be required.

3. **Recovering the PDBs.** Following the equilibration time, recover the PDB sampler from the monitoring well.

    a. Remove the PDB samplers from the well by using the attached line. The PDB samplers should not be exposed to heat or agitated.

    b. Examine the surface of the PDB sampler for evidence of algae, iron or other coatings, and for tears in the membrane. Note the observations in a sampling field book. If there are tears in the membrane, the sample should be rejected. If there is evidence that the PDB sampler exhibits a coating, then this should be noted in the report.

    c. Detach and remove the PDB sampler from the weighted line. Remove the excess liquid from the exterior of the bag to minimize the potential for cross contamination.

4. **Sample Container Filling and Shipping.** Transfer the water from the PDB sampler to sample container. This is typically accomplished by carefully cutting a small hole in the bag and directing the flow into the sample container. Some commercially available PDB samplers provide a discharge device that can be inserted into the sampler. When transferring the sample to the sample container, minimize agitation. Ensure that the required label information is completely and accurately filled in. Follow sampling packaging, shipping, and chain-of-custody procedures (see applicable SOG).

5. **Decontamination.** Follow personnel and equipment decontamination procedures (see applicable SOG).

Quality Control Guidance

Follow the quality control requirements specified in the Quality Assurance Project Plan (QAPP), project-specific field sampling and analysis work plan, and/or project-specific regulatory requirements, as applicable. The following may be used as guidelines.

1. Approximately one duplicate sample should be obtained for each sampling event or for each batch of samples (a batch is typically defined as 20 samples). Collect duplicate samples immediately after the original samples are collected. Purging is not performed between original sample collection and collection of duplicate samples. Original and duplicate samples are collected sequentially, without appreciable delay between collection cycles. Duplicate samples are to be submitted to the laboratory blind (i.e., not identified as a duplicate sample).

2. Typically, at least one type of field blank sample (rinsate or transfer) should be collected per day of water sampling. All field blank samples are to be collected, preserved, labeled, and treated like any other sample. Field blank samples are to be sent blind to the laboratory (i.e., not identified as a field blank). Record in the field notebook the collection of any blank sample (rinsate, transfer, trip). The types of field blank samples are discussed below.

    a. Rinsate blank samples. If rinsate field blank samples are required, prepare the sample by pouring deionized water over, around, and through the various reusable sampling implements contacting a natural sample. Rinsate blanks need not be collected when dedicated sampling equipment is used for purging and sampling the well. Rinsate blank samples are to be analyzed for the same parameters as the environmental samples.

    b. Transfer blank samples. Transfer blank samples are routinely prepared when no rinsate blank samples are collected. (The purpose of a transfer blank sample is to monitor for entrainment of contaminants into the sample from existing atmospheric conditions at the sampling location during the sample collection process.) A transfer blank sample is prepared by filling a sample container(s) with distilled or deionized water at a given sampling location. Transfer blank samples are to be analyzed for the same parameters as the environmental samples.

    c. Trip blank samples. Trip blank samples are submitted for VOC analysis to monitor for possible sampling contamination during shipment as volatile organic samples are susceptible to contamination by diffusion of organic contaminants through the Teflon-faced silicone rubber septum of the sample vial. Trip blank samples are prepared by the laboratory by filling VOA vials from organic-free water and shipped with field sample containers. Trip blank samples accompany the sample bottles through collection and shipment to the laboratory and are stored with the samples. It is suggested that a trip blank sample be included in each cooler of samples submitted for VOC analysis.

Investigation-Derived Waste (IDW) Management

Purge water is to be contained onsite in an appropriate labeled container for disposition by the client unless other project-specific procedures are defined. Other investigation-derived wastes, such as personal protective equipment, are to be properly handled and disposed. Preferably, PPE IDW should also be containerized and left onsite for disposal by the client. As a matter of practice, any waste, or potential waste, generated onsite, should remain onsite. Refer to the IDW SOG.

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Groundwater Purge and Sample Form Date: ________ **Kennedy/Jenks Consultants**

PROJECT NAME: ____________________ WELL NUMBER: ____________________

PROJECT NUMBER: ____________________ PERSONNEL: ____________________

STATIC WATER LEVEL (FT): ____________________ MEASURING POINT DESCRIPTION: ____________________

WATER LEVEL MEASUREMENT METHOD: ____________________ PURGE METHOD: ____________________

TIME START PURGE: ____________________ PURGE DEPTH (FT) ____________________

TIME END PURGE: ____________________

TIME SAMPLED: ____________________

COMMENTS: ____________________

WELL VOLUME CALCULATION (FILL IN BEFORE PURGING)	TOTAL DEPTH (FT)		DEPTH TO WATER (FT)		WATER COLUMN (FT)		MULTIPLIER FOR CASING DIAMETER (IN)				CASING VOLUME (GAL)
							2	4	6		
		-		=		X	0.16	0.64	1.44	=	

TIME								
VOLUME PURGED (GAL)								
PURGE RATE (GPM)								
TEMPERATURE (°C)								
pH								
SPECIFIC CONDUCTIVITY $\left(\frac{\text{micromhos}}{\text{cm}}\right)$ (uncorrected)								
DISSOLVED OXYGEN (mg/L)								
eH(MV)Pt-AgCl ref.								
TURBIDITY/COLOR								
ODOR								
DEPTH OF PURGE INTAKE (FT)								
DEPTH TO WATER DURING PURGE (FT)								
NUMBER OF CASING VOLUMES REMOVED								
DEWATERED?								

Groundwater Purge and Sample Form

Date: ________

Kennedy/Jenks Consultants

PROJECT NAME: ______________________ WELL NUMBER: ______________________

PROJECT NUMBER: ______________________ PERSONNEL: ______________________

SAMPLE DATA:

TIME SAMPLED: ______________ COMMENTS: ______________________

DEPTH SAMPLED (FT): ______________ ______________________

SAMPLING EQUIPMENT: ______________ ______________________

SAMPLE NO.	NO. OF CONTAINERS	CONTAINER TYPE	PRESERVATIVE	FIELD FILTRATION	VOLUME FILLED (ml or L)	TURBIDITY	COLOR	SHIPPED UNDER CHAIN-OF-CUSTODY AT 4°C?	ANALYSIS REQUEST (METHOD)	COMMENTS

PURGE WATER DISPOSAL NOTES:

TOTAL DISCHARGE (GAL): ______________ COMMENTS: ______________________

DISPOSAL METHOD: ______________ ______________________

DRUM DESIGNATION(S)/VOLUME PER (GAL): ______________________

WELL HEAD CONDITIONS CHECKLIST (CIRCLE YES OR NO - IF NO, ADD COMMENTS):

WELL SECURITY DEVICES OK (BOLLARDS, CHRISTY LID, CASING LID AND LOCK)?: YES NO

INSIDE OF WELL HEAD AND OUTER CASING DRY?: YES NO

WELL CASING OK?: YES NO

COMMENTS: ______________________

GENERAL:

WEATHER CONDITIONS: ______________________

TEMPERATURE (SPECIFY °C OR °F): ______________________

PROBLEMS ENCOUNTERED DURING PURGING OR SAMPLING? ______________________

cc: Project Manager: ______________
Job File: ______________
Other: ______________

Standard Operating Guideline
Equipment Decontamination

A.1 Introduction

This guideline describes field procedures typically followed by Kennedy/Jenks Consultants personnel during the decontamination of sampling and monitoring equipment. Proper decontamination procedures minimize the potential for cross-contamination among sampling points on a single site or between separate sites.

A.2 Equipment

- Two or three containers (e.g., 5-gallon buckets, or 5- or 10-gallon plastic tubs) for dip rinsing, washing, and collection of rinse water.

- Two or three utility brushes or test tube brushes for removal of visible contamination. A test tube brush (or similar) can be stapled to the end of a dowel and used to clean the inside of a bailer.

- Non-phosphate Alconox, Liquinox, or trisodiumphosphate (TSP) to be mixed with potable or distilled water.

- Rinse solutions, such as methyl alcohol (methanol), dilute nitric acid (0.1 molar), deionized or distilled water, and/or tap water. Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds as discussed below:

  Acid rinse (inorganic desorption) 10% nitric or hydrochloric acid solution reagent grade nitric or hydrochloric acid and deionized water (1% to be used for low carbon steel equipment).

  Solvent rinse (organic desorption isopropanol, acetone, or methanol; pesticide grade).

  Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds.

- Multi-gallon storage containers filled with potable water to be used for rinsing or washing.

- Spray bottles, squirt bottles, or garden sprayers to apply rinse liquid. A separate bottle should be used for each liquid.

- Solvex or neoprene gloves that extend, as a minimum, halfway up the forearm. In cooler weather, it is advisable to use different resistant chemicals neoprene gloves that provide better insulation against cold temperatures.

- Paper towels to wipe off gross contamination.

- Garbage bags, or other plastic bags, and aluminum foil to wrap clean sampling equipment after decontamination, to store sampling equipment or and to dispose of decontamination debris.

- Sample bottles for rinsate blanks. For these blanks, Laboratory Type II (millipore) water should be used. Purified water from the selected analytical laboratory is recommended. This water is often filtered and boiled to remove impurities.

- DOT-approved container (e.g., 55-gallon drum) to store contaminated wash and rinse water. Contained decontamination should be labeled appropriately.

- Steamcleaner with power source and water supply.

A.3 Procedures

In most cases, the following procedures are adequate to remove contamination.

1. Preclean sampling equipment. If there is gross contamination on equipment, wipe it off with paper towels and/or rinse it off with water. Additional internal decontamination may be possible by circulation of water or cleaning solutions.

2. Wash all parts of equipment with detergent water and scrub with brushes. Take equipment apart when appropriate to remove visible contamination.

3. Steamclean sampling equipment. The steamcleaner is effective in removing contamination, especially volatile hydrocarbons. Steamcleaning is highly recommended in most cases and sometimes is the only method for decontaminating equipment that is grossly contaminated with hydrocarbons.

4. Rinse equipment by dipping in rinse solution, spraying, or pouring solution over it. Dip rinsing can introduce contaminants into solution. Spraying might not allow a thorough rinsing of the equipment, but it is a more efficient rinsing method because less rinse solution is used. Appropriate rinsing solutions are specified in the project sampling and analysis plan. Some typical solutions are indicated in the equipment section of this SOG.

    Methanol (used to remove organic compounds)

    Dilute acids (used to remove metals and other cations)

    Tap water

    Deionized/distilled water.

5. Rinse the sampler with generous amounts of deionized water. Pouring water over the sampler is best, although spraying or using a squirt bottle to apply rinse water might be adequate if you are trying to minimize waste.

6. Prepare rinsate blanks. To ensure proper decontamination, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to decontaminate equipment, if appropriate.

    [Note: The heading for this section indicates procedures to remove contamination.]

To prepare a rinsate blank, pour millipore analyte-free water through or over the into the sampler. Collect the rinsate water in a clean bottle. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.

7. Wipe sampling equipment with a paper towel or allow it to air dry.

8. Place samplers in clean plastic bags or sealed containers, or wrap them in aluminum foil for storage in an undisturbed location that is free of contamination.

A.4 Investigation-Derived Residuals

For details of handling investigation-derived residuals refer to the project sampling and analysis plan.

A.5 Special Notes

- To reduce the potential for cross-contamination, samples should be collected so that the least contaminated stations areas are sampled first. Subsequent sampling should be completed in the order of increasing contamination. Areas that typically have lower levels of contamination include those upgradient of source, background areas, and the periphery of the contaminated area.

- Prepare rinsate blanks. To ensure proper decontamination, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to decontaminate equipment, if appropriate.

- To prepare a rinsate blank, pour analyte-free water through or into the sampler. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.

- Monitoring instruments that come into contact with sampled materials must be decontaminated, along with sampling devices. They should be washed, or at least rinsed before monitoring other sampling sites.

- As determined from analysis of rinsate blanks, decontamination using soap and water is adequate in removing detectable quantities of contaminants. This type of decontamination has been compared to laboratory procedures for decontaminating sampling bottles. Using methanol as a rinse does help in cases of contamination with organic compounds.

A.6 References

U.S. Environmental Protection Agency. 1987. *Handbook: Groundwater*. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

Washington Department of Ecology. 1982. *Methods for Obtaining Waste Samples*. Ch. 173-303 WAC. Washington State Department of Ecology, Olympia, Washington.

Standard Operating Guideline
Surface and Shallow Soil Sampling

A.1 Introduction

This guideline describes the equipment and procedures that are used by Kennedy/Jenks Consultants personnel for collecting surface and shallow soil samples, like those of drill cuttings or collected from a soil core.

A.2 Equipment

- Stainless steel or plastic scoops
- Six-inch long stainless steel or brass liners and sealing materials (plastic end caps, Teflon seals, silicon tape, zip-lock plastic bags)
- Shovel
- Photoionization Detector (PID)
- Measuring tape or measuring wheel
- Stakes or spray paint for sampling grid
- Sampler cleaning equipment
    - Steamcleaner (if available)
    - Generator (if available)
    - Stiff-bristle brushes
    - Buckets
    - High priority phosphate-free liquid soap, such as Liquinox
    - Deionized water
    - Potable water

- Insulated sample storage and shipping containers
- Personal protective equipment (as specified in site safety plan)

A.3 Typical Procedure

1. Obtain applicable drilling and well construction permits, prior to mobilization, if necessary.

2. Clear locations for underground utilities and structures by Underground Service Alert (USA) and subcontractors, if necessary.

3. Measure and mark sampling locations prior to initiation of the sampling program, as specified in the sampling and analysis plan. If sampling locations are based on a grid pattern, stakes can be used to define the grid layout.

4. Collect soil samples for chemical analysis by using precleaned scoops or a hand auger, or by driving a split-spoon drive sampler.

5. If overlying soil is to be removed (as specified in the sampling and analysis plan), use shovels, picks, or post-hole diggers, as needed.

6. Collect soil samples for lithologic logging purposes.

7. If applicable, as described in the site safety plan, use an PID to analyze *in situ* air samples from the breathing zone and other locations as necessary.

8. Have the soils classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D 2488-90) and the Munsell Color Classification (refer to SOG 21).

9. Prior to each sampling event, wash sampling equipment (scoops, hand auger, split-spoon drive sampler, and brass liners) with high purity phosphate-free soap. Double-rinse it with deionized water and methanol, and/or 0.1N nitric acid, as appropriate.

10. At each sampling interval, collect soil and place it in the appropriate sampling container. Fill the sample container and compact the soil to minimize air space. Minimize handling of the soil, especially if it is being collected for analysis of volatile compounds.

11. Cover the ends of this sample in Teflon sheets, seal it with plastic caps, and wrap it with silicon or Teflon tape. Place a completed sample label on the brass liner.

12. Place the selected samples in appropriate containers and store them at approximately 4 °C.

13. As a field screening procedure (if applicable), for each sampling interval, place soil not selected for chemical analysis in an airtight container (e.g., plastic bag or jar) and allow it to equilibrate. After this, monitor the headspace in the container using a PID. Record the headspace concentration in the field notes.

14. Complete chain-of-custody forms in the field and transport the selected samples in insulated containers, at an internal temperature of approximately 4°C, to the analytical laboratory (refer to SOGs 3).

A.4 Equipment Cleaning

Prior to collection of each soil sample, the sampling equipment should be either steamcleaned or hand washed. If the sampling equipment is hand washed, wash excavation equipment with a brush, in a solution of high purity phosphate-free soap and potable water. Rinse the equipment with potable water and methanol, and/or 0.1N nitric acid, as appropriate. Follow this with double-rinsing using distilled water (refer to SOG 11).

A.5 Investigation-Derived Residuals

If sufficient volumes of soil cuttings and other residuals are generated, contain the material in appropriately labeled containers for disposition by the client. All soil samples transported to the laboratory must be returned to the client for disposition if required by the laboratory. Kennedy/Jenks Consultants is available to assist the client with options for disposition of residuals.

Standard Operating Guideline
Well Construction and Development

A.1 Introduction

This guideline describes procedures used by Kennedy/Jenks Consultants personnel for well construction and development following completion of boring and soil sampling procedures (described in Standard Operating Guideline, Boring and Subsurface Soil Sampling).

A.2 Well Construction Materials

- 8-inch Schedule 80 PVC blank casing
- 8-inch stainless steel louvered well screen, of appropriate slot size
- 8-inch Schedule 80 PVC threaded end caps
- Stainless steel or PVC well centralizers, placed at top and bottom of well screen, and every 40 feet above well screen
- Hasp-locking standpipe
- Locking expansion plugs
- Combination or key lock
- Filter pack sand
- Type I or II Portland cement
- Concrete
- Bentonite powder
- 0.25-inch bentonite pellets or chips.

A.3 Well Development Equipment

- 8-inch-diameter vented surge block
- Submersible pump (4-inch-diameter wells or larger)
- Air compressor capable of lifting water from total depth to the surface at expected recharge rate.
- Double swab airlift or other appropriate device
- 55-gallon DOT-approved drums or temporary on-site mobile storage tank
- Appropriately sized steel or PVC bailer, sand pump, bladder pump, or other device for 8-inch well casing.

A.4 Typical Procedure

1. Following completion of selected borings, install the monitoring well casing through the center of the hollow stem auger, drive casing, or open boring. The monitoring well consists of slotted well casing of appropriate diameter and a blank casing with a threaded bottom cap and a slip or threaded top cap or watertight expansion plug. The casing string must be held in tension during initial installation.

2. Place clean, well graded sand around the slotted section of the monitoring well to serve as the filter pack. The grade of sand is chosen on the basis of aquifer units encountered. The filter pack is emplaced as the auger or temporary casing is removed from the boring.

3. Ensure that filter pack sand for the well extends to approximately 2-3 feet above the top of the screened interval.

4. If required in the well construction permit, notify the appropriate inspector prior to placing the well seal.

5. Place a 2- to 3-foot thick bentonite chip or pellet seal above the sand pack, as the casing is removed from the boring. If the seal is placed above the water table, the bentonite pellets must be hydrated with potable water prior to placement of the annular seal.

6. Fill the remainder of the annulus between the well casing and the borehole wall with cement/bentonite grout (no more than 5 percent bentonite) to a depth of approximately 1 foot below ground surface. If the water level is higher than the seal, use a tremie pipe to place the grout.

7. Install either a threaded cap or a locking watertight expansion plug on the well. Place a steel hasp-locking well housing over the top of the well and cement it into the annulus of the boring.

8. Place a traffic-rated precast concrete or steel well enclosure approximately 1 to 2 inches above grade, and cement it into place with concrete. Have a concrete apron constructed around the well housing enclosure to facilitate runoff.

9. For aboveground completion, ensure that the well casing extends approximately 3 feet above ground surface. An 8-inch diameter hasp-locking steel well housing surrounds the well casing. Traffic bollards can be installed around the well housing as necessary.

10. Repeat Steps 1 through 9 for all wells at site.

11. Following the curing of the grout (approximately 24 hours), each well is developed. Prior to development activities, measure the depth in each well to static water level and total casing depth.

12. First, bail accumulated sediments from the well.

13. When the well casing is clear to the bottom, use a close-fitting surge block to swab the casing at least 15 minutes.

14. Resume bailing and continue alternating bailing and swabbing until the majority of debris that can be removed by bailing is removed (target is less than 1 teaspoon sediment collected for each bailer prior to airlift).

15. An air-isolation tool will then be used to remove water from the well via air displacement. The air-isolation tool will be fitted with rubber diaphragms that focus the water removal from 5-foot sections of the well screen. Well development with the air-isolation tool will continue until the discharged water is visually absent of sediments. Water then will be removed from the well using a submersible pump until turbidity, temperature, pH, and conductivity field parameters have stabilized. If the parameters do not stabilize within what the field geologist or technician considers a reasonable amount of time, the field geologist or technician will contact senior technical personnel for guidance. The final maximum turbidity will be 5 nephelometric turbidity units (ntu).

16. During development of each well, ensure that field parameters and observations are recorded on a Kennedy/Jenks Consultants purge and sample form (attached). Information to be recorded includes, but is not limited to, the following items:

    Depth to water

    Development time and volume

    Development (flow) rate

    pH, temperature, specific conductivity, and turbidity

    Other observations, as appropriate (e.g., color, presence of odors, or sheen)

17. Develop each monitoring well until water of relatively low turbidity is removed from the casing.

18. When development of each well is discontinued, record the following field parameters/observations:

    Depth to water

    Temperature

    pH

    Specific conductance

    Turbidity

    Color

A.5 Investigation-Derived Wastes

Place groundwater produced by well development in appropriately labeled containers for disposition by the client. Kennedy/Jenks Consultants is available to assist the client with options for disposition of groundwater.

Standard Operating Guideline
Groundwater Pumping Tests

Introduction

This guideline describes the equipment and procedures typically used by Kennedy/Jenks Consultants personnel for conducting groundwater pumping tests (or “aquifer tests”).

Aquifer pumping tests are used to evaluate the hydraulic characteristics of water-bearing zones in natural formations. Pumping tests consist of extracting groundwater from a pumping well while measuring drawdown in the pumping well and observation well(s). There are two basic pumping test techniques, steady state and non-steady state. In steady state tests pumping generally continues until drawdown stabilizes. Non-steady state tests are concluded before water level equilibrium occurs. Both test types typically employ one or more observation wells to measure drawdown response due to groundwater extraction at some distance from the pumping well.

Aquifer pumping tests rely on efficient pumping well performance and good hydraulic connectivity between the observation well(s) and the aquifer. This is best ensured by proper design, construction and development of the pumping well and observation well(s).

In general, water levels in the pumping well and observation well(s) are continuously recorded during the pumping and recovery phases. These data are then interpreted to estimate aquifer hydraulic conductivity (K), transmissivity (T), storativity (S), and other aquifer hydraulic properties.

Some aquifer pumping test analytical methods utilize only a pumping well without observation wells (e.g. Thiem Method). These tests allow assessment of hydraulic conductivity and aquifer transmissivity only.

Aquifer pumping tests may be used to evaluate both unconfined (water table) and confined aquifers.

The results of aquifer pumping tests (K, T, S, etc.) are useful in predicting production well performance, aquifer storage, sustained yield, groundwater flow velocity, and other information related to water resource investigations and environmental studies.

Project Planning

The Kennedy/Jenks Consultants project manager or other qualified personnel will select the appropriate test method and procedures, method of field data interpretation, and reporting requirements and will instruct field personnel in specific project requirements and procedures.

These requirements and procedures are selected on the basis of local hydrogeologic conditions, project specifications, and other factors. Typical planning requirements include staging of field equipment, health and safety considerations, site access, permitting, and other relevant factors.

Management and final disposition of discharge water is an important consideration and should be carefully planned. Required permits, if any, should be acquired during the project planning phase.

Field Equipment

Field equipment typically required for aquifer pumping tests include the following items:

- Submersible pump
- Generator and fuel or reliable indoor power supply
- Field water quality instruments
- Appropriate water sampling equipment and containers
- Steel surveyors tape with “popper” (a sounding device)
- Electric contact or acoustic water level sounder
- Totalizing flow meter with adjustable valve or flow restrictor
- Discharge tube
- Decontamination equipment (buckets, soap, and DI water)
- Personal Protective Equipment
- Data logger and pressure transducers
- Stop watch
- Log-log and semi-log graph paper
- Aquifer-test record sheets and water tight clip board/notebook
- Daily field log book
- Calculator
- Appropriately sized water tank/container.
- Lap-top computer with data transfer program

Typical Procedures

1. Initially, the equipment and well(s) will be made ready for the pumping test through performance of the following activities:

    a. Decontaminate all down-hole equipment which will come in contact with groundwater.

    b. Install pressure transducers in the pumping well and observation wells to the desired depth and secure transducer cable firmly to well head.

    c. Calibrate transducers. Set equilibrium at zero; draw-down in negative numbers.

    d. Install submersible pump in the pumping well and secure pump at the desired depth.

    e. Measure the static water level in all wells (extraction and observation wells) after equilibration of water levels. Note measurement points, they should correspond to surface elevation (survey) data.

    f. Input setup parameter into data logger and initiate collection of antecedent monitoring data.

2. A step-drawdown test will typically be performed after well development is complete and before the constant rate discharge test. The step-drawdown test should only be performed after water levels return to static conditions following development. The drawdown and pumping rate observations made in the step-drawdown test are used to estimate the optimum pumping rate for the constant rate discharge test.

   The step-drawdown test will be performed by pumping the extraction well at 3 to 5 different discharge rates and monitoring the resulting drawdown. The test begins at a low flow rate and the flow rate of each sequential step is greater than the preceding step. Pumping is not stopped during the test. Each step’s duration should be sufficient to observe a steady rate of drawdown, and typically last from approximately 30 minutes to one hour in duration.

   At the beginning of each step the water level typically drops steeply for a brief period, then stabilizes to some constant rate of drop. Analyze the pumping rate and the drawdown rate to pick an optimum pumping rate that will depress the water level sufficiently to stress the aquifer without dewatering the well over the expected time duration of the constant rate discharge test. Using this information, a distance-drawdown graph can be constructed and the optimum flow rate for the constant rate discharge test can be estimated.

3. Ideally, wait approximately 24 hours after the step-test is performed for the wells to equilibrate before starting the constant-rate discharge test. If time and budget constraints do not allow this waiting period, the test can be initiated immediately following the step test, but interpreting the draw-down data will be more difficult. The flow rate used during the constant rate test will be based on the results of the step-drawdown test. The following activities will be performed prior to and during performance of the constant-rate drawdown test.

    a. Prior to discharge, the water levels of selected observation wells will be measured to identify static water level conditions.

    b. Prior to the test, the drop pipe should be primed with water to ensure the discharge test begins with the pump operating against the correct head. Read the water level in the pumping well, run the pump long enough to observe some water discharge, stop the pump. Observe the water level and begin the discharge test when the water level returns to the pre-priming level. As long as the pump has a check valve (and it should), then the drop pipe would be primed during the step-drawdown test and a separate priming event is not necessary.

    c. Program and initialize all of the pressure transducers prior to the test. Make sure each works properly. One way to test is to have the instrument read a water level, raise the cable one foot, have the instrument read the water level again and verify that the new water level is one foot “lower” than the previous water level.

   d. Rather than try to start the pump and the transducers at the same instant, have the transducers begin reading for a few seconds before starting the pump. The data from the pumping well will thus show a baseline water level and a sharp change when pumping begins.

   e. At the start of the discharge tests, water levels will be continuously recorded using pressure transducers and data loggers or by manual measurement. The frequency of measurements using data loggers will be variable throughout the test. Data will be collected electronically at one second intervals during the first few minutes of the test to once every one-half hour during the later stages of the test. Some data loggers can be programmed to acquire data on a logarithmic time basis.

   f. The discharge rate will be held constant to the extent possible, and will be calibrated every one-half hour after the start of the test. A totalizing flow meter with a ball valve will be used to regulate the flow rate. The pre-adjusted flow rate and the total discharge will also be recorded every one-half hour. If the flow allows, check the flow rate at the discharge end with a graduated bucket. Head losses in the system downstream of the flow meter can lead to erroneous meter readings.

   g. -During the course of the pumping test drawdown, measurements will be graphically plotted on log-log graph paper to identify potential anomalies in the drawdown curve. Plotting data will enable the supervising hydrogeologist to identify when the data objectives have been met, at which time the discharge test will be stopped.

4. At the termination of the drawdown test, the data loggers' sampling time base is reset and the pump is shut off. Recovery monitoring will continue for approximately 24 hours or until water levels have recharged to within 90 percent of the static levels.

Additional Field Activities

In addition to the above mentioned items, the following field activities will be performed in support of the pumping tests:

1. Prior to and during the pumping test, meteorological data, including temperature, hourly rainfall and barometric pressure will be collected.

2. Effluent groundwater will be discharged to holding tanks or receiving water located outside the area of influence.

3. If needed, samples of the effluent will be collected at regularly spaced intervals for possible chemical analysis.

Data Evaluation Techniques

The data evaluation procedures used will be dependent on the specific data needs of each test. Conditions such as partially penetrating wells, leaky confined aquifers, unconfined aquifers, and non-leaky confined aquifers will influence the technique(s) used to evaluate the pumping test response data. When possible, software programs that facilitate evaluation of data will be used. This may include, but will not be limited to, such software packages as AQTESOLV, which is distributed through Geraghty & Miller Modeling Group.

References

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Appendix F: District Laboratory Quality Assurance Plan

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SOUTH TAHOE PUBLIC UTILITY DISTRICT
LABORATORY QUALITY ASSURANCE PROGRAM

by

Terry Powers
Laboratory Director

Revised: April 5, 2017

Approved by: Terry Powers, Laboratory Director

Signature: ______________________________

Approval Date: April 11, 2017

PREFACE

The Quality Assurance Program of the South Tahoe Public Utility District (STPUD) is a major part of the daily laboratory routine. Quality assurance is incorporated in sampling procedures, analysis preparation, analysis, maintenance of laboratory equipment and supplies, as well as the reporting of analytical results.

The STPUD Laboratory quality assurance program will never be completely written. Like the Winchester House, it will always have additions, new procedures for better assuring the quality of our data. The STPUD Laboratory is trying its best to circumvent Werner Heisenberg's Uncertainty Principle: that matter is not susceptible to objective measurement. We believe that by continually enhancing our QA program that we can reduce that uncertainty.

The following pages outline the quality assurance program currently practiced by the STPUD Laboratory.

TABLE OF CONTENTS

I. LABORATORY ORGANIZATION and RESPONSIBILITIES

1. The South Tahoe Public Utility District (STPUD) laboratory is responsible for analyzing and reporting chemical, physical and microbiological results on drinking water, wastewater, surface waters (streams, lakes and reservoirs), groundwaters, and soils. The samples are taken for compliance and process control purposes. Samples from small public water systems and private individuals are also analyzed for a fee. The laboratory is certified by the California Environmental Laboratory Accreditation Program (ELAP), certification # 1569.

2. A list of analyses and methods used in the laboratory is included in Chapter VII.

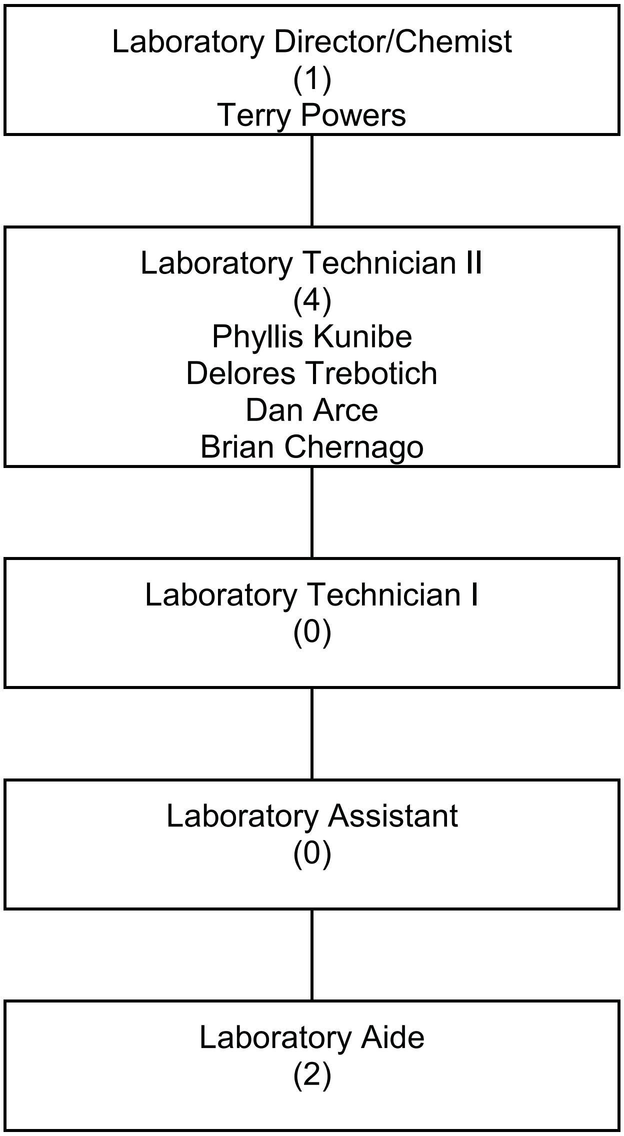
3. The following is a brief description of the staff support for the South Tahoe Public Utility District Laboratory:

   A. Director - Plans, organizes and controls laboratory operations. Coordinates laboratory interactions with other programs in the Health Department. Administers laboratory budget, billing and purchasing. Develops laboratory policy and procedures and supervises staff.

   B. Laboratory Technician I and II – Performs physical inorganic chemical analysis, both manual and instrumental, performs sampling, maintains quality assurance, reports results and maintains records.

   C. Laboratory Aide – Cleans, maintains and prepares laboratory for sampling and analysis.

SOUTH TAHOE PUBLIC UTILITY DISTRICT



II. QUALITY ASSURANCE OBJECTIVES FOR THE MEASUREMENT OF DATA

The quality assurance objectives for measurement of data are unique to the particular program for which the data are collected and utilized. They describe the overall uncertainty that the data user is willing to accept in order to make decisions for environmental or other concerns. This uncertainty describes the data quality that is needed, which are usually expressed in terms of precision, bias, representativeness, comparability, and completeness. Prior to starting, the project should define the data quality objectives and how they will be attained in order for all laboratory and field personnel involved to make informed decisions during the course of the project.

The STPUD laboratory uses approved and recognized test methods, and complies with their QC requirements. Quality control samples are measured and precision and accuracy are assessed, and need to be within the method prescribed limits. Internal acceptance criteria are established by analyzing laboratory control samples on a routine basis. The STPUD laboratory can attest to the quality of the measured data being provided to the client. If its personnel conduct the sampling, the STPUD laboratory will also be able to attest to the integrity of the sampling process.

III. SAMPLING PROTOCOLS

1. Bacteriological Samples

   A. Sample bottles are to be made of polypropylene. Use 125-250 mL bottles with threaded caps. Bottles should have 4 drops of 10% sodium thiosulfate added prior to autoclaving. All bottles should have sterile indicating tape on the caps. Bottles should be autoclaved for at least 30 minutes. The caps should be tightened as soon as bottles are cooled to room temperature. No bottle should be used which does not have black stripes appearing on the sterile indicating tape, nor which has caps loosely threaded.

      1) Alternatively, commercially sterilized plastic bacteriological sample bottles can be used. These must:

         1. Contain sodium thiosulfate for neutralizing chlorinated waters.
         2. Have a secure seal indicating sterility.
         3. Be constructed of clear plastic so it can be used as the culture flask for the Colilert method of Coliform analysis.
         4. Be clearly marked at the 100 mL volume.

   B. At the sample site, turn water on and allow to flush, at a rate of 1 gpm, for at least three minutes. When sampling from dedicated sampling stations, allow to flush for at least 30 seconds before obtaining sample. Make certain sample faucet is not leaking nor dripping from threads or valve handle.

   C. Obtain temperature and Free Cl_2 residual.

   D. Obtain coliform sample. **DO NOT TOUCH INSIDE OF BACTERIAL SAMPLE BOTTLE NOR INSIDE OF CAP.** If sample bottle cap is loose, use another bottle. Make certain sterile bottle cap is facing with threads toward ground when un-capped. Do not pre-rinse bottle but fill to just-below neck as soon as possible (Fill Colilert bottles to the 100 mL line.).

   E. Secure bottle cap and shake to mix sample with dechlorinating agent (sodium thiosulfate).

   F. Record sample time, water temperature, and Cl_2 residual on sample monitor sheet. Include on the sample field sheet and in Labworks LIMS each sample's type: routine, repeat, replacement, process control, or customer complaint.

   G. Place bacteriological sample bottle in ice chest. Transport samples to lab within 6 hours of collection.

2. Physical and Chemical Samples

A. When sampling drinking water wells make certain chlorine feed is turned off prior to collection of samples or that the sample site is upstream of the chlorine feed . The possibility of backflow of chlorine into sample taps located upstream of the chlorine feed is a distinct possibility.

B. Perform the following tests at the time of sample collection (if tests are required):

1) Temperature
2) Cl_2 residual, Total
3) EC (can also be done in the Lab)
4) Dissolved Oxygen
5) pH

C. All sample bottles, except for Oil & Grease, should be pre-rinsed with sample before taking aliquot. Bottles should be obtained from the Laboratory where they are properly prepared (see page 3).

D. All samples should be preserved on site according to the tests to be performed. A Lab ID# subscript should be assigned as described in Table 3.

1. **TABLE 3**

Sample Type	Preservative	Laboratory ID# Subscript
Physical	6 °C	a
Mineral	6 °C	a
Nutrients, next day analysis	6 °C	a
Nutrients, 28 day holding time	H_2SO_4, 6 °C	c
Metals	HNO_3	e
Radionucliides	HNO_3, 5 mL/L	e
Organics, TPH_{-D}, Pesticides, Herbicides,	6 °C	d
Volatile organics, BTEX, TPH_{-G}	6 °C, VOA vials	g
THM	6 °C, Ascorbic acid, VOA vials	g
Radon	6 °C, VOA vials	g
TOC	H_2SO_4, 6 °C	c
CN	pH ≥12, NaOH	h

3. <u>Radionuclides</u>

   A. Uranium and Gross Alpha

      1) Obtain sample in a plastic 2l liter plastic bottle.

   B. Radon

      1) Use 2 VOA vials for Radon. This sample needs to be sent to the analytical laboratory within 24 hours.

      2) Fill bucket with sample using a hose. The discharging end of the hose should be placed in the bottom of the bucket. When filled, remove hose, tap bucket to remove air bubbles and allow sediment to settle for 2-3 minutes.

      3) Place radon vials in top third of sample and fill. Cap vials while they are immersed in the sample. Check for air bubbles and repeat filling if necessary.

      4) Record exact time for filling the vials.

4. <u>VOC's and Trihalomethanes (THM)</u>

   A. To prepare for sampling obtain the following:
      1) VOA vials with HCl and/or ascorbic acid provided by commercial lab performing analyses
      2) Ice chest with blue ice
      3) Travel Blank, provided by commercial lab. If one is not available, prepare one by boiling deionized water for ten (10) minutes, cool and pour into a THM vial provided by commercial lab.
      4) Field Sheet and pen
      5) HACH Chlorine test kit, for Free Cl_2
      6) Thermometer
      7) Beaker

   B. <u>THM sampling procedures:</u>

      1) If there is no Cl_2 residual, do not sample at this site. Choose another site in the area that does have a Cl_2 residual.

      2) At the time of sampling, the following tests should be performed:

         1. Temperature
         2. Cl_2 residual, Free

      3) Use VOA vials provided by laboratory performing the analyses. These must be borosilicate glass vials of at least 40 mL capacity with screw caps (Pierce #13075 or equivalent). The screw caps shall have a Teflon-faced silicon septum (Pierce #12722 or equivalent). HCl, as a preservative must be added to the vial prior to sample collection. If Cl_2 is present, ascorbic acid for dechlorinating can be added to the vial after it is partially filled with sample.

      4) Allow the sample tap to flow freely until the temperature is stable.

Adjust the flow to about 500 mL/minute (½ quart/minute). Fill and seal the VOA vials as follows:

5) Slowly fill each vial ¾ full with sample. If Cl_2 is present, ascorbic acid for dechlorinating can be added now.

6) Screw on vial cap and invert 3-4 times to mix sample with preservative (and dechlorinating agent if Cl_2 is present).

7) Remove cap and continue to fill to overflowing, allowing the sample within the vial to form an inverted meniscus.

8) Set the container on a level surface (or hold level) and carefully screw on cap, making certain the septum's Teflon side is facing the sample. Avoid entrapping air (filling an upside-down cap with sample before screwing on cap aids in keeping air bubbles out of the vial). Make certain cap is screwed on tight.

9) **<u>NO BUBBLES SHOULD BE IN VIAL AFTER COLLECTING SAMPLE.</u>**

    1. To ensure the sample has been properly sealed, invert and gently tap the lid on a solid surface. The absence of entrapped air bubbles indicates a properly obtained sample. If air bubbles are present, open the bottle, fill again to overflowing and reseal lid in the same manner as stated above.

10) Place sample in ice chest for transport to laboratory. The sample must remain tightly sealed and maintained at 4 ^{o}C until it is analyzed.

11) **<u>EACH SAMPLE MUST BE TAKEN IN TRIPLICATE</u>**. This is done to provide backup samples in case of breakage during shipment and for confirmation analyses if VOC's are detected.

12) Ship by next-day air. Care should be taken to not ship on Fridays, since the sample will not arrive till the following Monday. The sample may warm to above 5 • C if the blue-ice melts. If the sample needs a 24-hour turn-around time, make arrangements with the laboratory to receive the sample on Saturday.

C. Volatile Organic Chemicals (VOC's, TPH$_{\text{-Gas}}$ and BTEX sampling procedures:

1) At the time of sampling, the following tests should be performed:

    1. Temperature
    2. Cl_2 residual, Free
    3. pH and EC if sampling for BTEX / TPH$_{\text{-Gas}}$

2) Use VOA vials provided by laboratory performing the analyses. These must be borosilicate glass vials of at least 40 mL capacity with screw caps (Pierce #13075 or equivalent). The screw caps shall have a Teflon-faced silicon septum (Pierce #12722 or equivalent). HCl, as a preservative must be added to the vial prior to sample collection. If Cl_2 is present, ascorbic acid for dechlorinating can be added to the vial after it is partially filled with sample.

3) Allow the sample tap to flow freely until the temperature is stable. Adjust the flow to about 500 mL/minute (½ quart/minute). Fill and seal the VOA vials as follows:

4) Slowly fill each vial ¾ full with sample. If Cl_2 is present, ascorbic acid for dechlorinating can be added now.

5) Screw on vial cap and invert 3-4 times to mix sample with preservative (and dechlorinating agent if Cl_2 is present).

6) Remove cap and continue to fill to overflowing, allowing the sample within the vial to form an inverted meniscus.

7) Set the container on a level surface (or hold level) and carefully screw on cap, making certain the septum's Teflon side is facing the sample. Avoid entrapping air (filling an upside-down cap with sample aids in keeping air bubbles out of the vial). Make certain cap is screwed on tight.

8) **NO BUBBLES SHOULD BE IN VIAL AFTER COLLECTING SAMPLE.**.

    1. To ensure the sample has been properly sealed, invert and gently tap the lid on a solid surface. The absence of entrapped air bubbles indicates a properly obtained sample. If air bubbles are present, open the bottle, fill again to overflowing and reseal lid in the same manner as stated above.

9) Place sample in ice chest for transport to laboratory. The sample must remain tightly sealed and maintained at 4 ^{o}C until it is analyzed.

10) **EACH SAMPLE MUST BE TAKEN IN TRIPLICATE**. This is done to provide backup samples in case of breakage during shipment and for confirmation analyses if VOC’s are detected.

11) Ship by next-day air. Care should be taken to not ship on Fridays, since the sample will not arrive till the following Monday. The sample may warm to above 5 • C if the blue-ice melts. If the sample needs a 24-hour turn-around time, make arrangements with the laboratory to receive the sample on Saturday.

5. Non-Purgeable Organic Chemicals (all organic chemicals that are not VOC's)

A. For Non-Purgeable Organic Chemicals (i.e., Base/Neutral and Acid Extractables, Organochlorine Pesticides and PCB's, etc.) use one (1) liter amber glass containers with caps threaded to screw onto the container. Caps shall be lined with Teflon. Foil may be substituted for Teflon if the water sample is not corrosive.

B. Allow the sample tap to flow freely until the temperature is stable. Adjust the flow to about 500 mL/minute and collect sample in a one (1) liter amber glass bottle (Section 5). Fill bottle so that head space is no greater than the threaded portion of the neck. Cap bottle with lined Teflon cap. Sample must be refrigerated at 4^{o} C from the time of collection until analysis.

IV. SAMPLE CHAIN OF CUSTODY

4. All samples obtained by the South Tahoe Public Utility District (STPUD) for in-house analysis are analyzed using methods approved for the STPUD by the California Environmental Laboratory Accreditation Program (ELAP). These methods are found in the Federal Register's approved procedures and include Standard Methods for the Examination of Water and Wastewater; and EPA's Methods for the Determination of Inorganic Substances in Environmental Samples, 1993 edition.

5. **PLANT SAMPLES** Samples obtained at the STPUD wastewater treatment plant are obtained both automatically and manually.

   A. Automatic Composite Samplers Samples obtained by automatic composite samplers are treated as follows:

      1) Sample bottles are prepared by laboratory personnel. The bottles are rinsed with both tap and deionized water daily. The bottles are detergent washed and HCl rinsed weekly.

      2) Sample bottles are placed in the automatic sampler refrigerator by STPUD personnel. The starting date and time of the sample period is recorded on a composite sample log sheet located at the sampler.

      3) Filled sample bottles are picked up the following day by STPUD personnel. The date and time of the end of the sample period is recorded on the composite sample log sheet, as well as the time the sample was picked up. The sample refrigerator temperature, in degrees Celsius, is also recorded.

      4) The technician who picks up the sample records his initials on the composite sample log sheet. The technician who picks up the filled sample bottle installs a cleaned bottle for the next sample period. A copy of the composite sample log sheet is attached.

      5) The filled sample bottles are brought to the laboratory and most analyses done on the same day.

      6) On delivery to Laboratory, all samples will be entered into the Laboratory Information Management System (LIMS) and assigned a STPUD Lab ID# in the following format: AANNNNN (i.e. AG50199). The LIMS is currently *Labworks*, by Labworks, Inc.

6. This Lab ID# is to be placed on the sample monitor sheet, any worksheets, and in the Labworks LIMS.

   A. Manual Composite Samples This is to be done only when flow-proportioned automatic sampler is not operating. Samples obtained manually are treated as follows.

      1) Sample bottles are prepared by laboratory personnel. The bottles are rinsed with both tap and deionized water daily. The bottles are detergent washed and HCl rinsed weekly. Refer to Section I.

      2) Samples are obtained in plastic bottles using a plastic dipper. The dipper is rinsed with sample, as is the sample bottle before obtaining sample.

      3) 24-hour composite samples are obtained in a 250 mL plastic bottle. Samples are collected in 2-hour intervals. The sampler records his initials on the manual composite sample log sheet at each hour he obtains a sample. The individual composite samples are stored in a 6 ^{o}C refrigerator until completion of the sample period. This refrigerator is adjacent to the laboratory.

      4) The flows are recorded for each sample hour on the manual composite sample log sheet. Calculations are made for the amount of sample to be used for each sample bottle proportionate to the flow at that hour. 2000 mL of composited sample is prepared. The technician who performs the compositing records his/her initials on the manual composite sample log sheet. A copy of this form is attached. Completed log sheets are filed and stored for a minimum of 5 years.

      5) Analyses are performed on composited sample the same day. The sample is referred to on all worksheets by its name and ID#.

   B. Manual Grab Samples Samples collected manually and analyzed individually, Grab samples, are treated as follows.

      1) Bottles are prepared according to recommended procedures found in Standard Methods for the Examination of Water and Wastewater. The preparation of the bottle is test dependent. Refer to Section I.

      2) The sample is collected by STPUD Laboratory personnel and returned to the Laboratory.

      3) If the sample is to be analyzed for routine tests such as pH or Cl_2 the sample is referred to on the test data sheets by location, and sample ID#.

      4) Bacterial samples are given a sample ID# and are identified on the Coliform worksheet by site, date and time collected, type (whether routine, repeat or replacement), sample ID#, and sampler.

7. Off Plant Samples

   A. Samples obtained off-plant can be any of the following:

      1) Indian Creek and Harvey Place Reservoirs

2) Alpine Groundwaters (GW-NN)
3) Alpine Surface waters (SW-NN)
4) Alpine Soils (SN)
5) Alpine monitoring wells (ACMW-NN)
6) Emergency Pond monitoring wells (MW-NN)
7) Heavenly Valley Creek HVC-N)
8) Sewage spills and possibly contaminated surface waters
9) Drinking Water system
10) Underground storage tank remediation systems' effluents and soils
11) Suspected sewage and water line leaks

B. All non-plant samples are treated as described below:

1) Bottles are prepared according to recommended procedures found in Standard Methods for the Examination of Water and Wastewater. The preparation of the bottle is test dependent. Refer to Section I.

2) The sample is collected by STPUD Laboratory personnel. A field worksheet is filled out at the site of sample collection. Items that must be tested for immediately, such as pH, Cl_2, temperature, and DO, are done so at the time of collection. This data is recorded on the field worksheet.

3) The location, date and time of sample collection, depth (if applicable) and type of preservative are also recorded at sample site. The sampler's initials are also recorded as well as any comments or observations.

4) All samples and sub-samples are preserved on site, except from Alpine County groundwater (ranch) sites (to prevent accidents to homeowners and school children from presence of concentrated acids). If a sample will be analyzed for several tests whose preservatives are mutually exclusive the sample is subdivided. Each sub-sample is obtained in its own specially prepared bottle and preserved using the recommendations found in *Standard Methods of Water and Wastewater Analyses*. All sub-samples share the same ID# except for the subscript which identifies the bottle-type and preservative used. Refer to Section III, **Table 3**. A copy of a typical field worksheet is attached.

5) Samples requiring filtration are filtered in the field. Use the portable suction pump and Nalgene filter apparatus. Special labeled bottles are to be used for each filtrate type (for TDS use Ahlstrom 161glass fiber filters or equivalent; for nutrients use Environmental Express F47045E 0.45 µm polyethersulfone membrane filters, or equivalent)

6) The sample is transported in a freezer chest and returned to the laboratory as soon as possible. The samples are entered into the Laboratory's LIMS, given ID #, and the sub-samples recorded.

7) The samples are then stored in a refrigerator kept at 4 ˚C, if applicable.

8) All non-plant samples are referred to by station #, or site description, and sample ID#. The subscript is also listed for each test performed. This is done by both STPUD laboratory personnel and outside commercial laboratories.

8. <u>Commercial Laboratories</u> Any samples that are to be sent to an outside laboratory for analysis must be given a STPUD sample identification number. The sample is labeled with the STPUD ID number. A letter describing the sample(s), preservative, if any, and test(s) requested is to accompany the sample. The form *Samples Sent To Commercial Laboratories* (found in Appendix B) can be used as an aid. The following information is to be entered in the *Sample Tracking Log*:

    1) STPUD ID numbers
    2) Sample type
    3) Laboratory sample(s) sent to
    4) Date sample(s) sent
    5) Date sample results returned to STPUD

    B. A SAMPLE CHAIN OF CUSTODY must accompany the sample(s).

    C. <u>Sample Storage</u>

    1) Water Samples

        1. All samples except soils are stored in the laboratory's sample refrigerator.

        2. Adhere to holding times specified in the most current Federal Register for Water and NPDES compliance. When storing samples enter information on *Repeat and Unfinished Analyses Sample Log* attached to sample refrigerator glass door. This information includes:

            a. Site
            b. ID#
            c. Sample date
            d. Analyses (check off required tests)

    D. Soil Samples

    1) Soils are air dried for 2-4 weeks. Prior to analysis they are ground to pass a 2 mm sieve (No 10) and homogenized.

9. <u>Sample Disposal</u>

    A. Water samples

    1) Most water samples are non-hazardous and are disposed down the sewer. These samples are usually obtained from streams, reservoirs, lakes, ranch soils, potable water wells, potable water distribution systems and storage tanks.

    2) Sludge samples are disposed of through the sludge treatment system. Unused samples are poured into the Headworks Raw sample access hatch..

    3) Any hazardous samples will be discarded though a hazardous waste facility.

B. Soils

1) Soils are kept for one year after analysis in case repeat analyses are required.

2) Unused soils are disposed by using them to fill the bore hole (of the same sample location) for new samples. This is usually done in the winter months, when the ground is frozen and it is difficult to obtain loose soil to fill the bore hole. The soil samples are taken from pasture lands. Unfilled bore holes are a danger to cattle and horses.

V. SAMPLE BOTTLE PREPARATION

Bottle preparation is to be done as follows:

Type	Size	Procedure
Bac-t	125 mL	Soap H_2O wash (as needed), hot H_2O rinse, deionize H_2O rinse, add 2 squirts of sodium thiosulfate. Autoclave at 121˚C
0.45 µm Filtrates	100 glass	Hot H_2O rinse, HCl rinse, hot H_2O rinse, deionize H_2O rinse
A/E Glass Fiber Filtrate	250 mL plastic QEC 1213-B008PP	Soap H_2O wash (as needed), hot H_2O rinse, HCl rinse, hot H_2O rinse, deionize H_2O rinse
Metals	500 mL 1,000 mL	Soap water wash, hot H_2O rinse, HNO_3 rinse, hot H_2O rinse, HCl rinse, hot H_2O rinse, deionize H_2O rinse
COD, NH_3, TKN, Total P, PO_4-P	500mL 1,000 mL	Soap H_2O wash (as needed), hot H_2O rinse, HCl rinse, hot H_2O rinse, deionize H_2O rinse
SS, Cl^-, pH, EC, Alk, BOD, NO_3	2,000 mL 1 gallon	Soap H_2O wash (as needed), hot H_2O rinse, deionize H_2O rinse
Oil & Grease	1,000 mL	Freon rinse, soap H_2O wash (as needed), hot H_2O rinse, deionize H_2O rinse.
Blue-Green Algae	250 mL	Soap H_2O wash (as needed), hot H_2O rinse, deionize H_2O rinse
Wastewater Plant Samples	1,000 mL 2,000 mL 2 gallon	Hot H_2O rinse, deionize H_2O rinse. Bottles should be washed with soapy H_2O when grease or algae deposits appear. After soap washing, hot H_2O rinse, HCl rinse, hot H_2O rinse and deionize H_2O rinse.
Organics	various	Supplied by commercial laboratory performing tests. Glassware to be prepared according to EPA specifications
VOC's	40 mL	Supplied by commercial laboratory performing tests. Glassware to be prepared according to EPA specifications. HCl to be pre-added.

Iron deposits can be removed by soaking with 1:1 HCl. Fill 1/10 to 1/8 of bottle with acid and dilute to neck (or above deposit) with tap H_2O. Allow to soak for an hour or more or until deposit is dissolved. Rinse with tap water, 1 N HCl, tap water, then deionized water.

Use brushes or nylon scouring pads as necessary to remove dirt or sludge deposits (but never when acids alone are in the bottle). Make certain threads on both cap and bottle are clean.

VI. CALIBRATION and STANDARD CURVE DEVELOPMENT

1. Calibration accuracy is critically dependent on the reliability of the standards used for the required comparisons. The concentrations of the calibration standards must bracket the expected concentration of the analyte in the samples. No data is reported beyond the range of calibration of the methodology. The calibration data, when plotted graphically, is referred to as a calibration curve. The calibration must be done under the same instrumental and chemical conditions as those that will exist during the measurement process. The frequency of calibration depends on the accuracy requirements of the investigation and the stability of the instrument used for the measurements:

2. The following are the criteria that must be used when evaluating whether a standard curve is acceptable. These criteria do not mean the curve must be accepted. If standard *determined values* are unacceptable to the technician, the graph does not have to be accepted.

   A. Standard curves for analysis must be generated at least once per year. Exceptions are metals analysis, segmented flow analysis for which a calibration graph is developed for each analytical run. A new calibration graph is also required whenever a change of equipment (i.e columns, detector, etc.) occurs. Annual calibration curves are required for:

      1) UV-VIS Spectrophotometer - The calibration procedure for the UV-VIS spectrophotometer is similar to that for the A.A. spectrophotometers. An integration interval is not required as the signal is very stable. It is important to use blanks and allow at least 1/2 hour warm up time for the spectrophotometer..
         1. Total Phosphorus
         2. Ortho-Phosphate Phosphorus
         3. Nitrite, manual method

      2) pH Meters - The calibration of pH meters requires the use of at least two buffer solutions and must be temperature compensated. The two buffer solutions must cover the expected range of samples to be tested. A third buffer (pH 7.00 – Green) is used to confirm calibration. A 3-pont calibration can also be performed using newer pH meters. The pH meter should be calibrated each day or whenever the confirmation buffer is out of range. The result of the confirmation pH buffer should be 7.00 ± 0.05. The calibration for the Lab pH meter is logged on the *pH Calibration Record*. Field pH meters calibrations are logged on the *Field Meters Calibration Log*.

      3) Conductivity Meter - The conductivity meter does not require frequent calibration but should be checked against a known standard each day of use. Recalibrate when the recovery is greater than ± 5 percent of the true value of the standard. Field conductivity meters are calibrated using fresh 100 µS and 1,413 µS standards.

      4) Field meters, single or multi-component, must be calibrated each day they are used. The calibrations, including lot numbers must be recorded on the *Field Meter Calibration Log*.

      5) Ion Chromatograph- Calibration of the Ion Chromatograph is performed at least once each year and whenever: 1) Controls are out of range; or, 2) the column, suppressor or detector is changed.

B. The calibration standards used must bracket the concentrations of the samples. No samples can be reported for compliance purposes that are outside the range of the standard curve. A sample can be diluted so that the concentration of the diluted sample is within the working range of the curve.

C. Standards must bracket the detection limit for reporting (DLR) to the maximum contaminant level (MCL) range for the samples.

D. The standard curve must be constructed from a method blank and a minimum of three standards. It is good laboratory practice to use at least five (5) standards when using automated analytical equipment, or when performing analyses whose standard curves are not linear over the entire range of concentrations.

E. The standard curve must have correlation coefficient (r)•≥•0.995. This is a measure of the linearity of the curve.

    1) Standards may be deleted from the curve to achieve an r ≥ 0.995. This is to be performed only as a last resort and only under the following conditions.

        1. The standard to be removed is outside the range of sample concentrations. The deleted standard may not be one that makes up either the upper or lower limit of the range of the sample’s concentrations. For example, if the samples have analyte concentrations •≤10 mg/L and the curve is composed of 6 standards (0, 0.5, 1.0, 5.0, 10, 20, 50), the 50 mg/L, and even the 20 mg/L standard may be deleted to achieve an r•≥ 0.995. No standard between the upper and lower limits of the curve can be removed.

        2. A standard within the range of sample concentrations may be deleted only if it is a duplicate point. These are usually found in segmented curves where only two standards are used for a segment. Both points of a standard can not be deleted.

F. An analysis must be stopped if any of the check standards exceed 10%. Those samples following the last acceptable check standard need to be re-analyzed with a new standard curve. Alternately, the run may killed and the check standard analyzed. If this check standard passes, the samples following the last acceptable check standard in the initial run may be analyzed with the original curve.

G. If an analytical run is unattended, and on completion it was found that a group of samples was bracketed by two acceptable check standards but had one unacceptable check standard in the middle (i.e. Chk Std Pass - samples - Chk Std fail - samples - Chk Std pass - samples...), those samples on both sides of the failed check standard must be re-analyzed.

H. Spikes and control standards should be set at between 5 and 50 times the MDL or 1-10 times the ambient level, whichever is higher.

I. QC limits should be set at:

Analysis	Recovery of Known Additions %	Precision of Low-level Duplicates Δ %	Precision of High-level Duplicates Δ %
Nutrients	80-120	25	10
Anions	80-120	25	10
Metals	80-120	25	10
Other Inorganics	80-120	25	10

1) Additions calculated as % of the known addition recovered, duplicates calculated as the difference as a percentage of the mean [100*(x_1-x_2)/•].

2) Low-level refers to concentrations less than 20 times the MDL. High-level refers to concentrations greater than 20 times the MDL.

VII. ANALYTICAL METHODS - October 11, 2017

The following methods are employed for all reported analyses. Exceptions will be stated where a different procedure was used.

Test	Methods
Alkalinity	SM-2320 B - 1997
Ammonia-Nitrogen	EPA 350.1 (Automated Phenate)
BOD	SM-5210 B - 2001
Bromide	EPA 300
Calcium	SM-3500 Ca-B - 1997; 3500 SM-3111 B - 1999
Chloride	EPA 300
Chlorine	SM-4500Cl-D - 2000
Conductivity	SM-2510 B - 1997
Coliform / E. coli	SM-9223 B - 2006
Color	SM-2120 B - 2001
Hardness	SM-2340 B - 1997
Heterotrophic Plate Count	Simplate
Metals, Flame	SM-3111 B-1999
Metals, Furnace	SM-3113 B-2004
Nitrate-Nitrogen	EPA 300; SM-4500-NO3 F
Nitrite-Nitrogen	EPA300; SM-4500 NO2 B - 2000; SM-4500 NO3 F – 2000
Odor	SM-2150 B -1997
Oxygen	SM-4500 O G - 2001
pH, water	SM-4500 H+ - 2000
Phosphate, ortho	EPA 300; SM-4500 P-E - 1999
Phosphorous, total	SM-4500 P-E; SM-4500 P-F-1999
Sulfate	EPA 300
Sulfides	SM-4500-S^{2-} D
Suspended Solids	SM-2540 D-1997
Total Dissolved Solids	SM-2540 C-1997
Total Kjeldahl Nitrogen	EPA 351.2
Total Nitrogen	USGS - Water-Resources Investigations Report 03–4174, Lahontan RWQCB approved for water: R6T-2004-0010A3
Turbidity	EPA 180.1 (Rev 2.0 (1993)
CEC	UC Davis Handbook, method S-19.0
pH, soil	UC Davis Handbook, method S-3.0
Saturated Soil Paste	UC Davis Handbook, method S-1.0
Soil Saturation %	UC Davis Handbook, method S-2.0
Saturation Extract	UC Davis Handbook, method S-5.0
Soil Conductivity	UC Davis Handbook, method S-6.0
Soil Nitrate-Nitrogen	STPUD Extraction Method / EPA 300
Soil Total Nitrogen	UC Davis Handbook, method S-30.0
Extractable Phosphorus	STPUD/Davis: Ascorbic acid detection

EPA = *Methods for the Determination of Inorganic Substances in Environmental Samples, 1993 edition*
SM = *Standard Methods of Water and Wastewater Analyses*
Methods of Soil Analysis, American Society of Agronomy, 1965

UC Davis Handbook = *Water, Soil and Plant Tissues, Tentative Methods of Analysis for Diagnostic Purposes*, by J. Quick, University of California, Davis, Agricultural Extension Laboratories.

VIII. ACQUISITION, REDUCTION, VALIDATION and REPORTING OF DATA

1. The analyst is responsible for describing and reporting the data in an appropriate manner. In order to insure the accurate transcription, calculation and reporting of analytical data, the analyst will adhere to the following quality assurance procedures.

    A. All measurements are made so that results are representative of the matrix (soil, water, etc.) and conditions being measured.

    B. Report data only to the number of significant figures consistent with their limits of uncertainty.

    C. Report data with the proper units of concentration. Units should be chosen which clearly indicate whether the concentration is in terms of weight by weight, weight by volume or volume by volume. Unless otherwise specified, all data are calculated and reported in standard units to allow comparison with data reported by other laboratories.

    D. The analytical methodology used will be cited. The raw data for each sample, along with reagent blanks, control, and spiked samples will be suitably identified if included in the report.

    E. The analytical worksheet or instrument report should include sample site, sample ID#, date of sampling (for worksheets only), name of the analyst, date of analysis, and the result.

    F. All results will be reviewed by Laboratory Director before a final report is released.

    G. Laboratory records will be retained in a permanent file for at least five years. This may be either the original record and a Laserfiche copy.

    H. Samples shall be retained until analytical results are verified.

2. <u>Analyst Review</u>

    A. The analyst will check the data for compliance with established control limits, that results were within the range of the standard curve, method blank quality, current trends and both state and federal requirements. Samples will be subjected to repeat analysis (with dilution if necessary) if any of the above items are not met.

    B. If a test is repeated because the initial result fell outside the current trend or exceeded the state or federal requirement but was within control limits, the original result will be reported. The second result will be used for confirmation, only.

    C. If the test was repeated because the QCS were outside the control limits, only repeat analytical results whose QCS were within control limits will be reported.

    D. Analysts will record results on summary forms. All worksheets will then be reviewed and corrected by lab personnel. All manual calculations will be repeated by the reviewer. The recorded results will be checked for proper accuracy and transcription mistakes. Once data has been reviewed, the worksheets will be signed and dated by the reviewer in red ink. Validated results on the summary sheets will be marked with a red dot in the upper right-hand corner of the entry box. A red dot signifies that the data is ready for reporting and entry into the LIMS.

1) After the data has been entered into the LLIMS a printout will be generated. The data on the red-dotted summaries will be cross-checked against the printout. All errors on the printout will be corrected in the LIMS.

3. Supervisor Review

A. All analytical results will be reviewed by the Laboratory Director before dissemination to outside agencies. The data will be checked for compliance with established control limits; that results were within the range of the standard curve; method blank quality; fit with current site-specific trends; and both state and federal requirements. Samples may be subjected to repeat analysis (with dilution if necessary) if any of the above items are not met.

B. If a test is repeated because the initial result fell outside the current trend or exceeded the state or federal requirement, but was within control limits, only the initial test results will be reported.

C. If the test was repeated because the QCS were outside the control limits, only repeat analytical results whose QCS were within control limits will be reported.

IX. INTERNAL QUALITY CONTROL CHECKS

1. Quality Control (QC) limits are established for every test for accuracy and precision. QC charts are developed for standard recovery, spike recovery (both accuracy) and range between duplicate samples (precision).

   A. Data is collect on each method for at least thirty (30), but usually sixty, analyses. Separate charts are developed for spike recovery, standard recovery and precision.

   B. Accuracy Standard and spike recovery charts are developed by calculating the arithmetic mean and standard deviation of the test, after discarding outliers. Warning and Control limits are established at ± 2 and ± 3 standard deviations from the mean, respectively.

   C. Precision Precision charts are developed by calculating the arithmetic mean (R) of the range between duplicate analyses and multiplying it by Shewhart's factors of D_3 and D_4 (2.51 and 3.27) to determine the warning and control limits, respectively.

      1) Warning Limit = $(D_3 \times R) = 2.51R$

      2) Control Limit = $(D_4 \times R) = 3.27R$

   Most analyses' precision requirements are based on RPD (Relative Percent Difference) and are set at ± 10%. Precision acceptance criteria for extreme low level results:

   Phosphorus: For samples with average result ≤ 0.10 mg/L RPD must be ≤ 20%.

   Suspended Solids: For samples with average net result <1.0 mg, Δ or the difference between duplicates, must be ≤ 0.25 mg to pass QC.

   To avoid problems of decreased precision due to sample dilutions, the ranges between duplicate absorbencies may be used for colorimetric analyses and the range between duplicate net weights will be used for gravimetric analyses. Titrimetric analyses may use the range between duplicates' titrant volume.

X. QUALITY CONTROL SAMPLES

1. <u>Source</u> Routine quality control samples (QCS) are prepared by STPUD laboratory personnel, obtained from the EPA or purchased from laboratory supply vendors. QCS are used to determine the accuracy of laboratory methods of chemical, physical and biological analyses and to ensure the instrument is operating properly.

   A. STPUD QCS samples are prepared as described in the section titled **<u>REAGENTS</u>**.

   B. Bacterial QCS samples are obtained commercially.

2. <u>Quality Control for Routine and Non-routine Samples</u>

   A. All routine and non-routine samples reported for NPDES and State Health requirements will follow QCS guidelines. Sample analysis will be repeated if QCS fall outside established limits. All samples whose tests results are to be used for planning purposes, contractual agreements, customer complaints, etc., will also have their analyses repeated until the QCS fall within acceptable limits.

   B. Routine and non-routine samples whose analytical results are used in-house by STPUD personnel, only, are not required to follow QCS guidelines, though it should always be attempted. These types of samples include Primary, Secondary, Pond effluents, centrifuge feed, centrate, and cake sludges, aeration basin liquors, etc. Such samples are not required to have the analyses repeated if the QCS fall outside acceptable limits. It is up to the analyst to determine if such data is acceptable to be reported to STPUD personnel. Such data should always be reported with the explanation that there may be error in the result.

3. <u>Frequency of Analysis of QCS</u>

   A. Every analysis will be run with some or all types of QCS. The following schedule will be followed for the analysis of QCS.

      1) <u>Standards</u> For each method, which specifies the preparation of standards, at least two standards shall be run with each batch of samples (BOD will be run with three (3) check standards). The standards used should cover both the low and high end of the sample concentration range. If any of the standards fall outside the established control limits the samples will be re-analyzed until the standards are within limits.

         1. For methods requiring a graph at the time of analysis, a curve with at least three (3) standards will be run for each batch of samples.

         2. When an automatic instrument is used for analysis, a calibration check standard will be run immediately after the calibration, and after every 10 samples. The results of each sample set (every 10 samples) will be approved if both the beginning check standard and ending check standard for each sample set is no more than ±10 per cent of the true value of the check standards.

2) External QCS standards Standards from a source not used to develop the calibration curve will be analyzed immediately after the calibration. Analysis will proceed only if the result of the External QCS is less than ±10 percent of the true value.

3) Duplicates At least one set of duplicates will be run with each batch of samples, or every 10 samples, for every analytical method. The range between duplicate analyses allows the analyst to determine the reproducibility of the test method.

   1. For spectrophotometric analyses, the range between duplicate calculated results will be used. In gravimetric analyses (Suspended Solids and Total Dissolved Solids) the net weight difference, in milligrams, will be used. This will negate the effect of increased error due to sample dilution. If the range between duplicate samples falls above the upper control limit the samples will be re-analyzed until the control limits are met.

4) Performance Evaluation Samples (PE) PE samples, from either commercial suppliers or from U. S. EPA PE studies, will be run at least annually for both water and wastewater methods. These will aid in determining whether internal laboratory error has developed.

5) Spikes Spiked samples or Laboratory-Fortified Matrix (samples with a measured amount of standard added also called LFMs) will be run with each batch of samples, or every 10 samples. The recovery of the standard is determined after the amount of analyte contributed by the sample is subtracted from the final result. This enables the analyst to determine if the sample has constituents (matrix effects) that may interfere with the test method.

   1. The percent recovery of the added standard should fall within established limits. The samples should be repeated if the limits are exceeded. The formula for spike recovery is:

$$\%\text{Recovery} = 100\% \times \left[\frac{(\text{Spike}\,\mu\text{g/mL} \times \text{Total mL in Spike}) - (\text{Sample}\,\mu\text{g/mL} \times \text{Total mL Sample in Spike})}{(\text{Standard}\,\mu\text{g/mL} \times \text{Total mL Standard in Spike})} \right]$$

6) Method Blanks A method blank will be run with each batch of samples. For colorimetric methods the spectrophotometer will be zeroed against the method blank and all subsequent readings compared to the zeroed method blank. The absorbency of the method blank should be compared to a deionized water blank and recorded. Instrument malfunction, reagent deterioration and improper methodology can be detected by uncharacteristic method blank absorbencies.

   1. Blanks will be run with suspended solids and total dissolved solids tests for information purposes only. The sample results will NOT corrected by the Blank values. Filter blanks usually have a negative value due to filter loss.

7) Reagent Blanks When an automatic instrument is used for analysis,

blanks will be run immediately after the calibration, and after every 10 samples for drinking water compliance samples and after every 20 samples for wastewater compliance samples and at the end of the analysis. The results of each sample set (every 10 or 20 samples) will be approved if both the beginning blank and ending blank have no detectable analyte. Ifanalyte is detected in the either of the blanks, the reporting limit will be adjusted to the amount detected in the highest blank.

8) Travel Blanks Travel blanks are sample bottles filled at the Laboratory with deionized water. The travel blanks' bottles and preservative will be the same as those of the field samples. Travel blanks are useful in determining if sampling methods, sample bottle preparation and sample preservation and storage are properly conducted.

    1. A travel blank will be analyzed with each batch of field samples for every constituent the field samples are tested for.

4. Quality Control Sample Requirements for Test Methods

A. The types of QC samples required for each method are listed in the table below:

Minimum Quality Control for Test Methods

Test	Method	Method Blank	Duplicate	LFB	LFM	LFM Dup
Alkalinity	SM-2320 B - 1997		X			
Ammonia-N	EPA 350.1	X	X	X	X	
BOD	SM-5210 B - 2001	X	X	X	X	
Boron	SM-4500 B-B - 2000	X	X	X	X	X
Bromide	EPA 300	X	X	X	X	
Calcium	SM-3111 B - 1999	X	X	X	X	X
Calcium, Titrimetric EDTA	SM-3500 Ca-B - 1997	X	X	X	X	
Chloride	EPA 300	X	X	X	X	X
Chlorine	SM-4500 Cl-D – 2000 SM-4500 Cl-G - 2000	X X	X X	X X		
Conductivity	SM-2510 B - 1997		X	X		
Color	SM-2120 B - 2001		X			
Hardness	SM-2340 B, C - 1997	X	X	X	X	
Metals, Flame	SM-3111 B-1999	X	X	X	X	X
Metals, Graphite Furnace	SM-3113 B-2004	X	X	X	X	X
Nitrate-N	EPA 300	X	X	X	X	
Nitrite-N	EPA 300	X	X	X	X	
Odor	SM-2150 B -1997	X	X			
Oxygen	SM-4500 O G - 2001					
pH	SM-4500 H+ - 2000		X			
Phosphate, ortho	EPA 300	X	X	X	X	
Phosphorous, Total		X	X	X	X	
Sulfate	EPA 300	X	X	X	X	
Suspended Solids, SS	SM-2540 D-1999		X			
Total Dissolved Solids, TDS	SM-2540 C-1999		X			
Total Kjeldahl Nitrogen, TKN	EPA 351.2	X	X	X	X	
Total Nitrogen	USGS - Report 03–417	X	X	X	X	
Turbidity	EPA 180.1	X	X	X		

LFB	Laboratory -Fortified Blank (Check standard)
LFM	Laboratory –Fortified Matrix (Spiked sample)
EPA:	*Methods for the Determination of Inorganic Substances in Environmental Samples*, 1993 edition
SM:	*Standard Methods of Water and Wastewater Analyses*

5. Performance Evaluation Testing

A. The STPUD Laboratory participates in several performance evaluation testing programs:

   1) Wastewater Laboratory Performance Evaluation Studies (annual).

   2) Drinking Water Laboratory Performance Evaluation Studies (annual).

B. Samples or each PE program type are received once at least once a year from a provider approved by the California Environmental Laboratory Accreditation Program (ELAP) and run along with routine samples. The results of annual PE samples are analyzed by STPUD Laboratory staff to determine the following:

   1) Does the STPUD Lab meet ELAP method approval requirements
   2) Methods are being properly performed.
   3) Reagent quality is satisfactory.
   4) Laboratory equipment is operating properly.

C. If the results of STPUD Laboratory test method fall outside acceptable limits, the method is closely scrutinized to determine the source of error.

D. When a PE result fall outside the acceptance limits, the test must be reviewed and the cause of the error fixed or removed. After the method review and fix another PE sample must be analyzed and passed. A summary of the steps used to assess the problem can be found in Section XII. CORRECTIVE ACTION.

E. **XI. ASSESSMENT OF PRECISION AND ACCURACY**

1. Data quality may be assessed in terms of precision, accuracy, representativeness, comparability (fitting ongoing trends), and completeness. The first two are assessed in quantitative terms, while the latter three are generally expressed as qualitative characteristics. The STPUD laboratory performs tests on most sample sites at least quarterly and has developed summaries displaying the analytical trends for most sites. Results should always be compared with historical trends to help determine if re-analysis should be performed.

2. Precision and accuracy data are documented and assessed through quality control charts as discussed in Chapter IX, INTERNAL QUALITY CONTROL CHECKS.

3. Precision is the agreement among a set of replicate measurements without knowledge of the true value. It is the degree to which a measurement is reproducible. Precision, expressed as Relative Percent Difference (RPD), is determined for each laboratory method by analyzing a number of duplicate pairs, or matrix-spiked duplicate samples. It can also be expressed as Relative Standard Deviation (RSD) when replicates of the same sample are analyzed, or laboratory control samples are routinely analyzed.

4. Accuracy is a measurement of how close the result is to the true value. Each laboratory method has its accuracy of measurement established by analyzing QC check samples (check standards, spiked samples, standard reference materials from a reliable source, etc.). The results of the QC samples are correlated to documented, certified values. Results of check standard and spiked samples are calculated as Percent Recovery. Actual Percent Recovery is compared to established reference data. The degree of closeness of the QC check sample contributes to the general assurance that the accuracy of the data is within acceptable limits.

XII. CORRECTIVE ACTION

1. Laboratory events and data that fall outside established acceptance criteria may require investigation or corrective action. The corrective action implemented depends on the type of analysis, the extent of the error, and whether the error can be determined and corrected. The purpose of the corrective action is to resolve the problem and to restore the system to proper operation. Investigative steps and corrective actions implemented are documented.

2. The initial corrective action procedures may be handled at the bench level. The analyst reviews the sample preparation for possible errors and checks the instrument calibration, calibration standards, spike solutions, instrument sensitivity, etc.

3. If the error cannot be resolved by the analyst, the Laboratory Director has the responsibility of resolving the problem with assistance from the analyst.

4. The corrective action adopted may be determined by the analyst or the Laboratory Director, or through a consensus. However, the final decision for corrective action rests on the Laboratory Director. An accurate and up-to-date record of corrective actions taken shall be noted on the worksheet or instrument report. The Laboratory Director shall periodically review corrective action records and plan for system improvement by involving analysts

5. General guidelines for initiating a corrective action response:

   A. Identify/define the problem.
   B. Assign responsibility for investigating the problem.
   C. Investigate and determine the causes.
   D. Develop corrective action to eliminate the problem.
   E. Measure the effectiveness of the corrective action.
   F. Analyst and Laboratory Director meet to review and evaluate the process, if necessary.
   G. Document the process on the worksheet, instrument report, or in a separate report.
   H. Notify other analysts of what was found.

XIII. REAGENTS

1. Grades

A. Reagents used in all analyses shall be at least ***Analytical Reagent Grade***. The term ***Analytical Reagent Grade*** is synonymous with ***ACS Analytical Reagent Grade*** and ***Reagent Grade***. In all cases, the method's specified reagent grade will be used. In methods where no reagent grade is specified, ***Analytical Reagent Grade*** will be used.

B. Special grades of reagents are required for specific analyses:

1) Metal Analyses
    1. ***Ultrex, Ultrex II***, or ***Trace Metal Grade***

2) Organic Analyses
    1. ***Ultra Resi-Analyzed Reagent, HPLC*** or ***Pesticide Grade***

C. Reagents will be purchased from reliable sources, i.e.: GFS, JT Baker, Fisher Scientific, Aldridch, and Sigma.

2. Preparation

A. Prepared solutions will be logged into the Laboratory Log Book with the following information:

1) Date of preparation.
2) Initials of preparer.
3) Solution's name (in red).
4) Solutions code, if applicable.
5) Names of each reagent used in solutions' preparation.
6) Reagents' manufacturer, manufacturer's catalog number, and lot number.
7) Weight or volume of each reagent used in preparation.
8) Special instructions such as: *filtered through 0.45* μ*m filter*
9) Purpose of prepared solution.
10) Concentration of solution, if a standard (i.e.: 10 ppm COD)

B. Solutions will be prepared with STPUD deionized water. The resistance of the deionized water shall be at least 10 megohms.

C. All prepared reagents' bottles will be labeled with date of preparation and preparer's initials. Solutions will be checked regularly for indications of deterioration: discoloration, precipitates, bacterial and algal growths.

D. Primary standards will be obtained from a reliable source, dried, accurately prepared using Class A calibrated volumetric pipets, graduate cylinders and flasks. Prepared primary standards will be stored in containers that will not alter the reagent.

3. Standardization

A. All standardizations will be conducted using a minimum of three titrations. Prepared standards will be labeled with the date of preparation, preparer, and standard code. Percent recoveries of the standards will be checked regularly and the standard discarded when the recovery falls outside the established control limits.

4. Storage

A. Use polypropylene, or polyethylene bottles; or borosilicate glass bottles with ground glass stoppers for storage of most prepared reagents. Only use plastic (polyethylene, polypropylene, etc.) containers for alkaline solutions such as sodium hydroxide (NaOH). Do not use plastic containers for organic reagents. Amber glass bottles should be used to store light sensitive reagents. Light sensitive reagents should be stored in a dark, cool place.

B. When not in use reagent bottles should be kept stoppered to prevent evaporation and resultant change in concentration.

C. Do not store incompatible chemicals together (i.e.: oxidizers and flammable liquids).

D. Purchase chemicals in safety containers (plastic-coated bottles) whenever possible.

E. Large quantities (1-gallon or more) of flammable liquids will be stored in the yellow Flammable Liquids cabinet, located outside the Laboratory's north-east door.

XIV. WEIGHING

1. General Instructions:

   A. Weighing of samples and chemicals should be conducted in an area free of dust, thermal convection currents and drafts. Use the appropriate balance for the item to be weighed. Large masses requiring a sensitivity of ≥ 0.01 grams should be weighed on the top loading balance. Masses requiring a sensitivity ≥ 0.01 milligrams should be weighed on the analytical balance.

      1) Level the balance

      2) Make sure the balance is calibrated. Balances must be calibrated annually by a certified technician.

      3) Keep balance and area around balance clean and free from dust.

      4) Handle all masses with forceps, never with fingers. Place all masses as close as possible to the center of the pan

      5) Make certain the mass has cooled to room temperature. Place all hot masses in a desiccator to cool to room temperature prior to weighing. Check to make certain desiccator has fresh desiccant. Chemicals used for standards should be dried at 104 ˚C for at least 2 hours and cooled in a desiccator to room temperature before weighing.

      6) Press all display-function buttons smoothly with finger. This will prevent jarring of balance. **Do not use pointed objects to press display-function buttons**.

      7) Do not overload balance

      8) Never place moist objects or chemicals directly on the balance pans.

      9) Close balance doors (if part of balance) when weighing.

      10) Do not lean on balance table as this may affect the balance's accuracy.

      11) Make certain balance has stabilized before recording mass. Even though the electronic balances have a stabilization indicator, wait until reading is consistent for at least 10 seconds before recording mass.

      12) Record mass on worksheet. Never try to remember mass for future recording. Do not write on balance table.

   B. Errors in Weighing: Changes in moisture or CO_2 content can cause problems. Some materials take up H_2O or CO_2 from the air during weighing. Warm objects will cause convection currents than may cause the pan to be buoyed up, causing the mass to weigh less than the true mass. Static electricity may cause problems to the balance.

XV. QUALITY ASSURANCE REPORTS

The Laboratory Director keeps the laboratory staff (Lab Technicians, Laboratory Assistants, and Laboratory Aides) abreast of quality assurance issues in laboratory operations through meetings, email memos, and reports. Typical reports may include internal system audit findings with recommended corrective actions, annual assessment of the Quality Assurance Program, and summary of laboratory proficiency in external Performance Evaluation QA Study Programs. Additional information is also provided through ongoing discussions and dialogues with laboratory staff.

Laboratory proficiency in external Performance Evaluation QA Study Programs include test results, acceptable ranges, corrective actions required, if any, and recommendations. A copy of this report is shown to the Laboratory Technicians.

XVI. CALIBRATION AND MAINTENANCE OF INSTRUMENTS

1. All Laboratory equipment will be maintained on a routine schedule. A maintenance log book will be kept with records of calibration and maintenance. Instruments requiring daily calibration will have monthly log sheets attached to the instrument. These log sheets will be kept on file for a minimum of five years.

2. Equipment operation manuals will be filed in the Laboratory office file cabinet for easy access to all analysts and instrumentation techs.

3. Following are the procedures for calibration of balances, D.O. meters, spectrophotometers, pH meters, and automatic samplers

LABORATORY WATER SYSTEM

1. The laboratory has three types of water: tap or community (#1), Type II (single-stage deionized water) and deionized water (DW or multi-stage deionized water).

   A. Tap water is groundwater that has been treated with chlorine, corrosion inhibitors and sequestering agents. Tap water, both cold and hot, is used for preliminary cleaning of laboratory equipment. Detergents are used with tap water. Tap water can also be used for the preliminary rinse of laboratory equipment. Tap water cannot be used for the final rinsing of lab equipment, to prepare reagents, nor bacterial culture media.

   B. Type II water is ≥1 megohm water. It is tap water that has had the chlorine removed with an activated carbon filter, minerals removed with single-stage deionization. Type II water is used to fill the water baths and rinse cleaned glassware after tap water rinsing. It can be used to make chemical solutions used for on-line instruments, such as chlorine analyzers. It is not to be used for lab reagent preparation nor for final rinsing of lab equipment used in metals or organic sampling and analysis.

      1) The electrical conductivity of the Type II water is measured daily. The Type II water unit should be serviced when the EC is ≤ 1.0 µmhos for two successive days.

   C. DW water is ≥ 10 Megohm water. It is RO water that has gone through organic removal, demineralizer, and sub-micron (0.2 µm) filters. It is used for reagent preparation and final rinsing of equipment used in metal and organic sampling and analysis.

      1) The electrical resistance of the DW is measured daily. The complete set of cartridges should be replaced when the resistance is •10 Megohms. The 0.2 µm filter should be replaced when the HPC is ≥ 10 CFU.

2. **Type II Water and Deionizer Cartridge Replacement**

   A. The following instructions are for the Siemens Type II and Barnstead E-Pure units.

3. **<u>Siemens SDI-01 Type II Water</u>**

   1) Unplug Inlet Influent line solenoid valve.
   2) Turn off Influent and Effluent water lines.
   3) Open needle drain valves to drain water. Close when lines are drained
   4) Remove Tank #1 (used tank) and place next to door for pickup.
   5) Move DI Tank #2 to Tank #1 position. Make sure to switch In-line 200 K ohm light to Tank #1 Effluent side (position between Tank #1 and Tank #2).

6) Place new tank in Tank #2 position.
7) Secure all connections. Tighten ONLY HAND TIGHT.
8) Make certain needle drain valves are closed.
9) Turn on both Influent and Effluent Water lines.
10) Plug in Inlet Influent line solenoid valve electric plug.
11) Log gallons meter reading and tank change
12) Call for new tankMembrane Installation

4. **E Pure**

A. Replacement of full set of cartridges: Instructions can be found in each replacement kit of cartridges (contains all 4 cartridges), not in single cartridge boxes. When removing old cartridges, drain canisters of water and rinse prior to cartridge replacement.

1) Remove 1st cartridge (left-most canister)
2) Replace first cartridge (left-most canister).
3) Remove final filter (0.2 µm)
4) Leave remaining old cartridges in place.
5) Turn system on.
6) Run to drain for 15 minutes.
7) Shut system off.
8) De-pressurize system
9) Replace cartridges in last three canisters.
10) Turn system on.
11) Run to drain for 5 minutes
12) Replace final filter (0.2 µm filter).
13) Flush 2 liters prior to use.

STANDARDIZING SPECTROPHOTOMETER
TEST PROCEDURES

Using the HACH DR4000 and Spectronic Spec Standards

A. <u>0% Transmittance Test</u>

1. Install the Single-Cell module. Turn on the UV lamp.

2. Select the Single λ (wavelength) mode.
3. Select View: %T
4. Insert the Control Standard (the one with no glass) in the instrument.
5. Set the wavelength to 400nm.
6. Set the meter to read 100%T by Zeroing.
7. Turn the control standard 90E to block light path.
8. Record the result, which is the 0%T reading.
9. If the 0%T reading exceeds tolerances, correct it by repeating steps 1 through 4 before proceeding.

B. <u>Stray Radiant Energy Test</u>

1. Select the Single λ (wavelength) mode.
2. Select View: %T
3. Insert the control standard (the one with no glass) in the instrument.
4. Set the wavelength to 400nm.
5. Set the meter to read 100%T by Zeroing
6. Replace the control standard with the SRE (Stray Radiant Energy) 400nm standard. Observe the %T reading and record it on the sheet.
7. Insert the control standard again.
8. Set the wavelength to 340nm.
9. Set the meter to read 100%T by Zeroing
10. Replace the control standard with the SRE 340nm standard. Observe the %T reading and record it on the sheet.
11. Insert the control standard again.
12. Set the wavelength to 220nm. The UV light must be turned on for at least 10 minutes.
13. Set the meter to read 100%T by Zeroing
14. Replace the control standard with the SRE 220nm standard. Observe the %T reading and record it on the sheet.

C. <u>Wavelength Accuracy Test</u>

1. Only those peaks within the wavelength range of the spectrophotometer will be detected by the wavelength accuracy test. The spectrophotometer can detect the three first-order peaks transmitted by the wavelength evaluation standard and automatically block the second-order peak. (On the diagram in the certificate provided with your standards, the first-order peaks are shown as solid lines; the second-order peak is shown by a dashed line.)
2. Select the Scan λ (Scan mode).
3. Select View: ABS

4. Set the Options for λ Min, λ Max and λ Step.
5. Set the λ interval from 395 - 405 nm in 0.1 nm steps.
6. Insert the Control Standard and perform a Baseline by pressing the Baseline soft-key.
7. Insert the 525.3nm wavelength evaluation standard in the cuvette holder.
8. Press the Start Scan soft-key to scan the wavelengths.
9. After scan is completed, press the CURSOR soft-key, then the · ¹ soft-keys to select the λ of maximum absorbance.
10. Record the wavelength (not the absorbance) where this peak is found. This wavelength should match the certified wavelength within the tolerances given in table 1.
11. Repeat steps 3-8 using the following parameters:

    a) λ interval from 520 - 530 nm in 0.1 nm steps (for 525.3 nm peak)
    b) λ interval from 777 - 787 nm in 0.1 nm steps (for 782.4 nm peak)

D. **Photometric Accuracy/Linearity Test**

1. Select the Single λ (wavelength) mode.
2. Select View: %T
3. Insert the control standard (the one with no glass) in the instrument.
4. Set λ to 590nm.
5. Using the Control Standard, adjust the instrument to read exactly 100%T by Zeroing.
6. Insert the 45.9 %T590 photometric performance standard. Record the instrument reading. The reading should conform to the tolerances in table 1.
7. Insert the 48.1 %T590 standard. Record the instrument reading. The reading should conform to the tolerances in table 1.
8. Insert the 9.7 %T590 standard. Record the instrument reading. The reading should conform to the tolerances in table 1.
9. Insert the 9.9 %T590 standard. Record the instrument reading. The reading should conform to the tolerances in table 1.

TABLE 1

HACH DR4000

Test	Maximum Acceptable Deviations
Stray Radiant Energy	0 - 0.05%T
Wavelength Accuracy	+/- 1 nm
0 %T	0.0
Photometric Accuracy	+/- 0.5%T

SPECTROPHOTOMETERS

1. This is a description of the procedure for starting up and using a UV/Visible spectrophotometer.

A. STARTUP

1) Remove the dust covers from the spectrophotometer and sample pump.

2) Turn on power to spectrophotometer and sample pump. Power should be turned on at least 10 minutes before readings are to be taken to obtain a stable light source.

3) Secure sample sipper to peristaltic pump.

4) Place sample tubing in a beaker of deionized water and sip up water.

B. OPERATION

1) Set spectrophotometer to analytical wavelength.

2) Make certain instrument is set to ***Absorbency*** or ***Concentration***

3) Set wavelength to desired reading.

4) Place sample tubing in a beaker of deionized water and introduce DI water into sample cell.

5) Set Absorbency to **0.000**.

6) Place sample tubing in reagent blank and depress sipper lever.

7) Read absorbency of reagent blank (compared to deionized water) and record in parentheses.

8) Set absorbency of reagent blank to **0.000**.

9) Wash cell by either sipping deionized water or air (you can also use the next sample to wash cell by sipping two aliquots of sample and take reading of second aliquot.)

10) Place sample tubing in either standard or sample and sipper sample.

11) Wait till absorbency readings stabilize and record result. These results have now been corrected against a reagent blank. Stabilization time is dependant on type of sample but usually takes no more than 10-15 seconds. Some tests, such as Brucine nitrates, can require up to 60 seconds before stabilization is complete.

C. SHUTDOWN

1) Place sample tubing in beaker of deionized water and wash with ten aliquots of water.

2) Disconnect pump tubing from pump.

3) Shut off spectrophotometer and sample pump.

4) Cover pump, spectrophotometer and power unit with dust covers.

ORION DISSOLVED OXYGEN PROBE CALIBRATION

1. The following is a description of the calibration of the Orion 97-08 DO electrode using the Orion 920 Ion Analyzer:

2. Determine barometric reading in mm mercury and divide answer by 100 to obtain mg/L oxygen.

3. Connect Orion DO electrode to electrode 2 on the Orion EA 920 pH meter.

4. Select the **O_2** mode on EA 920 pH meter, using the **mode** key.

5. Select **SAMPLE** function using the **display** key. Press **enter**. Pressing **enter** automatically zeroes the EA 920 and sets slope at 100%.

6. Choose the display resolution, **.1, .01, or .001,** by pressing and holding the **electrode** key while pressing the **x10** key.

7. Turn **mode** switch on electrode to **BT CK**. Good battery operation is indicated by a reading of **13.00** or greater on meter.

8. Turn **mode** switch on electrode to ZERO. Use zero calibration control to set meter to read **0.00**.

9. Insert funnel into a BOD sample bottle containing enough water to just cover bottom of bottle. Insert electrode, making sure that electrode tip is not immersed in the water and does not have water droplets clinging to outside of membrane. Let stand for 30 minutes to ensure water saturation of air in BOD bottle (if probe has been stored in this bottle there is no need to wait 30 minutes). Also use this bottle for storage between measurements..

10. Turn electrode mode switch to AIR position. Use AIR calibration control to set the EA 920 reading to the prevailing barometric pressure (divided by 100).

11. Turn electrode mode switch to **H_2O** for sample measurements.

SIRCO AUTOMATIC SAMPLER CLEANING

1. This is a description of the procedures to routinely clean SIRCO automatic samplers.

   A. Equipment

      1) Deionized water in 1 liter spray bottle
      2) Clean measuring chambers, if required
      3) Test tube brush
      4) Bottle brush (large diameter)
      5) Rags or paper towels (2 or 3 rags or 10 paper towels)
      6) Rubber gloves. A face shield is not a bad idea, either.
      7) Bucket

   B. It is a good idea to remove anything that might fall out of your lab coat, such as pens, forceps, etc. This is because the floor by the sampler is a grating.

   C. Procedure

      1) Open refrigerated sample compartment and remove sample bottle. Place bucket under sample outlet hose.

      2) Open door of sampler control panel. Turn off sampler with master **POWER** switch. Remove the two (2) wing-nuts at the top of the measuring chamber. Carefully set nuts to one side of compartment.

      3) Lift up chamber top and remove measuring chamber from below. Clean inside of chamber with brush and rags (or replace with clean measuring chamber). Use spray bottle to rinse scum into bucket.

      4) Wipe off stainless steel tubes on bottom of measuring chamber lid with a paper towel or rag. Use tube brush to clean inside of discharge tube and sample lines.

      5) Re-assemble unit, making sure chamber rests correctly on O-ring and replace wing nuts.

      6) Make certain obstructions (rags) are removed from intake hose in sample stream.

      7) Turn **POWER** switch ON and hit **RESET** and then the **MANUAL** sample button. Watch sample cycle (about 1-2 minutes). Make sure O-ring does not leak and final sample volume is less between 50 and 75 mL. Repeat this one more time. This will clean the sample outlet hose.

8) If sampler is set for ***Proportional/Flow***, adjust counts as follows:

Desired action	**Count Control**
Increase sample jug volume	Decrease counts
Decrease sample jug volume	Increase counts

9) Remove bucket from refrigerated sample compartment and replace the sample jug.

10) Record cleaning on sample composite log and initial.

GENERIC AUTOMATIC SAMPLER CLEANING

1. This is a description of the procedures to routinely clean automatic samplers.

   A. Equipment

      1) Deionized water in 1 liter spray bottle
      2) Test tube brush
      3) 600 mL beaker
      4) Bottle brush (large diameter)
      5) Rags or paper towels (2 or 3 rags or 10 paper towels)
      6) Rubber gloves. A face shield is not a bad idea, either.
      7) Bucket

   B. It is a good idea to remove anything that might fall out of your lab coat, such as pens, forceps, etc. This is because the floor by the sampler is a grating.

   C. Procedure

      1) Open refrigerated sample compartment and remove sample bottle. Place bucket or beaker under sample outlet hose.

      2) Wipe all surfaces with damp rag.

      3) Clean all dippers, tubing, funnels and discharge outlets with brush.

      4) Rinse all dippers, tubing, funnels and discharge outlets with deionized water.

      5) If present, remove plastic dams and allow sample flow to scour flow channel clean.

      6) Replace dams, if present.

      7) Make certain obstructions (rags) are removed from any intake hoses in sample stream.

      8) Make certain mode switch is set for proper setting (***Proportional*** or ***Flow*** for Raw and Final samplers, ***Time*** or ***Constant*** for Primary and Secondary effluent samplers).

      9) Adjust flow of sample stream, if it is controlled by valve. Make certain flow through models have flow stream high enough to fill dipper during sample episode.

10) If sampler is set for ***Proportional/Flow***, adjust counts as follows:

Desired action	**Count Control**
Increase sample jug volume	Decrease counts
Decrease sample jug volume	Increase counts

11) Remove bucket from refrigerated sample compartment and replace the sample jug.

12) Record cleaning on sample composite log and initial.

pH METERS

1. STANDARDIZATION

A. All standardizations should use two calibration standards which bracket the sample pH.

B. Make sure pH meter is set for pH mode and the correct electrode is selected.

C. Make certain the pH probe has both the correct electrolyte and sufficient electrolyte. The electrolyte level should be close to the filling hole. This will prevent backflow of sample into the pH probe. If too many crystals are clogging the junction, empty probe of internal filling solution, rinse several times with DI water, the two times with electrolyte. Consult electrode manual for further information of electrolyte maintenance. Fill probe with electrolyte.

D. Rinse electrodes with deionized H_2O and place in pH 7.00 buffer. When reading indicates a stable reading press enter.

E. Rinse electrodes with deionized H_2O and place in pH 10.00 or 4.00 buffer. When reading indicates a stable reading press enter.

F. Record standards used and slope on pH standardization QA form.

2. SAMPLE MEASUREMENT

A. Rinse electrodes with deionized H_2O and place in sample. Make certain mode is **pH** and meter is on.

B. When making pH measurements in the laboratory, place a Teflon stir bar in the sample container (usually a beaker) and place sample on magnetic stir plate. Set stir speed so that sample does not splash out of beaker.

C. Press the button to measure pH (this may be ***pH***, **=**, or **Read**)

D. Once the meter and electrode has reached a stable reading (indicated by a prompt such as ***Ready*** or some other symbol) record the reading.

E. To make next measurement repeat steps 1-3.

3. These meters never go wrong. If there is a problem, 99.9999999 % of the time it is a faulty electrode. However, check that the battery is good.

A. Check that the filling solution inside the electrode is higher than the level of the sample.

B. Determine if there are too many crystals forming inside the electrode. Use pipet to remove overly-saturated KCl solution, rinse with DI water. Rinse with fresh fill solution, then refill with fill solution.

C. Is the fill-hole covered (it shouldn't be).

D. Try alternately soaking in dilute (0.1 N) HCl and NaOH in one minute intervals.

E. Clean or replace ceramic junction.

F. Soak in 80 ˚C water for 5 minutes.

APPENDIX A
Sample Preservation

SAMPLE PRESERVATION AND HOLDING TIMES

Test	Bottle Type	Minimum Sample, mL	Sample Type	Preservation	Maximum Holding Time
Acidity	P, G	100	g	≤ 6• C	14 d
Alkalinity	P, G	500	g	≤ 6• C	14 d
BOD	P, G	1,000	g	≤ 6• C	48 hr
Boron	P	100	g, c	≤ 6• C	6 mo
Bromide	P	100	g, c	None Required	28 d
COD	P, G	100	g, c	H_2SO_4 to pH < 2	28 d
Chloride	P, G	50	g, c	None Required	28 d
Chlorine Residual	P(A), G(A)	500	g	Analyze immediately	Stat
Chlorophyll	P(A), G(A)	500	g	≤ 6• C	30 d
Color	P, G	250	g, c	≤ 6• C	48 hr
Coliforms, Drinking water	P, G, Sterile	100	g	≤ 6• C, in dark, dechlorinate with thiosulfate	24 hr
Coliforms, Wastewater	P, G, Sterile	100	g	≤ 6• C, in dark, dechlorinate with thiosulfate	6 hr
Conductivity	P, G	100	g, c	≤ 6• C	28 d
Cyanide, Total	P, G	500	g, c	NaOH to pH>12, ≤ 6• C in dark	14 d
Fluoride	P	250	g, c	None Required	28 d
Hardness	P, G	100	g, c	HNO_3 to pH < 2	6 mo
Iodine	P, G	500	g, c	Analyze immediately	N.S.
MBAS	P, G	500	g, c	≤ 6• C	48 hr
Metals	P, G	500	g, c	HNO_3 to pH < 2	6 mo
Mercury	P, G	500	g, c	HNO_3 to pH < 2, ≤ 6• C	28 d
Nitrogen					
TKN	P, G	250	g, c	H_2SO_4 to pH < 2	28 d
NH_3-N	P, G	100	g, c	H_2SO_4 to pH < 2	28 d
(NO_3 + NO_2)-N	P, G	100	g, c	H_2SO_4 to pH < 2, ≤ 6• C	28 d
NO_2-N	P, G	100	g, c	≤ 6• C, analyze as soon as possible	48 hr
NO_3-N	P, G	100	g, c	≤ 6• C, analyze as soon as possible	48 hr
Odor	G	500	g	≤ 6• C, Analyze immediately	N.S.
Oil & Grease	G	1,000	g, c	H_2SO_4 to pH < 2, ≤ 6• C	28 d
Oxygen, Electrode	G, BOD bottle	300	g	Analyze immediately	Stat
Oxygen, Winkler	G, BOD bottle	300	g	Analyze immediately, Add reagents	8 hr
pH	P, G	50	g	Analyze immediately	Stat
Phosphate, PO_4-P	P, G	100	g	Filter thru 0.45µ, ≤ 6• C	48 hr
Phosphorus, Total	P, G	250	g, c	H_2SO_4 to pH < 2, ≤ 6• C	28 d
Silica	P	200	g, c	≤ 6• C	28 d
Solids, All types	P, G	500	g, c	≤ 6• C	7 d
Suspended	P, G	500	g, c	≤ 6• C	7 d
Total Dissolved	P, G	150	g, c	≤ 6• C	7 d
Sulfate	P, G	250	g, c	≤ 6• C	28 d
Sulfide	P, G	100	g, c	4 drops 2N zinc acetate/100 mL, ≤ 6• ; add NaOH to pH > 9	7 d
Taste	G	500	g	≤ 6• C, analyze as soon as possible	N.S.
Temperature	P, G		g	Analyze immediately	Stat
TOC	P.G	100	g, c	H_2SO_4 to pH < 2	28 d
TPH	G, A	1,000	g.	≤ 6• C	14 d
Turbidity	P, G	100	g, c	≤ 6• C in dark, analyze same day	48 hr
VOC's / BTEX / 524	G	40	g,	≤ 6• C, HCl to pH < 2	14 d

Bottles: P = Plastic, G = glass, A = amber
Sample: g = grab; c = composite
Stat: Analyze immediately
N.S. Not specified

4• C +/- 2• C; Regulatory is ≤ 6• C

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APPENDIX B

FORMS

Sampling Forms

1. *Field Monitoring Record*
2. *Composite Sample Data (2)*
3. *Composite (manual) Sampling Record*
4. *Samples Tracking Log*
5. *Sample Chain of Custody Record*
6. *Samples sent to Commercial Laboratories Preparation Guide*
7. *Repeat Analysis or Unfinished Analyses*
8. *Metal Analyses Sample Log*
9. *Metals Sample Preparation Log*

Equipment Calibration Forms

1. *Autoclave Temperature Check*
2. *Bacterial Media Preparation & Sterilization (Autoclave)*
3. *Bacterial Working Stock Preparation Log*
4. *Bacterial Pipet Sterilization Record*
5. *Bacterial Reagent Water* Cl_2 Record
6. *Balance Calibration Quality Control Record*
7. *Balance (Analytical) Daily Calibration Record*
8. *Balance (Top Loader) Daily Calibration Record*
9. *BOD Incubator Temperature Monitoring Form*
10. *Coliform Incubator Temperature Monitoring Form*
11. *Coliform Water Bath Temperature Monitoring Form*
12. *Colilert Media, Bottles and QuantiTray Sealer quality Control Record*
13. *E-Pure / Deionizer Water Quality Record*
14. *Field Meters Calibration Log*
15. *Hot Air Oven Sterilization Indicator*
16. *Ion Chromatograph Daily Operations Log*
17. *Ion Chromatograph Standard Preparation Log*
18. *Oven, 104 ˚C Temperature Monitoring Fomr*
19. *Oven, 180 ˚C Temperature Monitoring Form*
20. *pH Check for Ammonia and Total N by USGS Method Worksheet*
21. *pH Check for Direct Analysis by Atomic Absorption Worksheet*
22. *pH Check for Nitrate by Cadmium Reduction Worksheet*
23. *pH Meter Calibration Record*
24. *pH Meter – Flat electrode Record*
25. *Sample Refrigerator Temperature Monitoring For*
26. *Spectrophotometric Spectronic Standards Test Log*
27. *Sterile Sample Bottle Sterilization Record*
28. *Thermometer Calibration Worksheet*
29. *Thermometer (Maximum) Calibration Worksheet*
30. *Turbidimeter Calibration Quality Control Record*
31. *Used Media Sterilization Record*
32. *Weekday Cleanup Schedule*
33. *Weekend Cleanup Schedule*

Test Worksheets

1. *Alkalinity*

2. *BOD WWTP samples*
3. *BOD miscellaneous samples*
4. *Calcium / Calcium Hardness (EDTA)*
5. *Carbon Dioxide by pH and Alkalinity*
6. *Cation Exchange Capacity – Soils*
7. *Chlorine*
8. *Color*
9. *Daily Physical Tests: pH, Turbidity, Settleable Solids, Alkalinity and Chlorine*
10. *Hardness, Total*
11. *Nitrite - Manual Spectrophotometric*
12. *Odor*
13. *pH, Solids, Soils and Wastes*
14. *Phosphorus, Total*
15. *Phosphorus, Ortho*
16. *Phosphorus – Bicarbonate of Soils*
17. *Percent Saturation, pH, Conductivity of Soils*
18. *Suspended Solids*
19. *TDS*
20. *Turbidity*

Bacterial Worksheets

1. *Bacteriological Sampling Instructions*
2. *Wastewater Coliforms Worksheet*
3. *Surface water Coliforms Worksheet*
4. *Drinking Water Weekly Coliform Field / Test Worksheet*
5. *Drinking Water Repeat Coliform Worksheet*
6. *Colilert Worksheet*
7. *Completed Test Worksheet*
8. *Heterotrophic Plate Count Worksheet*
9. *Quality Assurance Worksheet*
10. Bacteriological Working Stock Preparation Log
11. *Reagent Water (E-Pure)* Cl_2, NH_3*-N, and TOC Analyses*
12. *Colilert Media QA Sheet*
13. *API Bacterial Identification Worksheet*
14. *Feelab Drinking Water Colilert Worksheet*